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Neutronics Characterization of a High Density Uranium Zirconium Carbon Nitride LEU Fuel

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ABSTRACT

A high density nuclear fuel for high temperature reactor applications has been under development in Russia for several decades. As a part of this fuel testing activities under the Russian Research Reactor Fuel Return (RRRFR) Program, the GIACINT and CRYSTAL critical facilities of Belarus has been used to determine its neutronics characteristics. The fuel material is uranium zirconium carbon nitride ($U_{0.9}Zr_{0.1}C_{0.5}N_{0.5}$) with 11.9 g/cm^3 density and 19.75% uranium-235 enrichment. The uranium density of this fuel material is 10.8 g/cm^3. The fuel pellets are packed in stainless steel or niobium alloy cladding. The GIACINT and CRYSTAL critical facilities are designed to operate with different configurations using different moderator and reflector materials. The criticality condition can be set by varying the liquid level if liquid is used as a moderator material or using the facility control rods. The facility control system design allows to operate without distributing the geometrical configurations since the control rods
have followers matching the fuel, the moderator, or the reflector material. Several detectors are used for measuring the neutron flux. Critical and subcritical configurations using this fuel have been examined experimentally and/or analytically. GIACINT experiments with water moderator have been performed and analyzed. GIACINT and CRYSTAL critical facilities are being prepared to perform critical and subcritical experiments simulating fast reactors and fast accelerator driven systems using gas and liquid- metal coolants. The results include the effective multiplication factor, the delayed neutron fraction, the neutron generation time, and the sensitivity coefficients. Different computational programs and nuclear data libraries were utilized and the experimental and the analytical results were compared.