



Contribution ID: 38

Type: oral

Application of Passive Gamma-ray Spectroscopy for Special Nuclear Material Accountancy in Molten Core Material of Fukushima Daiichi Nuclear Power Plant

Wednesday 22 October 2014 16:00 (20 minutes)

For the nuclear material accountancy of molten core material in Fukushima Daiichi unit 1, 2 and 3, feasibility studies of variety of technologies are being performed in JAEA. As one of the technologies, feasibility study of passive gamma spectroscopy of low-volatile fission products (FPs) for nuclear material accountancy in molten core material has been performed with reviewing TMI-2 experience, and the correlation of actinides and FPs inventory in BWR spent fuel was reported, considering the sensitivity of axial neutron spectrum, void, burn-up, enrichment distribution unique to BWR fuel.

In the present paper, numerical simulation of leakage gamma-ray from molten core materials in hypothetical canister is dealt with for determination of radioactivity of low-volatile high-energy emission FPs, which could be utilized for special nuclear material (SNM) quantity estimation coupling with SNM/FPs ratio derived from core inventory calculation. The model of canister is assumed based on the fuel type one in used TMI-2 for gamma-ray leakage calculation, with 3 main geometrical regions; canister, surrounding water/air and shielding/collimator for detectors. Homogeneous loading model of molten core material and water/air is taken as a reference model as same as TMI-2 core bore cases, and patterns of loading model are also evaluated, and the effectiveness of several attenuation correction techniques and the detector applicability are compared.

The coexistence of SNM and index FP is essential condition in case of using this methodology. As a consideration, even with their low-volatility of, for example, lanthanides such as cerium and europium, small but non-zero volatility, local migration inside debris and dissolution to cooling water must be considered.

Country or International Organization

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Session Classification: Challenges in Spent Fuel Verification