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A 9m Drop Test Simulation of a Dual Purpose Cask for Nuclear Research Reactors Spent Fuel Elements

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ABSTRACT

The qualification of casks for transportation or storage of nuclear spent fuel elements involves the evaluation of some conditions that simulate possible accidents. The cask should maintain its safety functions through its structural and functional integrity (in any condition, there should be the containment of the radioactive products inside it, the integrity of its biological shielding and assurance against criticality). The main conditions the cask should satisfy, mainly by test, to be qualified are: a 9m drop test against a rigid surface, a penetration test, 30min of fire under 800 °C and 200m immersion during one hour. The first condition is the most critical one. The regulatory bodies stress the qualification "by test" instead of "by analysis". However, numerical simulations are important to determine, for instance, the most critical position for the free drop tests, saving a lot of money without reducing the project degree of safety. There is a multi-country project, sponsored by the IAEA, with the participation of Latin American countries with research reactors, to develop and qualify a shipping cask for their spent fuel elements. It involves, in its first phase, the project, construction, test and numerical simulation of a half scale model to establish parameters for the tests (mostly the 9m drop test). The cask is a stainless steel cylinder with flat heads, the bottom one is welded while the upper one has flanged threaded connections, and internal structures for the fuel elements. An external stainless steel cylinder contains the biological lead shielding. There are two impact limiters contained by steel shells, which are planned to be filled with a reconstituted wood. This work describes the cask project in details, the main hypothesis and some results obtained with the 9m drop test numerical simulation. Its purpose is to develop a modeling and results evaluation methodology to help the field tests, in order to be applied in future prototype design. In the simulations all non-linearities, mostly associated with the contacts among the cask several parts, the mechanical properties of the materials and the geometric changes, were considered.