

# Environmental radiation surveys of FIR1 research reactor decommissioning

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FiR1 TRIGA Mark II type research reactor by General Atomics (USA) was the first reactor in Finland. FiR1 was commissioned in 1962 and shut down in 2015. During the over 50 years of operation, FiR1 had a key role in Finland's nuclear energy program and in training of nuclear energy and technology professionals. More specifically, neutron beam research, activation analyses, isotope production, and Boron Neutron Capture Therapy (BNCT) treatments were carried out. Decommissioning planning began promptly, and dismantling was carried out 2023-2024.

Environmental aspects have been an important part of the decommissioning project, which began with an Environmental Impact Assessment showing that the FiR1 decommissioning will not cause a significant impact on the environment. However, potential releases would be possible in accidents. The decommissioning licence application detailed the measures which were put in place to restrict and monitor environmental releases. The main release pathways to the environment during the operations and dismantling were the same; via wastewater and air ventilation. During the operations, wastewater characterisations showed no measurable amounts of main contaminants (i.e., Mn-54, Co-60, Cs-134, Cs-137). The air ventilation surveillance showed that only gaseous Ar-41 was released during operation hours. Therefore, it was concluded that the environmental impact of FIR1 regarding release of artificial radionuclides had been negligible.

In order to verify the environmental impact of FIR1 decommissioning, the approach included three phases with different measurement points:

- 1) Collection of environmental samples prior to dismantling and their analysis for decommissioning relevant artificial radionuclides namely H-3, Co-60 and Cs-137 in 2017. Samples were collected from air, soil, plants (moss and fern), sediment (pond), and water (sea and pond). The results showed that none of the samples contained Co-60 or H-3 whereas Chernobyl related Cs-137 was measured in the soil samples (max 80 mBq/g), the moss sample (50 mBq/g), and the sediment sample (40 mBq/g). Additionally, a narrowed environmental survey was conducted during spent nuclear fuel removal in 2019.
- 2) During dismantling, the environmental measurements were focused on air samples taken regularly from the air ventilation and from the roof of a nearby building. The results showed that no measurable amounts of Co-60, Cs-137 or Eu-152 activities were detected in the air ventilation. The results were similar for the roof of the nearby building. Additionally, direct gamma exposure measurements were carried out during removal of most activated components.
- 3) The final environmental survey was carried out in September 2024. The content was the same as in the initial survey, but additionally artificial Eu-152 was analysed. The results showed that no H-3, Co-60 or Eu-152 activities were detected in any of the samples. Cs-137 activities were measured in all soil samples, in one fern sample, and one air sample (roof). However, the soil and fern sample Cs-137 activities were similar to the initial survey results (15-80 mBq/g and 15-76 mBq/g, respectively). However, the Cs-137 activity in the air sample was detected only due to a significantly longer measurement time after STUK announced that they had detected small amounts of Cs-137 in their air sample stations. The pollution was postulated to originate from Ukrainian forest fires.

As a conclusion, no artificial radionuclides from FiR1 decommissioning had been released to the environment during the decommissioning project.