**High-Temperature Magnetostrictive Acoustic Emission Transducer for Stainless Steel Pin Burst Detection**

**Bibo Zhong1 and Joshua Daw1**

1 Idaho National Laboratory

Idaho Falls, ID 83415

[*Bibo.Zhong@inl.gov*](mailto:Bibo.Zhong@inl.gov)*;*[*Joshua.Daw@inl.gov*](mailto:Joshua.Daw@inl.gov)

ABSTRACT

In a loss-of-coolant accident, residual decay heat leads to a rapid increase in temperature and internal pressure within the fuel pin, resulting in plastic deformation and subsequent bursting. Acoustic emission (AE) monitoring has been explored as a potential method to accurately detect the timing of pin bursts. While most AE transducers are of the piezoelectric type, magnetostrictive materials provide an alternative. Magnetostrictive materials like Remendur and Galfenol are often considered better suited than piezoelectric materials in environments with high temperatures, nuclear radiation, or both. In terms of mechanical robustness, magnetostrictive metals tend to outperform piezoelectric crystals and ceramics, which are inherently brittle. This study presents experimental results from burst detection tests on stainless-steel pins using both piezoelectric and magnetostrictive-type (Remendur in this study) AE transducers. The piezoelectric AE sensor is commercially available, while the magnetostrictive-type transducer was developed in the laboratory. During the burst test, stainless steel pins were pressurized and placed in a high-temperature furnace, with one pin used in each burst test. The furnace temperatures were set at 300°C, 400°C, 500°C, and 650°C for individual tests. The stainless steel pins were pressurized until they burst. Both types of AE transducers were clamped onto the heat sink surrounding the stainless-steel pins. The results indicate that both piezoelectric and magnetostrictive AE transducers were able to detect the timing of pin bursts and can cross-verify each other up to a temperature of 500°C. At the temperature of 650°C, which exceeds the maximum operating temperature of 540°C for the commercial piezoelectric AE sensor, only two magnetostrictive AE sensors were used. However, both magnetostrictive AE sensors successfully detected the timing of pin bursts at the temperature of 650°C. These pin burst experiments demonstrate the effectiveness of magnetostrictive AE sensors.

**Keywords:** magnetostrictive, loss-of-coolant accident, nuclear, acoustic emission, pin burst, high temperature