Imaging a Dry Storage Cask with Cosmic Ray Muons

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Program: Fuel Cycle - 3

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ABSTRACT:

The overarching goal of this project is to develop an imaging system to monitor the content of a dry storage cask (DSC) with cosmic ray muons. Because of the growth of the nuclear power industry in the U.S. and the policy decision to ban reprocessing of commercial used nuclear fuel, the used fuel inventory at commercial reactor sites has been increasing. Used nuclear fuel needs to be moved to independent spent fuel storage installations (ISFSIs), as its inventory approaches the limit on capacity of on-site wet storage. Given the cancellation of the Yucca Mountain project and no clear path forward, extended dry-cask storage (~100 yr.) at ISFSIs is very likely. Used nuclear fuel presents extra complexity of security and proliferation issues. A very large amount of plutonium under nuclear safeguards is contained in used fuel assemblies stored in DSCs. These fuel assemblies are practically inaccessible for inspection purposes, as reopening a DSC would require special facilities and would be tremendously expensive. There is currently no practical method to verify the content of a DSC. Thus, expensive, redundant containment and surveillance instrumentation have to be used to avoid loss of knowledge of the content. Muons are highly penetrating particles. Muon imaging can be performed on a DSC by the shipper and receiver for inventory verification. It can also be used as a re-verification tool for used nuclear fuel stored over decades to maintain Continuity of Knowledge (CoK). Furthermore, before being transported to a final repository or opened at a reprocessing plant, a DSC's content and integrity can be evaluated via muon imaging. To support next generation nuclear materials management and safeguards for future U.S. fuel cycles, tools and technologies are needed to verify DSC content and maintain CoK. Thus, the proposed work is directly related to work scope FC-3 (Nuclear Materials Control and Instrumentation).