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## Development of a Handheld Low-Frequency Ultrasonic System for Precise Stave Wear Measurement in Blast Furnaces

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Stave wear in blast furnaces is a critical issue affecting operational efficiency and campaign longevity. Several factors influence wear severity, including furnace design, operational practices, raw material properties, and cooling performance. However, stave wear patterns are often unpredictable and irregular, making accurate monitoring essential for maintaining the integrity of the cooling system.

In 2013, we developed a low-frequency ultrasonic system capable of measuring stave thickness from the furnace shell while the furnace remained in operation. In 2019, we launched a new research and development initiative to enhance measurement accuracy, reliability, and robustness, particularly for complex wear profiles. The result is the StaveCheck™ system, a handheld Low-Frequency Pulse Ultrasonic (LFPU) device designed to penetrate thick furnace shells, variable ramming materials, and copper or cast-iron staves, achieving measurement accuracy within  $\pm 2$  mm. This patented system is flexible of detecting the vertical profile of staves, which outweighs the conventional ultrasonic probe technique.

This paper details the development process, key technological advancements, and performance validation of the StaveCheck™ system, highlighting its potential for improving blast furnace maintenance and operational safety.

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