

## Non-Contact Energy Harvesting for Rural Grade Crossings - 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)) and Carl Nelson (Co-PI, UNL)

**Project Partners:** Mohsen Amjadian (Collaborator, UTRGV)

**Research Project Funding:** \$73,750 (Federal), \$50,576 (Non-Federal Cost Share)

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

**Project Description:** The network of US railroads often spans remote parts of the country that are sparsely populated. In these areas, rail grade crossings are much less likely to have warning lights or crossing gates primarily due to the lack of electricity. Such unprotected or passive crossings have the majority of the grade crossing fatalities and accidents. In order to reduce rail accidents, enhanced warning systems are needed at as many passive crossings as possible. We propose to create a new energy harvesting approach based on the motion of the wheels to generate sufficient power for an LED-based grade crossing warning system. Recent advances to create small and powerful magnets allow for the design of a non-contact power generation approach that is activated with each passing wheel. The feasibility of this approach has been shown in previous research and an initial prototype will be designed and tested as part of the research plan.

**US DOT Priorities:** This project aligns with three USDOT strategic goals: **(a) Safety:** The project plans to address the safety of rural grade crossings which represent a significant number of accidents. The ability to provide low-cost power near existing passive crossings would allow additional signaling to be added which will greatly enhance the visibility of the crossings to approaching vehicles. **(b) Economic Strength:** Accidents at rural grade crossings affect more than the economics of the railroads. The livability of rural populations is greatly impacted by safety issues and improvements to railroad crossings will provide a higher quality of life and stronger economies. **(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. This project will support one student who completed his MS degree at UTRGV.

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

1. Computational models will be developed to understand the impact of the various design choices on power generation.
2. Design implications for magnet arrays to modify the symmetry of the magnetic field will be quantified.
3. An initial laboratory prototype will be created for one or two of the designs.
4. Experimental data will be collected to quantify the potential for maximum power generation.
5. General concepts for implementation in the field will be initiated.
6. 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** are focused on a new energy harvesting approach that

could be implemented in many different locations, especially rural areas. The proposed design does not depend on motion of the rail so it could be integrated more easily at specific sites, which will reduce the installation costs tremendously. Overall railroad safety would be enhanced if additional signals could be installed, and the results thus far suggest that sufficient power could be generated with this concept. The expected **Educational Activities** include training of engineering students in multi-disciplinary subjects that involve both mechanical and electrical engineering. Future engineers will need to design with a team approach and this project will be an excellent training ground for students. In addition, 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.