



Contribution ID: 54

Type: Oral Presentation

Comparison of calculated and measured radionuclide inventory of a Zircaloy-4 cladding tube plenum section

Monday, 30 October 2017 17:30 (15 minutes)

Cladding tubes of water-cooled nuclear reactors are usually made of Zircaloy and are an important retaining element for radionuclides present in the fuel. However, cladding integrity is affected by various processes during reactor operation and beyond, e.g. oxidation, hydrogen uptake, PCI, fission product precipitation, alpha-decay, and radiation damage. Using experimental and modelling methods, the radionuclide inventory of an irradiated Zircaloy-4 plenum section is analyzed.

Quantities of U-235/238, Np-237, Pu-238/239/240/241/242, Am-241/243, Cm-243/244 besides C-14, Fe-55, Sb-125, Cs-134/137 were (radio-)chemically determined in digested Zircaloy-4 subsamples. Measured inventories of activation products in the Zr-alloy are in good agreement with calculated values. However, amounts of actinides and fission products exceed the calculated inventory by factor ~50 (Pu isotopes) and ~120 (Cs-137). Excess Pu and part of excess Cs inventory originate from fuel residues on the inner cladding surface, whereas vast amount of cesium is volatilized from subjacent fuel pellets and transported to the plenum.

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Session Classification: Spent Fuel & Zircaloy Cladding

Track Classification: National and international collaborative waste management programs