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Study on the nuclear forensics analysis of uranium pellet sample

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The study of nuclear forensics can effectively deal with nuclear security incidents and potential nuclear terrorist threats, and prevent radioactive crimes or terrorist attacks. Through the analysis of the nuclear material of nuclear fuel cycle different stage, the initial source of nuclear material and the whole production process could be revealed. Due to the different geological conditions and the industrial process a unique characteristics in nuclear materials and the characteristics can be distinguished. The age of nuclear material, trace impurity and stable isotope composition are important characteristics in the analysis of nuclear materials and various analysis indicators of material properties.

In this work, the uranium pellets, the most important product in the nuclear fuel cycle, were used as the analysis objects, and the analysis technology of nuclear forensic is used to trace the source and process conditions of the pellets. The fingerprint information, including physical appearance, micro structure, trace impurity, stable isotopic composition and uranium age etc. were analyzed. Following the analysis principle of lossless analysis first, the diameter of the pellet is deduced about 8mm. The diameter of the uranium pellet is one of the most important fingerprint information, considering may be used in different size of pellets in different reactors. Combined with the X-ray energy wave analysis and X-ray diffraction analysis, the main ingredients of the sample were uranium and oxygen existing as UO_2 . By measuring the surface dose of sample, the micromorphological analysis includes the microscopic statistical analysis of the hole and grain size of the sample surface. The surface roughness is analyzed by surface profile analyzer, and the density of the sample is measured by buoyancy method. Those characteristics are closely related to the production process of the uranium pellets. The amount of ^{235}U was 1.8% and with no ^{236}U . The source of the pellet is natural uranium, and the pellet was never irradiated by the reactor. After cleaning, drying and dissolving, most impurities were separated from the sample and measured by Inductively coupled plasma mass spectrometry, and the content of stainless steel components such as Fe, Cr, Ni were high concluding that the UO_2 powder was produced by wet process, because the stainless steel container is used in the wet process. Using U-Th to analyze the uranium age in the pellet, the raw uranium material was enriched around December of 2007. Based on the measurement and comprehensive analysis of the information of the above nuclear forensic evidence, and in comparison to the domestic data of nuclear fuel pellets, the sample pellet was produced in the early 2008 and called type AFA-3G nuclear pellet used in the Lingao nuclear power station.

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