8-5 Analysis for Safety Assessment of Radwaste Disposal

— Validation of Calculated Values of Content of Difficult-to-Measure Nuclides ^{79}Se and ^{135}Cs —

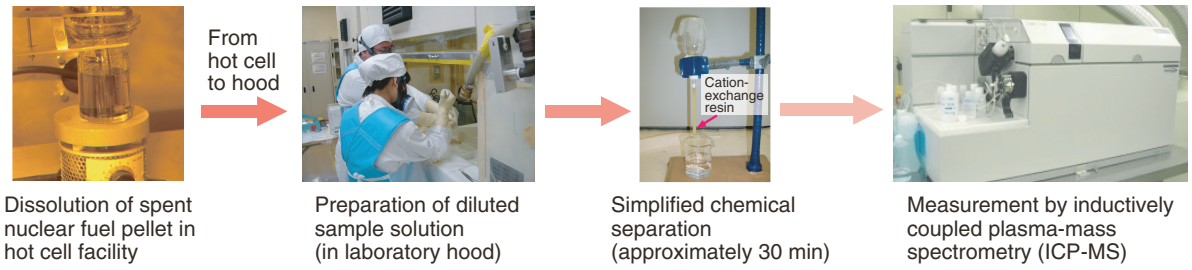

Fig.8-15 Procedure for determination of ^{79}Se and ^{135}Cs in spent nuclear fuel sample
Sample solution was prepared by dissolving a spent nuclear fuel pellet in a hot cell, which is a shielded facility for working with highly radioactive substances by remote operation. The preparation steps were significantly simplified to reduce the radiation exposure time.

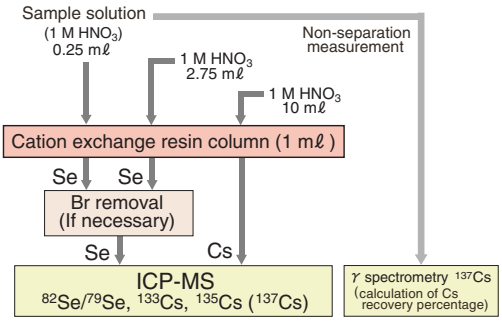

Fig.8-16 Analytical procedure for ^{79}Se and ^{135}Cs
This procedure enables mutual separation of Se/Cs along with removal of highly radioactive coexisting components and sources of interference in ICP-MS measurement.

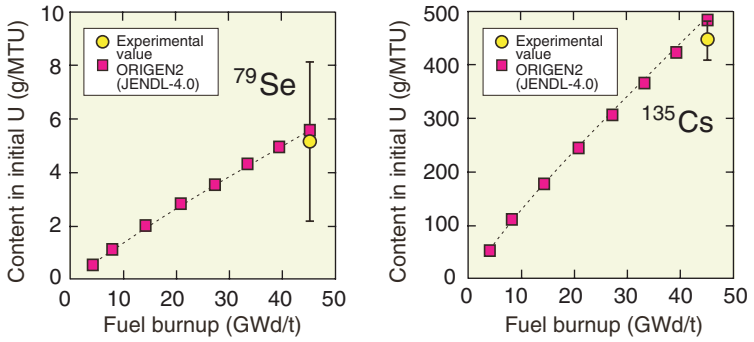

Fig.8-17 Comparison of measured values and calculated values obtained by ORIGEN2
^{79}Se and ^{135}Cs contents in spent nuclear fuel were calculated using ORIGEN2. The measured values proved that ORIGEN2 provided reliable calculation.

High-level radioactive waste (HLW) produced in a nuclear fuel reprocessing plant contains long-lived radionuclides with half-lives of more than 10^4 years. Among such radionuclides, ^{79}Se and ^{135}Cs will govern the public dose originating from the HLW repository 10^4 to 10^6 years after disposal is implemented. Therefore, inventory estimation of ^{79}Se and ^{135}Cs in HLW is essential for realizing safe HLW disposal. However, the reliability of the nuclear data used for dose evaluation has not been sufficiently verified by experimental values because of difficulties in their measurement. In ^{79}Se analysis, a sample containing a large amount of radioactive substances is necessary for accurate and precise determination because only a small amount of ^{79}Se is present in HLW.

In this study, we developed a simple and reliable separation procedure to reduce the radiation exposure time (Fig.8-15). Mutual separation of Se/Cs along with removal of highly radioactive coexisting components and sources of interference in inductively coupled plasma mass spectrometry (ICP-MS) measurement was achieved by a single cation-exchange step (Fig.8-16). The analytical method presented in this study provided the first experimental values for the ^{79}Se and ^{135}Cs contents of spent nuclear fuel in Japan. In addition, the measured values showed good agreement with the values calculated using ORIGEN2 (an isotope generation and depletion code) based on the latest evaluated nuclear data library, JENDL-4.0 (Fig.8-17). This confirms that ORIGEN2 is applicable to the estimation of the ^{79}Se and ^{135}Cs contents of spent nuclear fuel.

The present study is the results of "Experimental study on the inventory estimation of long-lived and scarcely analyzed radionuclides in high-level radioactive waste (Stage I)" funded by Japanese 11 electric power companies.

Reference

Asai, S. et al., Determination of ^{79}Se and ^{135}Cs in Spent Nuclear Fuel for Inventory Estimation of High-Level Radioactive Wastes, Journal of Nuclear Science and Technology, vol.48, no.5, 2011, p.851-854.