

# Ultrasonic Inspection of Reconditioned Railroad Bearing Components - Year 2

Deliverables and Reporting Requirements for UTC Grants Awarded in 2023 (June 2023)

## Exhibit D

**Recipient/Grant (Contract) Number:** University of Texas Rio Grande Valley (UTRGV)/Grant No. 69A3552348340

**Center Name:** University Transportation Center for Railway Safety (UTCRS)

**Research Priority:** Promoting Safety

**Principal Investigator(s):** Joseph Turner (PI, University of Nebraska-Lincoln (UNL))

**Project Partners:** Constantine Tarawneh (Collaborator, UTRGV), Anish Poudel and Matt Wenger (Collaborators, MxV Rail)

**Research Project Funding:** \$73,749 (Federal), \$25,088 (Non-Federal Cost Share)

**Project Start and End Date:** 06/01/2024 to 08/31/2025

**Project Description:** Freight rail bearings are often subjected to heavy loads such that the performance of each bearing plays a crucial role in the safe operation of the entire train. Even bearings that are properly maintained may still fail due to rolling contact fatigue (RCF) if local regions within the bearing race do not meet established effective case depth (ECD) standards. In addition, little is known about potential changes that may occur within the highest stress region after extensive service life. Ultrasonic grain scattering shows sensitivity to both microstructure and residual stresses such that nondestructive measurement methods based on diffuse ultrasonic backscatter have shown a high correlation with the overall status of the raceway. Previous research has shown clear differences between new and reconditioned bearing cups in terms of their ultrasonic signatures. That work will be expanded to include spatial maps of raceways to identify locations that are outside the statistical bounds expected for a given part. Those locations will be identified, and those parts will be tested in simulated service life testing at UTRGV for comparison with the predictions.

**US DOT Priorities:** This project aligns with four USDOT strategic priorities: **(a) Safety:** The project impacts the structural performance of railroad bearings, which must maintain their integrity for overall rail safety. Bearings are major safety concerns such that enhanced inspection strategies are critical. **(b) Economic Strength:** Poor performing bearings may lead to slower train speeds, field repairs, and stoppages that can affect profit margins for railroads and their customers. **(c) Equity:** In the past decade, UNL has developed partnerships with minority serving institutions to increase the graduate enrollments of these groups. In particular, the UNL MME Department has a cooperative PhD program with UTRGV which has enhanced underrepresented groups at UNL. **(d) Sustainability:** The new inspection approaches to be developed will lead to longer life of bearings and higher performance metrics that will provide a more sustainable transportation footprint.

**Outputs:** Expected results and products include:

1. Laboratory ultrasonic experiments will be performed on bearing components at various stages of service life.
2. Statistical analysis of the ultrasonic data will be performed to identify differences present within parts and between different categories of parts (e.g., new, used, spalled, repaired).
3. Statistical results will be used to identify outliers and anomalies within each part and with respect to the ensemble of parts.
4. A select number of bearing components will be subjected to laboratory service life testing to quantify the inspection approach.
5. Conference presentations, reports, journal articles, and patent disclosures.

**Outcomes/Impacts:** The proposed project will have broader impacts from both the research itself as well as the educational aspects. The anticipated **Research Activities** may lead to new ultrasonic inspection approaches that can identify positions within component raceways that may be candidates for early failure. Thus, overall railroad safety would be enhanced if suspect components are removed from further service. Although the measurements proposed here will take place within an ultrasonic immersion tank, other measurement modalities, such as a hand-held measurement tool, may result from this work. The expected **Educational Activities** include training of engineering students in NDE methods with applications to the rail industry. The PI has a strong track record with respect to recruitment of students from underrepresented groups and that will continue so that a well-educated workforce is available.

**Final Research Report:** Upon completion of the project, a URL link to the final report will be provided.