High-Temperature Guided Wave Electromagnetic Acoustic Transducers (EMATs) for Structural Health Monitoring

PI: Joseph Corcoran,
University of Cincinnati

Collaborators: Peter B. Nagy, University of Cincinnati
Matthew Weathered, Argonne National Laboratory
Teddy Kent, Argonne National Laboratory

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ABSTRACT:

The aim of this project is to develop a prototype guided wave electromagnetic acoustic transducer (EMAT) monitoring system for the structural health monitoring (SHM) of pressure vessels and piping operating up to 550 °C. Two example defects will be targeted: axially aligned thermal fatigue, and circumferentially aligned type IV girth weld damage. The monitoring system will be capable of measurements with up to 10 m range to ensure adequate area coverage, and will be suitable for both austenitic stainless steels and ferromagnetic materials. The project will build on the basic science, fundamental design principles, and advanced manufacturing techniques developed in Phase I to produce a transformative technology for the structural integrity assurance of high-temperature plant.

The project will include four main research areas. The first is to design and optimize the ultrasonic design of the EMAT given the limitations and constraints imposed by high-temperature operation. The second is the magnetic design of the EMAT, which much be designed to minimize the demagnetizing field which is critical for avoiding thermally activated magnetic losses. The third is to design an electromagnetic coil that suitable for long term use at up to 550 °C. Finally, a prototype monitoring system will be built and installed at the Mechanisms Engineering Test Loop (METL) at Argonne National Lab. The installation will provide an important demonstration opportunity and help position this transformational monitoring technology towards industry transfer.

The project will be a collaborative effort between the University of Cincinnati and Argonne National Lab. The basic science and development phase will be based at UC Center for NDE. The project team has a wealth of experience of developing metrology systems for extreme environments and liquid metal reactors. The project will deliver a first of its kind capability for the power generation industry. The project will have a transformative impact in enabling a range of *in situ* SHM and process control measurements.