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## **High temperature embedded/integrated sensors (HiTEIS) for remote monitoring of reactor and fuel cycle systems**

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**ABSTRACT:**

Small Modular Reactors (SMRs) represent a fundamental shift in the nuclear power industry. This shift must acknowledge the design differences of these reactors, which are typically much smaller and less accessible than conventional reactors. It is expected that the inspection of these smaller reactor structures and fuel cycle structures will be much more readily accomplished if it is possible to remotely inspect and control the reactor and fuel cycle systems via an embedded/integrated sensor system. Such a system would be more able to inspect areas of a reactor and fuel cycle systems that are difficult to access. These sensors should also be able to inspect a reactor and fuel cycle system at elevated temperatures in a high radiation environment, which would enable monitoring and control of the reactor and fuel cycle systems without significant interruption to operation that such an inspection would require if conducted via traditional manned entry and off-service methods. In conventional inspections, ultrasound non-destructive testing (NDT) has been effective in locating defects and measuring residual stresses, temperatures, microstructures, and elastic properties of nuclear power plant components, and hence will play an important role in reactor and fuel cycle system inspections. However, most of these tests are not in-service inspections, largely because of the limitations from embedded/integrated sensors. The extremes of high temperature and radiation in the reactor and fuel cycle environment exceed the capabilities of conventional piezoelectric sensors and ultrasound transducers. It would be of great benefit to extend the capabilities of piezoelectric sensing and ultrasound NDT so that they could provide valuable and sufficient data to monitor and control reactor and fuel cycle components in-situ.

The objective of this project is to develop high temperature (> 600 °C) embedded/integrated sensors (HiTEIS) for unprecedented wireless monitoring and control of reactor and fuel cycle systems. HT pressure sensors, vibration sensors, liquid level sensors and laser ultrasound transducers will be designed, fabricated, embedded, integrated and characterized, followed by nuclear structure integration and evaluations. The proposed technique will likely be used to enhance the safety and efficiency of nuclear power systems.