ABSTRACT

As the nuclear community adapts to meet a constantly changing environment driven by policy development, so must the technology associated; in particular is the case of technology qualification. While government institutions and industry leaders have done much for nuclear materials progression, these technologies must first be tested and qualified before they will see any practical use. Technetium-99m ($^{99m}$Tc) is a diagnostic radiopharmaceutical that is currently used about 100,000 times daily for diagnostic imaging procedures globally. The parent isotope for $^{99m}$Tc is molybdenum-99 ($^{99}$Mo), most commonly obtained through the irradiation of high enriched uranium (HEU). In accordance with the Department of Energy’s Global Threat Reduction Initiative, an effort is underway to develop a process to produce $^{99}$Mo using low enriched uranium (LEU). One method utilizes LEU cast in the form of a metal foil as opposed to current powder based dispersion designs for HEU. New high-volume production LEU target concepts need to be analyzed to assure safe, reliable operation during all stages of production as use of a foil requires a significant modification to the current target design. Analytic and numeric models have been built to simulate the thermal-mechanical behavior of LEU-foil based targets under irradiation conditions. This thesis presents new target geometry designs utilizing the LEU foil technology. Experimental techniques were then designed to test and characterize surrogate targets in conjunction with the numerical models also presented. Overall, the research aims to help with the qualification of new LEU foil based targets.