Use of ^{137}Cs Calibration Source in Evaluation of BWR Fuel Burnup

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A method for evaluating the burnup (BU) of BWR spent fuel was investigated by using a novel type of ^{137}Cs calibration source. The source is constructed to fit in the fuel handling fixtures of all the BWR type power plants in Sweden and Finland. It can be used also in the interim storage facilities for spent fuel, CLAB in Sweden and TVO-KPA-STORE in Finland.

The source is covered by a watertight steel cylinder which is fixed inside a 0.65 m long section of ASEA-ATOM type BWR fuel channel. Inside the cylinder there is a 37 GBq ^{137}Cs pellet fixed to a wagon which can be driven up and down by means of a stepping motor. By moving the source, the repeatability of the geometrical positioning is attained. The amplitude and scanning speed are controlled by a remote control unit. The apparatus is easy to handle and decontaminate. The source can be transported in a custom made box (45 cm × 45 cm × 70 cm) under category II-Yellow.In repeated measurements the precision of the new calibration source was found to be 1l.7%. Use of this calibration source makes it possible to calibrate the whole measurement chain and to compare the data measured in different geometries. A typical calibration time is 15 min including source handling.

In recent measurements, a Westphal loss free counting (LFC) system was used in connection with an ND66 multichannel analyser for scanning of fuel assemblies. By use of LFC, real time correction of counting losses is performed.

For BU verification 21 assemblies with mean BUs from 14 to 31 MW·d/kg U and cooling times from 200 to 1500 d were scanned on each of the four corners. The total time needed per assembly was typically half an hour. The ^{137}Cs measurement data were corrected for radioactive decay, self-absorption and inhomogeneous Cs distribution. By use of the arithmetic mean for the four corners and the earlier defined relation between BWR fuel BU and ^{137}Cs activity [1], the BU could be calculated.

The BU calculated from the measured data is shown plotted against the declared BU in Fig. 1. Error bars reflect the precision of measurements for single assemblies. The ±5% deviation lines are also plotted. A more detailed description of the method will be published elsewhere [2].

The measurement system has been developed to be used by the Swedish and Finnish national safeguards authorities for verification of spent fuel BU.

FIG. 1. Operator declared BU compared with the calculated BU values based on the ^{137}Cs activity measurements.

[1] EKENSTAM, G., Cs^{137} measurements of spent BWR fuel", Safeguards and Nuclear Material Management (Proc.6th ESARDA Annual Symp. Venice, 1984), CEC Joint Research Centre, Ispra (1984) 327-330.

[2] EKENSTAM, G., TARVAINEN, M., Verification of Burnup of BWR-type Nuclear Fuel by Measurement of the Cs^{137} Acitivity, Rep.STUK-A52, Finnish Centre for Radiation and Nuclear Safety, Helsinki (in press).