Contribution ID: **48** Type: **Wedge Participant**

Muography of spent fuel containers for Safeguards purposes

Verification of heavy shielded spent fuel containers in case of loss of Continuity of Knowledge (CoK) is a challenge for the safeguards inspectorates. Stores with such containers are regularly equipped with at least two layers of containment and surveillance (CS;) technology. While this approach has proven to be very reliable, failures cannot be completely excluded and reverification options are currently not satisfactory. The growing number of spent fuel containers in intermediate storage sites stored for tens of years increases the probability of loss of CoK. The ultimate minimum requirement in terms of the detection limit for potential re-verification techniques would be the detection of one Significant Quantity of nuclear material missing, which is roughly comparable to 1 PWR or 4 BWR spent fuel assemblies.

Cosmic muons originating at the higher atmosphere because of primary cosmic radiation are sufficiently present (10,000 μ/m2/min) at sea level. Muons can penetrate meters of dense material and therefore can be used to image the contents of spent fuel held in heavy shielded containers. Recent development of innovative imaging techniques using cosmic muons and muon trackers (muography) offers unique opportunities for Safeguards.

For CASTOR measurements two muon tracking techniques are used simultaneously: the muon transmission which allows the measuring of the density of investigated volume and the muon scattering giving possibility to estimate the product of the density and the average Z of the elements contained in this volume.

The National Institute of Nuclear Physics (INFN) in Italy has built a prototype of a drift tube detector with the purpose to study the behaviour of such a detector in the proximity of spent fuel containers and demonstrate that it can record muon tracks with high efficiency, even in presence of the radioactive background produced by them. The prototype detector consists of a single muon tracker based on eight layers of eight 2 meter-long drift tubes. The detector has been successfully tested in a radiation-free environment.

Field tests with a CASTOR container loaded with spent fuel are planned in an intermediate spent fuel store in the European Union.

Which ”Key Question” does your Abstract address?

NEW1.2

Topics

NEW1

Which alternative ”Key Question” does your Abstract address? (if any)

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Session Classification: [New] Safeguards Techniques for New Facilities and Campaigns

Track Classification: Preparing for safeguards new facilities, processes and campaigns (NEW)