Benchmarking of Uranium-238 Evaluations Against Spherical Transmission and (n,xn)-Reaction Experimental Data

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The neutron leakage spectra from Uranium-238 sphere of 24 cm outer and 8 cm inner diameters were measured at the Institute of Physics and Power Engineering with the central fusion and fission type neutron sources. 14 MeV neutrons were produced by the pulsed D-T neutron generator KG-0.3, whereas fission neutrons by the ^{252}Cf fast ionization fission chamber. The spectra of leaking neutrons were measured by the time of flight technique at flight path 4 m by a fast scintillation detector having the neutron threshold of 0.2 MeV.

Double differential neutron emission cross section from ^{238}U(n,xn) reaction were measured at 14 MeV incident neutron energy employing the same experimental technique but a hollow cylinder uranium sample with diameter of 4.5 cm, wall thickness 0.3 cm and height 5 cm. The neutrons with energies above 0.5 MeV were detected at angles 30 to 150 degrees. Elastically scattered neutrons were subtracted from the energy spectra using the shape of the D-T source neutrons.

The experimental data were analysed by Monte-Carlo technique using the MCNP-4C code. A detailed three-dimensional model was elaborated to represent the neutron source, uranium sphere or sample and neutron detector. The corrections have been applied for the time-of-flight measurement technique, the response function of spectrometer in the case of neutron transmission experiment and for the multiple neutron scattering in the case of the U(n,xn) reaction measurement.

The neutron leakage spectra from U sphere with D-T and ^{252}Cf neutron sources and U(n,xn) double differential cross sections at 14 MeV were compared with the transport calculations and the ENDF-B7 (preliminary version), JINER ('Maslov' evaluation), ENDF-B6, JEFF-3 and ENDL-85 libraries. It was found that the latest evaluations (ENDF-B7 and JINER) predict leakage spectra and emission cross section within 10-15% that is clearly less than earlier versions or libraries do.

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