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KUCA Conversion Project - challenges and achievements -

On June 2016, the governments of the United States of America and Japan has agreed to convert Kyoto University Critical Assembly (KUCA), located at Osaka, Japan from highly enriched uranium (HEU) fuel to low enriched uranium (LEU) fuel and to return all HEU fuel materials from KUCA to United States. Based on this mutual agreement, Kyoto University has been working extensively on both the LEU conversion and HEU return of KUCA with close collaboration with USDOE and MEXT and, especially with support from ANL, CERCA and KAERI on the LEU conversion project, which will be focused on this paper.

The Kyoto University Critical Assembly (KUCA) is a multi-core type critical assembly dedicated for the fundamental research and education on reactor physics. KUCA consists of one light-water moderated ("Wet") core and two solid-moderated ("Dry") cores, both currently utilizing highly enriched uranium fuels. Pulsed D-T neutron generator is installed in the reactor building and could be used in combination with one of the solid-moderated core (A-core). 100MeV proton beam from the FFAG proton accelerator complex (installed in adjacent building) together with tungsten or beryllium targets is also available as spallation neutron source in combination with the A-core for fundamental studies on accelerator driven system (ADS). The combination of different core types and neutron sources could be considered as the unique feature of KUCA among the existing critical assemblies in the world.

This LEU conversion project is the first attempt to convert a critical assembly from HEU to LEU. Extensive efforts have been hitherto made to conserve and even extend the capabilities of KUCA experiment after conversion. Preceding the present conversion project, a joint feasibility study on neutronic characteristics of the KUCA LEU cores have been initiated between ANL and Kyoto University, which finally resulted to show the feasibility of converting KUCA with LEU fuel and to preserve the wide variety of neutron spectrum as well as core configuration achievable at the facility. Further investigation in the fuel design resulted to selection of uranium silicide dispersion fuel for Wet core fuel, and uranium molybdenum dispersion fuel for Dry core fuel. The latter posed a significant challenge in coating / cladding technology development to ensure the integrity of the fuel during manipulation for the KUCA operation. Innovative design for Dry core coupon fuel based on "jewelry box"concept has been adopted, which conceals the U7Mo-Al fuel core inside machined aluminum case and aluminum lid fixed by laser welding. Technology development using both surrogate material and depleted U7Mo at CERCA is ongoing.

The Dry core coupon fuel fabrication will be the first experience for UMo based fuel production. In order to facilitate the startup of the fabrication project, KAERI has joined this project as a supplier of the U7Mo atomized powder for industrial production of Dry core coupon fuel; the atomized powder will be fabricated at KAERI using LEU metal supplied by USDOE.

The conversion project is foreseeing the KUCA conversion to be achieved on calendar year 2021. This conversion is expected to be the first critical facility to be converted to LEU and be a significant achievement for nuclear threat reduction and HEU minimization in civilian sector. Moreover, this would be the first critical reactor to be operated by U7Mo based fuel, which shall be providing invaluable scientific data to research reactor conversion community.

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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