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Origin assessment of sealed neutron sources with X-ray radiography, a new method for nuclear forensic investigations

In the recent years sealed radioactive sources are getting more interest from nuclear forensics point of view, because these materials, unlike the more rigorously guarded nuclear materials, are relatively easier to access due to their use in the industry or in the medical care system. As well-known, nuclear forensic science uses destructive and non-destructive methods for the analysis of an unknown material. In the case of sealed sources, for the characterization, non-destructive analysis is the simplest way, i.e., there is no need to open the capsule. X-ray radiography is a widely used technique in the medical field and also in industry, and it gives a non-destructive alternative for the nuclear forensic analysis of different kind of radioactive materials.
Prior to X-ray radiography, the sources were characterized physically, visible-light photos were made, and the main physical characteristics and properties were described. An X-ray radiography method was developed and used to characterize 11 (7 pieces of 252Cf and 4 pieces of 244Cm) sealed neutron sources. The 2D projections were acquired at the X-ray facility of the bimodal imaging station of the Budapest Neutron Centre, RAD. We operated the portable X-ray tube (ERESCO 42 MF3) at 200 kV voltage with a 0.6 mm Sn filter to produce a more energetic beam, which was necessary to penetrate the sealing more effectively. The spatial resolution was around 0.2 mm.
For the comparison we investigated sealed sources of Russian and US origin (Figure 1.).

Figure 1 - Sealed Cf-source from USA

Through our investigations we found clear similarities but significant differences among sources from the same and the different manufacturers, respectively. It means difference in the encapsulation of the sources, the size, homogeneity, and the shape of the source material. Therefore, these methods can clearly help to identify the sources from unknown origin, and hence, their manufacturer and owner, or at least it is possible to identify the country or territory where the source has been made. It will allow authorities to review the licensees' physical protection system. To identify the sources, additional parameters should also be investigated such as X-ray fluorescence properties and gamma-ray emissions.
This research presents a novel non-destructive methodology to analyse sealed radioactive sources and contributes to the expansion of the nuclear forensic library in Hungary.

keywords: sealed sources, X-ray radiography, nuclear forensics

Primary authors: VÖLGYESI, Péter (Nuclear Security Department, Centre for Energy Research); Dr KIS, Zoltán (Nuclear Analysis and Radiography Department, Centre for Energy Research); NAGY, György (Nuclear Security Department, Centre for Energy Research); Mr ALMÁSI, István (Nuclear Security Department, Centre for Energy Research); Mr KAPOSY, Nándor (Nuclear Security Department, Centre for Energy Research)

Presenter: VÖLGYESI, Péter (Nuclear Security Department, Centre for Energy Research)

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