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# FIRST-Nuclides

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## Status of dissolution based fast/instant radionuclide release studies

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## Introduction

This report summarizes the progress made in Work Package 3 of FIRST-Nuclides in the second year of the project. The laboratories that participate to WP3 are the Belgian Nuclear Research Centre (SCK•CEN), the Paul Scherrer Institute (PSI), the Karlsruher Institut für Technologie (KIT), Studsvik Nuclear AB (STUDSVIK), the Joint Research Centre – Institute for Transuranium elements (JRC-ITU), the Fundacio CTM Centre Tecnologic (CTM), and the Hungarian Centre for Energy Research (EK).

The overall objective of WP3 is the quantification of the fast release of radionuclides by means of leach tests with spent nuclear fuel, and – to the extent possible – the determination of their chemical speciation. Such leach tests are performed by SCK•CEN, PSI, KIT, STUDSVIK, ITU and CTM. The experiments are done with PWR fuels having a burnup in the range of 50 to 70 MWd.kg<sub>HM</sub><sup>-1</sup>, with BWR fuels of 42-59 MWd.kg<sub>HM</sub><sup>-1</sup>, and a MOX fuel of 63 MWd.kg<sub>HM</sub><sup>-1</sup> (average burnups). As a complement to the leach tests performed on fuel samples under controlled laboratory conditions, the leaching behaviour of damaged and leaking VVER fuels is studied by EK.

## Status after 24 months

The first year (2012) had been used to define the detailed experimental matrix and to prepare the leach tests and analytical methods. The sample preparation methods, leachant composition and analytical methods had been discussed between the participating institutes, to come to an optimal program in which the various contributions give complementary information, produced in conditions that are sufficiently harmonized to allow intercomparison. The only laboratory that had already started some of the planned leach tests in 2012 was STUDSVIK .

In the second year (2013), the analytical methods were further developed, the preparations of the leach tests have been continued, most planned experiments have been started, and the first results have become available.

SCK•CEN [Ref. 1] has started the two planned leach tests (cladded fuel segment and uncladded fuel fragments with cladding) and obtained the first results.

PSI [Ref. 2] has started part of the planned experiments (cladded fuel, segments, fuel fragments, cladding with fuel residues) and plans the remaining tests (cladding without fuel residues) for early 2014. PSI has further used combined X-ray fluorescence (XRF) and X-ray absorption spectroscopy (XAS) on Se doped non-irradiated UO<sub>2</sub> and HBU spent fuel to gain insight into the redox state and the microscopic distribution pattern of selenium in the fuel.

ITU and CTM have started the first leach tests (cladded fuel segments) and obtained the first results. They further have developed a method for the determination and speciation of <sup>79</sup>Se, <sup>126</sup>Sn and <sup>126</sup>Te at trace levels by high resolution ICP-MS coupled to an automated chromatographic system [Ref. 3 and 4].

KIT [Ref. 5] has made further preparations and started the leach leach (cladded and uncladded segments, cladding with residues) in the second semester of 2013.

STUDSVIK [Ref. 6] had started four of the six planned leach tests already in 2012 and has started one more test in 2013. The remaining test will be started in 2014. The first results are available. The radial selenium profile was determined by laser ablation, and the methods for measurement of selenium and carbon-14 in the leaching solutions have been tested.

EK [Ref. 8] has determined dissolution rates of different isotopes from damaged and leaking VVER fuel stored in water for several years as planned.

Detailed information on the developments in the second year is given in the scientific and technical papers that were prepared for the second annual workshop of FIRST-Nuclides, held in Antwerp (Belgium) on the 5<sup>th</sup> – 7<sup>th</sup> of November, 2013.

### **Further planning**

The leach tests that were started in 2012 and 2013 will be continued in 2014. The few remaining planned tests will be started early 2014. The results will become available gradually, and be integrated in the final report and complementary publications.

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