The nuclear fuel cycle is a complex, multi-step process to construct, transport, use, and store nuclear fuel; oversight and safeguard measures are necessary to ensure the safe and secure transportation, delivery, and storage of nuclear fuel. A considerable amount of research has focused on preventing tampering or mitigating negligence of spent nuclear fuel; however, this research concentrates on identifying components for a low-cost, radiological, non-destructive detection system for fresh nuclear fuel.

Although there are non-destructive means of verification, such as weighing fresh fuel or scanning the package number, there is no commonly used, best-practice radiological detection system to non-destructively verify the composition of the fresh fuel upon arrival at nuclear power plants or if it is left in unexpected/unplanned longer term storage prior to use at the nuclear power plants or facilities. This leaves a potential safeguards gap in the nuclear fuel cycle.

This work will conduct a cost-vs-value analysis for multiple detector components that could potentially be combined in a system for fresh fuel detection observables. This study will analyze three proposed evaluation criteria: quantity of detectors required; speed and accuracy of detector verification; and overall efficiency of neutron and gamma detections. These evaluation criteria when compared to their cost will be used to assess the most ideal configuration of detectors for future research.

The results of this work will be used to make recommendations for a development of a versatile, multi-data system for fresh fuel verification. Future work will utilize the results of this research to construct and test the recommended radiological verification system against PWR and BWR fresh fuel. Ideally, this research will eventually contribute to development of a system that nuclear power plants, facilities, and/or inspectors will be able to use for low-cost, non-destructive verification of fresh nuclear fuel and an adaptable safeguard for the future.