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# Concept of multifunctional fast neutron research reactor (MBIR) core with metal (U-Pu-Zr)-fuel

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Multifunctional fast neutron research reactor MBIR is intended to provide the basis for broad scope of research and experimental activities due to achieving 5E15 n/cm2/s integral neutron flux in central loop channel, i.e. MBIR is considered as neutron source of high intensity.
This work focuses on the possibilities of the use of different fuel in MBIR to provide required neutron flux in loop channels and experimental cells without perturbation of the core design. Three options has been investigated: 6 mm diameter fuel pin with vibrocompacted MOX-fuel, with metal (U-Pu-Zr)-fuel and gaseous sub-layer and fuel pin of decreased diameter (5.5 mm) with metal (U-Pu-Zr)-fuel and sodium sub-layer. In the last option the fuel pin structure has been slightly changed: gap filled with sodium resulted in gas plenum arrangement in top part of the fuel pin. In all options considered fuel assemblies contain the same amount of fuel pins and keep their sizes across-flat and height.
It is shown that metal fuel with gaseous sub-layer option enables to decrease reactivity drop over reactor lifetime and keeps acceptable neutron flux in central loop channel. Metal fuel with sodium sub-layer option provides reactivity drop and neutron flux in central loop channel at the level of as-designed vibrocompacted MOX-fuel core option.
Thermo-hydraulic simulation shows that pin cladding temperatures in all three core options meet criteria of reliable heat removal provided design coolant flow rate. Moreover, 5.5 mm fuel pin option provides secure fuel assembly cooling for wide range of power density distribution in the core in case of the linear heat load is limited by 48 kW/m.
Stress-strain behavior analysis shows that metal fuel with sodium sub-layer and MOX-fuel options demonstrate appropriate stress-strain conditions of the fuel pin during burnup. Taking into account irradiation embrittlement of austenitic steels under high fluence and circumferential strain exceeding 2%, tangential stresses developed in cladding of MOX and metallic fuel pins don't exceed maximum permissible value of 200 MPa up to damage dose of 80 dpa.
The studies have shown the use of metallic fuel in the pins of decreased diameter in the MBIR core meets design requirements on operability and extends the reactor experimental performance for end user due to improved neutron balance and enlarged thermal-hydraulic margins.

## Country/Int. Organization

Russian Federation, National Research Center "Kurchatov Institute"

**Primary author:** Mr BLANDINSKIY, Victor (NRC "Kurchatov Institute")

**Co-authors:** Mr FROLOV, Aleksei (NRC "Kurchatov Institute"); Mr SEDOV, Aleksei (National Research Centre "Kurchatov Institute"); Mr SUBBOTIN, Aleksei (NRC "Kurchatov Institute"); Mr STEPANOV, Alexander (NRC "Kurchatov Institute"); Mr TIMOSHINOV, Andrey (NRC "Kurchatov Institute"); Ms LUBINA, Anna (NRC "Kurchatov Institute"); Mr ZIZIN, Mikhail (NRC "Kurchatov Institute"); Mr ALEKSEEV, Pavel (NRC "Kurchatov Institute"); Mr FOMICHENKO, Peter (NRC "Kurchatov Institute"); Mr SUBBOTIN, Stanislav (NRC "Kurchatov Institute"); Mr NEVINITSA, Vladimir (NRC "Kurchatov Institute")

**Presenter:** Mr BLANDINSKIY, Victor (NRC "Kurchatov Institute")

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