ADVANCED THICK-FILM ULTRASONIC SENSORS

RELIABLE INSPECTION IN THE HARSHEST ENVIRONMENTS

Thick-Film UT sensor applied to a critical bolt. The electrode is visible in the center of the bolt head.

LIMITATIONS OF TRADITIONAL UT INSPECTIONS

Traditional ultrasonic inspection faces challenges in extreme conditions. Conventional UT sensors often require gel-based couplants that degrade over time, especially at high temperatures, making them unsuitable for long-term structural health monitoring. Additionally, conventional transducers struggle to conform to complex geometries, limiting their effectiveness.

Introducing Thick-Film Ultrasonic Transducers
Structural Integrity Associates (SIA) has extensively tested these in high-temperature fossil applications. This technology is now positioned for evaluation and use in advanced nuclear settings, with a focus on RIM monitoring and NDE programs.

TECHNOLOGY OVERVIEW

Ultrasonic testing (UT) uses electrical energy converted into mechanical vibrations (sound waves) to inspect materials and components. Piezoelectric materials, key to UT technology, convert electrical pulses into sound and back again, enabling precise visualization and monitoring of internal structures.

HOW THICK-FILM UT SENSORS WORK

- Piezoelectric powder combined with an aqueous binding agent creates a specialized coating
- Application directly onto the surface of the component via aerosol deposition forms a mechanically robust bond—eliminating the need for traditional gel couplants
- Films are layered to precisely control thickness, enabling custom resonance frequencies tailored for specific inspection tasks

ADVANTAGES OF THICK-FILM UT SENSORS

- **Couplant-Free Design:** Eliminates degradation issues associated with gel couplants, enabling consistent, reliable performance in high-temperature nuclear environments
- **Complex Geometry Compatibility:** Directly bonded sensors conform seamlessly to complex structures, such as reactor vessel internals, piping elbows, and bolted connections
- **Durability and Longevity:** Designed specifically for long-term operation in harsh conditions, providing sustained structural health monitoring capability
- **Field-proven:** Tested for long-term use to 740°F — tested up to 1250°F*

*Sensors have demonstrated operation for several days at 1250°F under test conditions. Application-specific testing (temperature, radiation dose, etc.) is required to qualify within the MANDE framework for RIM program use.

FLEXIBLE DESIGN FOR ENHANCED INSPECTION

Thick-film UT sensors leverage customizable electrode designs, offering versatility beyond basic thickness measurements:

- **Single-Element Configuration:** Ideal for simple, precise thickness monitoring with sound waves traveling perpendicular to the part's surface
- **Advanced Array Configuration:** Electrodes patterned into customizable arrays provide precise steering and focusing of ultrasonic waves—allowing detailed internal imaging and defect characterization, including accurate detection and tracking of cracks and other defects

info@structint.com

www.structint.com

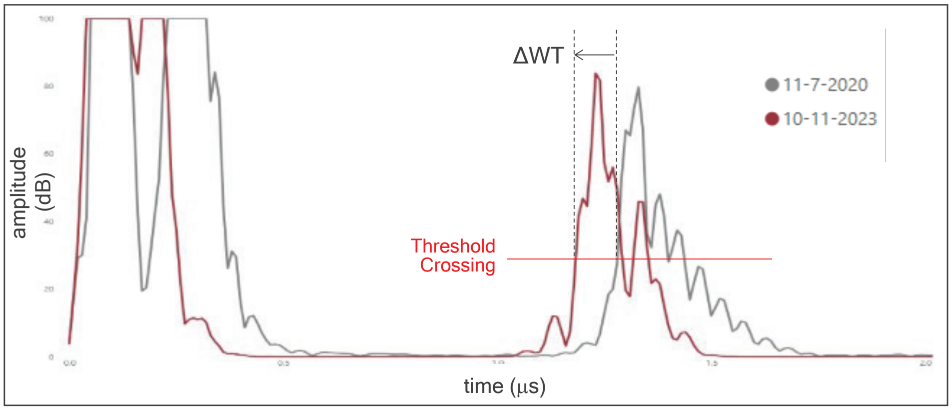
1-877-4SI-POWER
1-877-474-7693

11515 Vanstory Drive, Suite 125
Huntersville, NC 28078

REAL-TIME STRUCTURAL HEALTH MONITORING

Installed thick-film UT sensors enable continuous monitoring and provide real-time data even during component operation:

- Enhanced repeatability and consistency of measurements
- Precise trending of critical parameters such as wall-thickness reduction and crack propagation rates
- Improved predictive capability to accurately estimate remaining component life, optimizing operational safety and asset management



TRANSITIONING PROVEN TECHNOLOGY INTO NUCLEAR

Building on extensive deployments in high-temperature fossil applications, thick-film UT sensors provide a direct path for use in advanced nuclear systems under ASME BPVC Section V, Article 14 Examination System Qualification. As a conventional ultrasonic method, this approach is already Code-compliant and falls within the MANDE framework established in Section XI, Division 2 for sodium fast reactors, high-temperature gas reactors, and molten salt reactors. When applied to critical SSCs such as reactor vessels, core barrel supports, or piping, the couplant-free design enables more repeatable measurements and more accurate trending than traditional UT, which can vary due to couplant inconsistencies. This makes thick-film sensors well aligned with RIM Program monitoring and MANDE qualification methods (IV-3, IV-4, and Appendix V), providing a clear path forward for integration into advanced reactor reliability strategies. While the technology already addresses the temperature ranges expected in most advanced designs, additional testing is underway to confirm performance in specific reactor environments, including radiation exposure.