Ultrasonic Inspection of Reconditioned Railroad Bearings

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

Exhibit D

Research Project Requirement Template

Recipient/Grant (Contract) Number: University of Texas Rio Grande Valley (UTRGV), University of Nebraska Lincoln (UNL)/Grant No. 69A3552348340

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

Research Priority: Promoting Safety

Principal Investigator(s): Jospeh Turner (PI, UNL), Constantine Tarawneh (Collaborator, UTRGV)

Project Partners: University of Texas Rio Grande Valley.

Research Project Funding: $60,741 (Federal), $26,442 (Non-Federal Cost Share)

Project Start and End Date: 06/01/2023 to 08/31/2024

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 ECD. Thus, this project will exploit the relationship between ECD and ultrasonic scattering with respect to reconditioned bearings. Bearing components at several different usage states will be inspected with a goal to identify locations that may be more susceptible to early spalling. During later stages of this program, those parts will be tested using laboratory rolling contact fatigue tests for comparison with predictions.

US DOT Priorities: This project aligns with the following USDOT strategic goals, as established in the USDOT Strategic Plan for FY2022-FY2026: **(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 unnecessary 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 in order to grow the graduate enrollments of these groups. In particular, the UNL Mechanical and Materials Engineering Department has a cooperative PhD program with UTRGV which has enhanced underrepresented groups at UNL. This project will support one student who completed their MS degree at UTRGV to pursue their doctoral degree 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: In the initial year of this project, several results are expected. These include:

a. Laboratory ultrasonic experiments will be performed on bearing components at various stages of service life,

b. 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),

c. Statistical results will be explored with respect to identification of outliers and anomalies within each part and with respect to the ensemble of parts, and

d. Initial measurement protocols will be defined with respect to future research that will correlate outlier spatial positions with spall development.

Relevant products include conference presentations, reports, journal articles, and patent disclosures. Building on previous research, one conference presentation should be possible during the first year.

Outcomes/Impacts: This project will improve rail safety, efficiency, and sustainability by gaining insight into bearing defect mechanisms, and by developing improved inspection techniques. The project will also contribute to developing a diverse workforce with advanced knowledge in rail safety, through the cooperative doctoral program.

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