Performance of CdZnTl SFAT in verification of different types of BWR fuel assemblies

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In Olkiluoto NPP, STUK is performing annual spent fuel measurements with BWR SFAT (Spent fuel attribute tester) verification tool. SFAT is a NDA verification method, where air-filled collimated tube is placed on the top of a fuel assembly in the spent fuel storage pool. A gamma detector is on the top of the tube and since radiation from the assembly can pass through the collimator, gamma-rays emitted by the assembly can be recorded. Usually, SFAT is equipped with either NaI or CdZnTl spectrometers.

The BWR SFAT used in Olkiluoto has been developed under the auspices of the IAEA support programme, within which it is thoroughly documented. It consists of a gamma detector inside a lead shield and a metal frame with the dimensions of BWR fuel element, telescopic collimator tube and ultrasonic distance gauge. Results from measurement to measurement are comparable with each other, since the BWR SFAT is manipulated with fuel transfer machine and the ultrasonic gauge is used to accurately control the distance between the collimator and assembly handle.

It is widely known fact that BWR fuel assemblies have been under constant development. For instance in Olkiluoto, spent fuel storage contained 9 different types of assemblies during our campaign. Older assemblies had no or very little axial profiling and all fuel rods of full length. More modern assemblies, on the contrary, have much less enrichment at the upper part of the rods and some of the rods are partial. Therefore, the signal from SFAT, which is able to see only the upper part of the assembly, varies greatly between different assembly types. It was also noted that original 2x2 inch NaI was not capable of detecting any significant peaks from fission products in many of modern assemblies. Especially the GE12 and Asea9x9AB assemblies were problematic. This was the reason why the detector of the BWR SFAT was upgraded from the NaI scintillator to a 1500-mm3 CdZnTl crystal.

During the campaign, held in April 2007, altogether 71 fuel assemblies were verified with the upgraded device. The results were encouraging: Each of the measured fuel elements produced a gamma spectrum mainly exhibiting $^{60}$Co and $^{137}$Cs, consistent by approximation with irradiated fuel with declared irradiation and cooling times. All types and ages of fuel could be verified. This is a significant improvement to the earlier version of the device, whose resolution was not enough to verify the modern, highly profiled elements (GE and 9x9-AB). The presentation compares the detection capability of the upgraded SFAT device for different types of BWR assemblies. Also the effect of detector upgrade is discussed.