Semi-Annual Progress Report for University Transportation Centers

Reporting Period [October 1, 2025 – March 31, 2026]

- **Federal Agency and Organization Element to which Report is Submitted**
  United States Department of Transportation (USDOT), Office of the Assistant Secretary for Research and Technology (OST-R)

- **Federal Grant or Other Identifying Number Assigned by Agency:** 69A3552348340

- **Project Title:** University Transportation Center for Railway Safety (UTCRS) – Tier 1 Center

- **Center Director Name, Title and Contact Information**
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- **Recipient Organization:**
  The University of Texas Rio Grande Valley (UTRGV)
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- **Signature of Submitting Official**

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Director, University Transportation Center for Railway Safety (UTCRS)

1. ACCOMPLISHMENTS

1.1 What are the major goals of the program?

The UTCRS will support the Infrastructure Investment and Jobs Act (IIJA) research priority of promoting safety of railway transportation systems by innovating new technology, providing critical data, and developing the technical workforce. The center will engage and focus its partners' established expertise and leverage and expand their existing resources to establish comprehensive programs of rail research with results that are relevant, actionable, and accessible to all stakeholders.

The UTCRS aims to reduce the number of accidents and equipment failures in rail transportation systems, leading to reduced fatalities and injuries. Economic losses to stakeholders will be reduced by improving the safety and durability of rail transportation infrastructure. This will be accomplished through the development of technologies and materials, condition monitoring, remote sensing, asset management, performance management, and construction methodologies.

The UTCRS will ensure that its work directly benefits the US rail industry by working in continuous consultation with an External Advisory Board of industry leaders, and by seeking collaborations with Class I railroads, local railroads, rail equipment manufacturers, labor unions, and state and federal agencies.

For this sixth reporting period, our major goals were:

- Continue work on the third year (2025CY) research projects
- Disseminate results and transfer technology to industry, government, and the public.
  - Deliver prototypes, laboratory test results, and software to industry partners.
  - Present research results in journal and conference publications
  - Submit reports to industry partners and sponsors
- Educate and develop technical workforce
  - Employ and supervise undergraduate and graduate students for 18 research projects
  - Offer courses in transportation related subjects
  - Offer transportation seminars and workshops by industry and government experts
- Engage the community in rail related activities
  - Prepare for the UTCRS STEM Summer Camps, STEM Teacher Workshop, and RET Program
  - Provide consultation for industry and government agencies
- Seek, expand, and develop opportunities for collaboration and technology transfer
  - Engage with partners including labor organizations and corporations
  - Build on existing cooperation agreements with local railroads
  - Provide testing services for industry and government agencies
  - Work to convert research results into products, guidance, and recommendations.

1.2 What was accomplished under these goals?

A summary of accomplishments is in Table 1, followed by a brief summary of major initiatives and activities during the reporting period. More information is given in Section 4, Outcomes, and Section 5, Impacts.

Table 1 – Accomplishments During the Reporting Period		
Administrative	**Status**	**% Complete**
Hold regular meetings of the Executive Committee	**Complete**	**100%**
Fund and hire staff for eighteen (18) USDoT-approved 2025CY projects	**Complete**	**100%**
Complete 2024CY final reports and submit to TRID database	**In progress**	**85%**
Research & Technology Transfer	**Status**	**% Complete**
Continue work on eighteen (18) USDoT-approved 2025CY projects. Further details in Section 1.2.2 Research Projects and Section 4 Outcomes	**In Progress**	**60%**

52 journal and conference papers were submitted, accepted, or published. **31** new papers were submitted of which **18** were accepted, and **19** papers previously listed as accepted or submitted were published/presented (see Table 4)		**Complete**	**100%**
New indoor 40-ft rail track panel (See Section 1.2.4)	Ballast and track installation	**Complete**	**100%**
	Instrumentation and Data Production	**Initial Planning**	**10%**
Two (2) static load calibration rigs for new railcar load sensors. Completed in previous reporting cycle.	Transfer of design to Hum Industrial	**Complete**	**100%**
	Continued data production	**Ongoing**	
Development of new cyclic lateral tester for bearing pads	Mechanical and Electrical Design	**Completed**	**100%**
	Construction	**In Progress**	**75%**
Construction of a new single bearing test rig (SBT) with advanced capabilities		**In Progress**	**75%**
Construction of a new four bearing test rig (4BT) to expand capabilities		**In Progress**	**75%**
Evaluation of onboard condition monitoring systems for commercial applications. (**Hum** Industrial Technologies, Inc. funded)		**Ongoing**	
Field testing with Iron Horse (see Section 1.2.3)	First pilot test of new UTCRS load sensor for Hum Industrial	**Completed**	**100%**
	Testing of RF propagation channels	**Initiated**	**20%**
Public database of bearing test data, automatically updated from testers. Hardware completed in previous reporting cycle.	Software Development (Version 1.0)	**Completed**	**100%**
	Public Rollout and Demo	**Completed**	**100%**
	Database Online	**Completed**	**100%**
	Continuous data uploads	**Ongoing**	
Funded project with Oak Ridge National Labs, for testing and calibration of vibration and temperature sensors (See 1.2.2 below).		**Follow-Up Completed**	**100%**
FRA-funded CRISI program to integrate UTCRS-developed onboard sensing technologies into railroad operations. (See 1.2.1 below).	Contracts in place and work authorized	**Completed**	**100%**
	Staffing and acquisition of instruments	**Completed**	**100%**
	Product development and testing	**Ongoing**	
Education & Workforce Development		**Status**	**% Complete**
Supported **93** graduate/undergraduate students involved in UTCRS activities		**Completed**	**100%**
Center-affiliated faculty taught **7** undergraduate and **6** graduate courses in transportation-related subjects		**Completed**	**100%**
2026 summer transportation internships (MxV Rail) for ***three*** students		**Arranged**	**100%**
2026 summer transportation internships (Wabtec) for ***two*** students		**Arranged**	**100%**
2026 summer transportation internship (ENSCO/TTC) for ***one*** student		**Arranged**	**100%**
2026 summer transportation internship (Hum Industrial) for ***two*** students		**Arranged**	**100%**
2026 Research Experience for Undergraduates (REU) at TAMU for ***three*** students		**Arranged**	**100%**
Engagement & Outreach		**Status**	**% Complete**
Planning, organization, and technical program review for the 2026 IEEE-VTS INNOVARail Conference to be held in May 2026. (See Section 1.2.5)		**In Progress**	**95%**
Planning for the 2026 UTCRS STEM Summer Camps and Teacher Workshop. Over **925** already enrolled, and over **1000** expected to participate this summer.		**In Progress**	**85%**
Onsite visits to UTCRS facilities by personnel from Class I railroads, short lines, and equipment manufacturers.		**Ongoing**	
UTCRS Website updates		**Ongoing**	

1.2.1 FRA Sponsored Collaboration

In January 2026, final FRA approval was gained and funding initiated for a consortium under the CRISI program. This collaboration is led by the Brotherhood of Railroad Signalmen (BRS), which includes UTCRS, Hum Industrial Technologies, Inc., and ENSCO-TTC. In addition, subcontractors Tidal Basin, Signal

Technology Solutions, and Hill International are participating. Total funding for the project is **$9.7** million of which the UTCRS is managing a **$7.5** million portion of this grant. The goals of the project are to:

- integrate onboard sensing into railroad operations,
- test performance against existing wayside technologies,
- develop new wireless communication capabilities for onboard sensors,
- integrate onboard-generated warnings into positive train control (PTC) systems, and
- train of rail industry professionals on installation and operation.

Specific accomplishments at UTRGV during the reporting period include:

- Hosting a February 24-26th technical kickoff meeting at UTCRS, attended by all consortium members, to create a project schedule, identify challenges and critical paths, and construct a preliminary system architecture.
- Monthly update meetings with BRS and FRA, and weekly technical meetings with Hum Industrial on the design and testing of a railcar-to-wayside communication solution.
- Completion of a hardware prototype for the railcar-to-wayside link by Hum, with an identical prototype for lab and field testing built at UTCRS. Firmware development is currently in progress, with lab and roadside tests at UTCRS and on-track testing at ENSCO (TTC) planned for the summer.
- Finalized plans for a training workshop on onboard sensing, to be given at the IEEE-VTS INNOVARail Conference on May 26, 2026, in Champaign, IL.

1.2.2 Completion of Oak Ridge National Laboratory (ORNL) Project

In previous reports, we described an ORNL-funded project for laboratory benchmark testing of an ORNL bearing vibration and temperature monitoring system intended for specialty railcars transporting spent nuclear fuel. In the current reporting period:

- UTCRS completed the tests requested by ORNL on our SBT (single bearing tester), including tests with impact simulating wheel flats and/or track defects.
- UTCRS provided ORNL with our own vibration and temperature data, simultaneously collected for validation purposes.
- The project was closed out and the system hardware was returned to ORNL.

1.2.3 Expanded Collaboration with Iron Horse

UTRGV has significantly expanded our work with Iron Horse, operator of the Rio Valley Switching Company, which operates on more than 73 miles of track in South Texas. New accomplishments during the report period included:

- A two-month pilot test of new wireless onboard load-sensing technology developed by UTCRS for Hum Industrial. See Section 4 for more discussion. This pilot test was conducted on hopper cars operated by Iron Horse.
- Field measurements of vibration crosstalk between bearings, using a data acquisition system developed entirely at UTCRS. This information will make bearing defect detection more accurate and reduce false positives.
- Preliminary field measurements of sub-GHz radio propagation channels between positions on railcars. This data will enable better antenna designs and transmit power management, leading to extended battery life.

1.2.4 Expanding Capabilities and Services

UTCRS is continuously working to upgrade our test facilities and expand services that can be offered to industry and government. One landmark accomplishment during this period was installation of a new 40-ft rail track panel. The rail components and material required to fabricate the 40-ft track panel were provided by BNSF Railway, a Class I railroad. This major facility adds important new capabilities including:

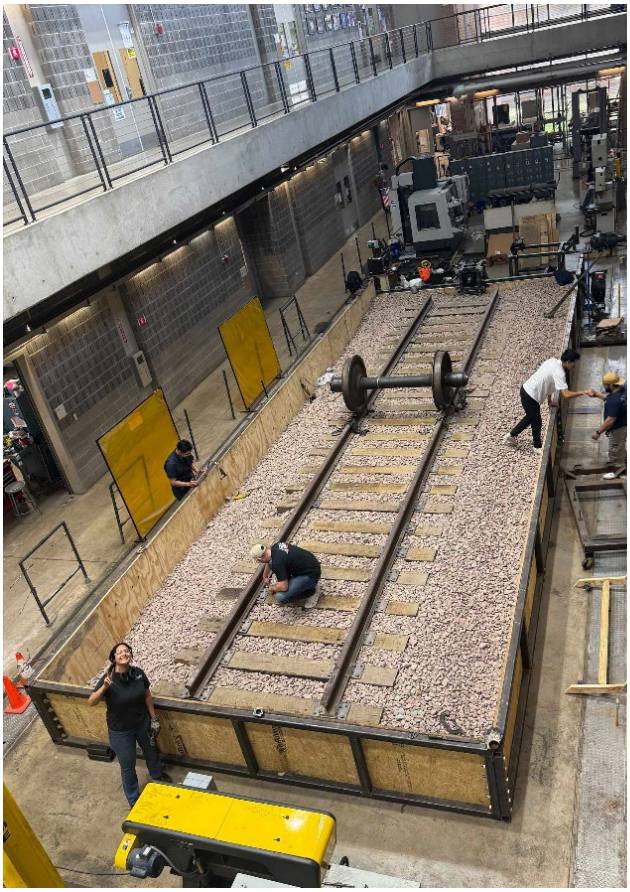

Figure 1 – New UTCRS 40-ft Rail Track Panel

- Realistic testing of rail resistance to movement, including the effects of ballast. Quantifying this resistance is critical for controlling rail neutral temperature (RNT) to prevent buckling and breakage.
- In-house emulation and evaluation of track-mounted sensors and cameras.
- A testbed for prototyping automated rail condition monitoring technologies, including low-profile track-crawling robots and rail inspection drones.

Other initiatives include:

- Fabrication of two new testers, one advanced single bearing tester (SBT) with improved wheel and track impact replication, and one four bearing tester (4BT) with expanded testing capability.
- Adding data to our searchable database of bearing vibration and temperature profiles, which includes more than 12 years' worth of data and hundreds of distinct experiments. The database has already attracted a new collaborator, Oracle North America Consulting. See Section 3.2.2.

1.2.5 Final Preparation for 2026 IEEE-VTS INNOVARail Conference

UTCRS is one of three transportation centers (along with NuRail CoE and C-STTAR) collaborating on organizing the inaugural INNOVARail Conference, a major rail-focused venue intended to bring together academia, rail industry stakeholders, and state and federal agencies. UTCRS Director, Constantine Tarawneh, is Technical Program Chair for the conference, which is sponsored by the IEEE Vehicular Technology Society. IEEE sponsorship means the papers will be archived and widely available in the highly prominent IEEE Xplore database. During this reporting period:

- Final versions of all technical papers were received and reviewed.
- The technical program was finalized. It includes 32 sessions and 138 papers, not including student posters, all focused on railroad technology and operations.
- As part of this conference, BRS, UTCRS, and Hum are organizing a well-publicized workshop on new rail sensing technologies, integration with rail operations, and role of labor organizations.

1.2.6 Current UTCRS Sponsored Research Projects

Eighteen (18) research projects for 2025CY, listed in Table 2 were initiated September 2025 after receiving final approval from USDoT UTC Program leadership. Eleven projects have industrial and/or government agency partners, and twelve early-career academic professionals are PIs or co-PIs. Selected highlights from UTCRS sponsored research are mentioned in Section 4. Problem statements and goals for each project can be found in the Exhibit D links provided in Table 2.

The table does not include 17 research projects for 2023CY and 20 research projects from 2024CY. Final reports for completed projects from previous years are available on the UTCRS website.

Table 2 – 2025CY Research Projects	Status
1. (Infrastructure) Advanced Model for Predicting Buckling in Rails	In progress
2. (Infrastructure) Computational Model for Predicting Fracture in Rails Subjected to Long-Term Cyclic Fatigue Loading	In progress
3. (Infrastructure) Temperature-Induced Cyclic Loading Effects on Rail Anchor Slip Force	In progress
4. (Infrastructure) Buckling and Breakage Prevention in Continuous Welded Rail (CWR) Using Improved Longitudinal Resistance Modeling Software	In progress
5. (Infrastructure) Evaluating Ballast Performance with Freeze/Thaw Cycles	In progress
6. (Infrastructure) Experimental Determination of Crack Growth in Rails Subjected to Long-Term Cyclic Fatigue Loading	In progress
7. (Infrastructure) Rapid Detection of Track Changes from In-Motion Data Acquisition Records: Lab Setup and Field Implementation - Year 3	In progress
8. (Infrastructure) Experimental Determination of Rail Fracture Properties	In progress
9. (Mechanical) Comparison of Onboard Condition Monitoring System Mounting Location for Freight Railcar Bearing Defect Detection Using Vibration Signatures	In progress
10. (Mechanical) Effect of Long-Term Inactivity on Railcar Bearing Lubricant and Seal Function	In progress
11. (Mechanical) Laboratory and Field Testing of an Impact-Driven Multi-Resonant Energy Harvester for Electrical Power Generation in Rail-Track Systems – Phase II, Year 2	In progress
12. (Mechanical) Non-Contact Energy Harvesting for Rural Grade Crossings – Year 3	In progress
13. (Mechanical) Ultrasonic Inspection of Reconditioned Railroad Bearing Components – Year 3	In progress
14. (Operations) Quantifying Traffic at Highway-Rail Grade Crossings Using Artificial Intelligence	In progress
15. (Operations) Design of Dynamic Train Crossing Estimation and Real-Time Traffic Control Systems for Grade Crossing Safety	In progress
16. (Operations) Intelligent Aerial Drones for Railroad Track Traversability Assessment, Intrusion Detection and Integrity Evaluation	In progress
17. (Operations) Multi-modal AI Agents for Railway Safety	In progress
18. (Operations) Non-Motorist Safety at Highway-Rail Grade Crossings: Developing a Crash Prediction Model with Integrated Non-Motorist Exposure – Year 3	In progress

1.3 How have the results been disseminated?

1.3.1 Direct Interaction with Industry and Government Partners

In many cases, UTCRS directly sends results to key stakeholders and partners. In the current reporting cycle, this includes:

- Transfer of design files, prototypes, and calibration data to Hum Industrial, our industry partner.
- Transfer of rail fracture and buckling data to MxV Rail, an international rail testing facility.
- Transfer of vibration data to Oracle North America and other users.
- Transfer of vibration data to Oak Ridge National Laboratory.
- Transfer of rail anchor performance data to BNSF Railway and MxV Rail.
- Transfer of reconditioned bearing data to AAR via MxV Rail.
- Transfer of inactive bearing performance data to NTSB, MxV Rail, and Class I Railroads.

1.3.2 Professional Community

Publications: For the professional community, the primary dissemination is through publications in journals and conferences. During this reporting cycle, we have 49 conference and journal publications, listed in Table 4 in Section 3 (Outputs). UTCRS is planning a major presence at the 2026 IEEE-VTS INNOVARail Conference. The center is one of the sponsoring organizations, and more than 30 UTCRS

faculty, staff, and students are expected to attend and present their work as part of the technology transfer initiatives of the center. A well-publicized workshop is also planned as part of the conference.
Memberships: UTCRS personnel have been actively engaged in technical committees, panels, and industry organizations. The following is a list of activities during this reporting period:

- **Constantine Tarawneh (UTRGV)** is technical chair for the inaugural 2026 IEEE-VTS INNOVARail Conference, which will be one of the largest rail-focused conferences in North America. He is also serving as a guest editor for an MDPI Applied Sciences journal special issue entitled "Resilient and Sustainable Railway Infrastructure: Monitoring, Inspection, and Innovative Technologies."
- **Heinrich Foltz (UTRGV)** along with Hum Industrial collaborator Brent Wilson are Guest Editors for an Applied Science special issue on "Technical Advances in Railway Systems: Condition Monitoring, Smart Control and Optimization."
- **Dimitris Rizos (USC)** is on the technical committees AREMA 24, TRB AR060, and is the academic Co-coordinator for the AREMA Railway Engineering Education Symposium and scientific committee of the 2026 INNOVARail conference.
- **Yu Qian (USC)** is on Technical Committee (TC) 202, International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), and the AAR Substructure Technical Advisory Group (TAG). He serves as Communication Coordinator for TRB committee AR060, Associate Editor for the Journal of Smart and Resilient Transportation, and is on the editorial boards of High-Speed Railway, Intelligent Transportation Infrastructure, and Transportation Geotechnics.
- **Nikolaos Vitzilaios (USC)** is an Editor for the Journal of Intelligent & Robotic Systems, and Associate Editor for IEEE Robotics and Automation Letters.
- **Yuche Chen (USC)** is a member of the Editorial Board for Transportation Research Part D, serves as research coordinator for the Transportation Research Board Committee on Transportation Environment and Ecology AEP 70.
- **Evangelos Papalexakis (UCR)** is the Steering Committee Chair for the 2026 SIAM International Conference in Data Mining, an Action Editor for Springer Data Mining and Knowledge Discovery, Associate Editor for IEEE Transactions on Intelligent Systems and Technology, General Co-Chair for SIAM International Conference and Co-Chair for the ACM SIGKDD 2026 Blue Sky Ideas Track.
- **Aemal Khattak (UNL)** is an editorial board member of the Transportation Research Board and Area Editor with the Journal of Transportation Safety and Security.
- **Carl Nelson (UNL)** is joint Editor in Chief of ASME Journal of Medical Devices, Associate Editor for Robotica and Mechanism & Machine Theory, conference organizing committees for Design of Medical Devices Conference and ASME IDETC, member of external advisory board for BYU-I mechanical engineering program.

1.3.3 General Community

UTCRS reaches the general community through news media, online presence, campus events, and direct contacts. Two recent examples are UTRGV news stories related to work performed by UTCRS students:

- The Newsroom - TRAINING TOMORROW'S RAILROADERS: UTRGV engineering students build 40-foot track panel to advance railway safety research
- A LinkedIn story about the development and testing of an onboard railcar load sensor as part of the partnership with our rail industry partner, Hum Industrial Technologies, Inc.

The UTCRS website has photos (https://www.utrgv.edu/railwaysafety/news/gallery/index.htm) and news, particularly about K-12 events such as UTCRS STEM Summer Camps and teacher workshops, awards received by UTCRS students, and trips such as the annual TRB meeting. Our main website (https://www.utrgv.edu/railwaysafety/) gives a more in-depth look intended for both professionals and the general public.

1.4 What do you plan to do during the next reporting period to accomplish the goals?

Our objectives for the next reporting period (April 1, 2026 – September 30, 2026) include:

- **Administrative**
  - Meet all USDoT UTC Program reporting requirements including semi-annual progress meeting
  - Complete External Advisory Board (EAB) review of 2026CY research projects
  - Submit 2026CY research projects for USDoT approval
  - Initiate funding for projects approved by EAB and USDoT
- **Research**
  - Complete approved 2025CY research projects and Initiate 2026CY approved projects
  - Continue to engage with rail industry stakeholders as part of our technology transfer activities
  - Submit manuscripts for journal and conference publications
  - Expand UTCRS test facilities to improve service to rail industry and increase pace of research
- **Education and Workforce Development**
  - Continue to employ, train, and develop undergraduate and graduate student researchers
  - Continue offering students opportunities to take on professional responsibilities by directly interacting with industry and government partners of the UTCRS
  - Send students for Summer 2026 research experiences and industrial internships
  - Offer transportation-related courses for the Fall 2026 and Spring 2027 semesters
  - Offer a national workshop at the 2026 INNOVARail Conference (see Section 4.2.2)
  - Offer webinars and workshops on railway safety technology
- **Engagement and Outreach**
  - Engage over 1000 students at the 2026 UTCRS STEM Summer Camps
  - Engage dozens of teachers at the 2026 UTCRS Summer Teacher Workshops
  - Build on our existing relationships with rail labor organizations

Our strategies to ensure the accomplishment of these objectives include the following:

- Communicate effectively with USDoT UTC administration and respond promptly to all guidance
- Implement recommended improvements to project selection process
- Hold regular (at least monthly) meetings of the UTCRS Executive Committee
- Hold regular (at least twice per year) meetings with our External Advisory Board (EAB)
- Hold bi-weekly meetings of faculty with research students to provide mentorship and training
- Student workforce development through weekly presentations to our rail industry partners
- Emphasize to UTCRS faculty and students the importance of technology transfer practices
- Make sure all PIs are aware of reporting and data management requirements
- Solicit more industry projects in which students can engage with engineering professionals
- Give students leadership roles in mentoring and outreach via community engagement events
- Create a productive, collaborative work environment where initiative by young researchers is encouraged, facilities are accessible, and adequate resources are available
- Continue to build relationships with school districts and community partners

2. PARTICIPANTS AND COLLABORATING INSTITUTIONS

2.1 What organizations have been involved as partners?

Table 3 – Participants and Collaborating Institutions

Organization and Location	Contribution
University of Texas Rio Grande Valley (UTRGV)	**Consortium Institution and Project Lead**

Edinburg, TX	Extensive facilities for railway research with a focus on railcar rolling stock and sensors. Financial and in-kind support for research projects (five in CY2023, eight in CY2024, and six in CY2025).
University of South Carolina (USC) Columbia, SC	**Consortium Institution** Extensive facilities for railway research with a focus on infrastructure inspection. Financial and in-kind support for research projects (five in CY2023, four in CY2024, and four in CY2025).
University of Nebraska – Lincoln (UNL) Lincoln, NE	**Consortium Institution** Extensive facilities for railway research with a focus on intelligent transportation systems. Financial and in-kind support for research projects (three in CY2023, three in CY2024, and three in CY2025).
Texas A&M University (TAMU) College Station, TX	**Consortium Institution** Extensive railway research facilities at the Center for Infrastructure Renewal (TAMU-CIR). Financial and in-kind support for research projects (four in CY2023, four in CY2024, and four in CY2025).
University of California Riverside (UCR) Riverside, CA	**Consortium Institution** Computing facilities made available for UTCRS research include a Lambda Vector Server with three NVIDIA RTX A6000 GPUs. Financial and in-kind support for one research project each year.
South Texas College (STC) McAllen, TX	**Consortium Institution** STC operates the UTCRS Bridge to Engineering (B2E) program, including recruitment, selection, and orientation prior to transfer.
MxV Rail Pueblo, CO	**National Rail Testing Facility – Industry Collaborator** Technical support and consultation for UTCRS research projects, including the rail buckling and rail fatigue modeling projects at TAMU, and rail anchor and reconditioned bearing testing at UTRGV.
Transportation Technology Center (TTC) Operated by ENSCO, Inc. Pueblo, CO	**FRA Testing Facility – Industry Collaborator** ENSCO, Inc., is a partner on the newly funded FRA CRISI award. They will facilitate testing of new technologies in their TTC facility.
Hum Industrial Technology, Inc. St. Louis, MO	**Industry Sponsor** Hum financially sponsors onboard sensor research carried out at UTCRS and provide in-kind contribution of their wireless sensors and gateways. They also facilitate technology transfer and deployment of our newly developed sensor technologies worldwide.
CSX Transportation Jacksonville, FL	**Industry Collaborator** CSX is a primary partner for the inactive rail bearing study. They locate and provide UTCRS with bearings that have experienced long periods of inaction and/or unusual weather conditions.
BNSF Railway Fort Worth, TX	**Industry Collaborator** BNSF is our main partner and inspiration for the rail anchor slip project. They provide technical support and consultation, and supplied and helped us install a 40-ft track panel for an indoor testbed.
Ironhorse Resources and Rio Valley Switching Company (RVSC) McAllen, TX	**Industry Collaborator** Ironhorse Resources is the owner and operator of multiple short lines in Texas, including the RVSC. We have an agreement with Ironhorse to access RVSC facilities for testing and assessment of our sensors, energy harvesting, and grade crossing monitors.
Oak Ridge National Laboratory (ORNL) Oak Ridge, TN	**Industry Sponsor** ORNL has contracted with UTCRS to provide testing and calibration services for ORNL-developed vibration and temperature sensors for railcars carrying nuclear waste.

Brotherhood of Railroad Signalmen (BRS) Front Royal, Virginia	**Labor Organization Collaborator** BRS represents over 10,000 technical professionals working on railway signals, including hazard detection and positive train control. BRS and UTCRS are collaborating on an FRA CRISI funded project to develop and integrate our technologies into the existing railway signals framework. This collaboration includes workforce development, trainings, and workshops for students, staff, and railroad workers.
National Transportation Safety Board (NTSB) Washington, DC	**Government Agency Collaborator** NTSB is the driver for the inactive bearing study that is investigating the effects of long periods of inactivity on bearing performance.
Oracle North America Consulting Redwood Shores, CA	**Industry Collaborator** Oracle uses datasets from the UTCRS online database to demonstrate the potential of their MSET2 software in detecting defective bearings.
Riverside Transit Authority (RTA) Riverside, CA	**Government Collaborator** RTA collaborates with the AI and machine learning group at UTCRS-UCR to share data and methodology.
Vanguard Academy Edinburg, TX	**Community Collaborator** Vanguard Academy participates in the annual UTCRS STEM Camps.
Region One Education Service Center Edinburg, TX	**Community Collaborator** The Region One Education Service Center assists school districts in South Texas. UTCRS works with Region One to develop teacher training programs and workshops and K-12 student recruitment
IDEA Public Schools Weslaco, TX	**Community Collaborator** IDEA Public Schools participate in the annual UTCRS STEM Camps.
La Joya Independent School District La Joya, TX	**Community Collaborator** La Joya ISD participates in the annual UTCRS STEM Summer Camps.
Weslaco Independent School District Weslaco, TX	**Community Collaborator** Weslaco ISD participates in the annual UTCRS STEM Camps.
South Texas ISD Edinburg, TX	**Community Collaborator** South Texas ISD participates in the annual UTCRS STEM Camps
Pharr-San Juan-Alamo ISD Pharr, San Juan, Alamo, TX	**Community Collaborator** PSJA ISD participates in the annual UTCRS STEM Summer Camps.
Monte Alto ISD Monte Alto, TX	**Community Collaborator** Monte Alto ISD participates in the annual UTCRS STEM Camps.
Valley View ISD Pharr, TX	**Community Collaborator** Valley View ISD participates in the annual UTCRS STEM Camps.
Edcouch-Elsa ISD Edcouch, Elsa, TX	**Community Collaborator** Edcouch-Elsa ISD participates in the annual UTCRS STEM Camps.
Edinburg CISD Edinburg, TX	**Community Collaborator** Edinburg CISD participates in the annual UTCRS STEM Camps.
Donna ISD Donna, TX	**Community Collaborator** Donna ISD participates in the annual UTCRS STEM Camps.

3. OUTPUTS

3.1 Publications, conference papers, and presentations

A list of journal and conference submissions and publications during the current reporting period is given in Table 4. Note that this list only includes new publications and publications that have changed status since the last report (e.g., from accepted to published). UTCRS researchers have submitted more than 80 journal and conference publications since the start of funding in June 2023. All publications can be found on the UTCRS website at https://www.utrgv.edu/railwaysafety/technology/index.htm.

Table 4 – Journal and Conference Publications (Reporting Period Only)			
Citation	**Type**	**Status in Previous Report**	**Status in Current Report**
1. G. Gutierrez, G. Ali, and C. Tarawneh (2026). "Network-Level Risks of Extreme Temperature Weather on Rail Infrastructure: A Graph-Based Probabilistic Risk Assessment Framework." Journal of Infrastructure Systems, ASCE	Journal	N/A	Submitted
2. M.I. Monsury, M. Amjadian, P. Mensah, C. Tarawneh, J. Turner, and H. Foltz (2026). "Impact-Driven Dual-Resonator Electromagnetic Energy Harvester with Dynamic Coupling for Broadband Power Generation."	Journal	N/A	Submitted
3. U.M. Farooq, M. Bukhari, A.J. Khattak, and M.N. Aman (2026). "Investigating Non-Motorist Exposure at Highway-Rail Grade Crossings Using AI-Based Object Detection and Generalized Linear Count Models." Transportation Research Record, Journal of the Transportation Research Board, (Ms. No. 24-01649R2)	Journal	N/A	Submitted
4. T.-M. Liu, V. Musu, and D.H. Allen (2025). "Computational Model for Predicting Buckling due to Rail Misalignment in Railways."	Journal	N/A	Submitted
5. S. Reddy, Y.-R. Kim, and D.H. Allen (2025). "Simulation of the Properties of Rails Undergoing Fracture due to Cyclic Loading."	Journal	N/A	Submitted
6. S. Saberi, and D. Allen (2025). "Simulation of Crack Growth in Rails Due to Cyclic Loading Using a Nonlinear Cohesive Zone Model."	Journal	N/A	Submitted
7. B. Altay, S. Saberi, and D.H. Allen (2025). "Computational Evaluation of Fracture Parameters for Modeling Crack Growth in Rails Due to Cyclic Loading."	Journal	N/A	Submitted
8. S. Saberi, and D.H. Allen (2025). "Multiscale Modeling of Seasonal Thermal–Mechanical Effects on Subsurface Crack Growth in Continuously Welded Rail."	Journal	N/A	Submitted
9. S. Saberi, D.H. Allen, and Y.-R. Kim (2025). "Experimental and Multiscale Computational Investigation of Subsurface Crack Propagation in Railheads under Rolling Contact Fatigue," International Journal of Rail Transportation	Journal	N/A	Submitted
10. S. Saberi, and D.H. Allen (2025). "Computational Analysis and Comparison of One-Way and Two-Way Multiscale Models."	Journal	N/A	Submitted
11. Y.G. Tang, and Y. Qian (2026). "Real-Time Railroad Crossing Surveillance with YOLO-RCNN and Edge Computing," Engineering Applications of Artificial Intelligence. (https://doi.org/10.1016/j.engappai.2025.113338)	Journal	Under Revision	Published
12. D.C. Rizos, S. Byraju, M.A. Sutton, and N. Li (2025). "Implementation of Multi-Temporal SAR for Ground Hazard Risk Monitoring on the Railway Right of Way," Transportation Research Record: Journal of the Transportation Research Board (https://doi.org/10.1177/03611981251372086)	Journal	Accepted	Published
13. V. Musu, D.H. Allen, G. Fry (2025). "Computational Model for Predicting Lift-Off Induced Buckling in Rail Structures," ASCE Journal of Engineering Mechanics https://doi.org/10.1061/JENMDT.EMENG-8584	Journal	Accepted	Published
14. S. Ocaña, S. Flores-Osuna, G. Ali, C. Tarawneh, "Estimating highway rehabilitation projects using machine learning," 2026 Construction Research Congress (CRC), San Antonio, TX, March 18-21	Conference	Accepted	Published

15. G. Gutierrez, G. Ali, C. Tarawneh, “Evaluating the impact of extreme temperature events on the US rail network,” 2026 Construction Research Congress (CRC), San Antonio, TX, March 18-21	Conference	Accepted	Published
16. S. Flores-Osuna, G. Ali, D. Espinoza, F. Chavez, and C. Tarawneh, “Detecting Hazards at Rail Grade Crossings using Computer Vision and AI,” 2026 Construction Research Congress (CRC)	Conference	Accepted	Published
17. R. Naseri, B. Gedney, and D.C. Rizos, “Development and Implementation of a Novel Technique for In-Motion Track Change Detection and Identification,” Transportation Research Board Annual Meeting, TRBAM-26-02692, Washington, DC, 2026	Conference	Accepted	Published
18. D. Aguila, A. Blanton, S. Luna, A. Gonzalez, C. Tarawneh, B. Wilson, “Development and Testing of an Onboard Load Sensor Embedded within Passive Steering Bearing Adapter Pads,” 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
19. A. Sanchez Trinidad, J. Montalvo, C. Tarawneh, A. Fuentes, “Examining the Effects of Lateral Loading on Freight Tapered Roller Bearings,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
20. S. Flores-Osuna, G. Ali, C. Tarawneh, “Traffic Tracking at Grade Crossings using AI,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
21. D. Cantu, S. Martinez, C. Tarawneh, P. Xu, H. Foltz, D. Timmer, “Feature Extraction from Railroad Bearing Onboard Vibration Sensors Using Machine Learning Models,” 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
22. D. Vera, J. Encinia, S. M. Rahmaninezhad, C. Tarawneh, A. Fuentes, “Temperature Effect on Rail Anchor Longitudinal Resistance,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
23. E. Cantu, S. Martinez, C. Tarawneh, J. Yang, P. Xu. “Predictive Condition Monitoring of Freight Rail Bearings: A Vibration-Based Machine Learning Approach,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
24. J. Montalvo, S. Garcia, J. Mojica, C. Tarawneh, H. Foltz. “Accelerometer Placement Effect on Measured Vibration Response of Freight Railcar Bearings,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
25. C. Tarawneh, M. Abrego, K. Lopez, A. Serrano, M. Adame, R. Jones, “Effects of Prolonged Inactivity on Railcar Bearing Performance,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
26. R. A. Palacios Jr., C. Tarawneh, H. Foltz, B. Wilson, “Integration of Solar Energy Harvesting on Wireless Onboard Condition Monitoring Systems for Long-Term Power Sustainability,” 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
27. R. Avila, R. Salinas, H. Foltz, C. Tarawneh, B. Wilson, “A Comparative Study of Analog and Digital Accelerometers: Performance, Signal Integrity, and Application Suitability for the Rail Industry,” 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
28. A. Sanchez, M. Amjadian, C. Tarawneh, and H. Foltz, “Harvesting Electrical Energy from Vibration of Railway Track Using an Electromagnetic Energy Harvester with Circular Halbach Array,” 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
29. O. Bulguoglu, Y.-R. Kim, T.-M. Liu, and D.H. Allen, “Nonlinear Displacement Controlled Computational Model for Predicting Buckling and Post-Buckling Response of Rail Structures,” 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted

30. S. Saberi, and D. Allen, "Multiscale Modeling of Seasonal Thermal Mechanical Effects on Subsurface Crack Growth in Rails," 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
31. H. Mortazavi, S.R. Kommidi, Y.-R. Kim, and D.H. Allen, "Fatigue Crack Modeling in Railheads: Material Characterization and Simulation of Varying Flaws," 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
32. R. Naseri, B. Gedney, D.C. Rizos, "Detection of Temporal and Spatial Track Stiffness Changes Using Multi-Run Onboard Data" 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
33. B. Gedney, R. Naseri, D.C. Rizos, "A Data-Driven Health Monitoring Concept for Railway Bridges Under Loaded Conditions: Feasibility Study," 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
34. D.C. Rizos, B. Gedney, R. Naseri, "On the Field Implementation of a Non-Contact System for Rail Neutral Temperature and Rail Stress Measurements," 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
35. T. Sucin, N. Vitzilaios, and D.C. Rizos, "Vision-Based UAV Navigation for Autonomous Railway Inspection," 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Full Paper Accepted
36. D. Ahn, H. Patel, A. Khattak, J. Chen, E.E. Papalexakis, "Extracting and Analyzing Rail Crossing Behavior Signatures from Videos Using Tensor Methods," 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Full Paper Accepted
37. D. Tu, Y. Qian, "Investigating the Effect of Freeze-Thaw Cycles on the Permanent Deformation Behavior of Railroad Ballast through Large-Scale Triaxial Cyclic Testing," 2026 IEEE INNOVARail Conference	Conference	Abstract Accepted	Accepted for Presentation
38. M. Bukhari, A.J. Khattak, and M.N. Aman, "Impact of Non-Motor Vehicle Traffic on Highway-Rail Grade Crossing Crash Prediction," 2026 IEEE INNOVARail Conference, Champaign, IL, May 26-28	Conference	Abstract Accepted	Accepted for Presentation
39. E. Cantu, A. Rodriguez, A. Hernandez, S. Martinez, C. Tarawneh, L. Ai, J. Yang, "Quantitative Vibration-Based Prognostics of Railcar Bearings Using Encoder-Decoder LSTM," ASME 2026 53rd Annual Review of Progress in Quantitative Nondestructive Evaluation, Albuquerque, NM, September 13-16	Conference	N/A	Paper Submitted
40. A. Rodriguez, A. Hernandez, E. Cantu, C. Tarawneh, Q. Lu, L. Ai, J. Yang, "Laser-Excited Downconversion Nanoparticle Sensing for Crack Characterization in Infrastructure Monitoring," ASME 2026 53rd Annual Review of Progress in Quantitative Nondestructive Evaluation, Albuquerque, NM, September 13-16	Conference	N/A	Paper Submitted
41. R. Naseri, B. Gedney, and D.C. Rizos, "Development and Implementation of a Novel Technique for In-Motion Track Change Detection and Identification," Transportation Research Board Annual Meeting, TRBAM-26-02692, Washington, DC, 2026	Conference	Accepted	Published
42. C. Lim, H.S. Shahgir, Y. Dong, J. Chen, and E.E. Papalexakis, "A Real-Time System to Populate FRA Form 57 from News," 19th ACM International Conference on Web Search and Data Mining, Demonstrations Track, Boise, ID, February 22-26, 2026	Conference	Accepted	Published
43. C. Tarawneh, J.R. Pams, J.M. Montalvo, and H.D. Foltz, "Effect of Outer Raceway Indexing on the Measured Vibration Response of Defective Railway Tapered-Roller Bearings," IHHA-WCRR 2025 Joint Conference, Colorado Springs, CO, November 17-21	Conference	Accepted	Published
44. S. Martinez, E. Miranda, C. Tarawneh, N.J. Matz, and J.A. Turner, "Defect Prediction for Bearings Using Ultrasonic and Eddy Current Inspections," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Published

45. M. Adame, R. Jones, D. Timmer, and C. Tarawneh, "Effect of Extended Bearing Inactivity on Lubricating Grease Characteristics and Performance," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Published
46. P. Mensah, J. Turner, C. Nelson, M. Amjadian, C. Tarawneh, "Non-Contact Energy Harvester for Rural Grade Crossings," IHHA-WCRR 2025 Joint Conference, Colorado Springs, CO, November 17-21	Conference	Accepted	Published
47. B. Gedney, R. Naseri, D.C. Rizos, "Accounting for Spatially Varying Track Conditions in Derailment Risk Assessment," IHHA-WCRR 2025 Joint Conference, Colorado Springs, CO, November 17-21	Conference	Accepted	Published
48. T. Sucin, N. Vitzilaios, B. Gedney, "Robust Track Following for UAV-Based Inspection," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Published
49. O. Bulguoglu, G. Dorsett, G. Whetstone, Y.-R. Kim, and D.H. Allen, "Experimental Assessment of Fracture in Rails Due to Cyclic Loading," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Published
50. S. Saberi, D.H. Allen, and Y.-R. Kim, "Modeling Crack Growth Due to Cyclic Loading in Rails Using a Cohesive Zone Model Embedded within a Finite Element Code," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Published
51. H. Mortazavi, S.R. Kommidi, Y.-R. Kim, and D.H. Allen, "Development of Materials Parameters for Prediction of Rail Fracture," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Published
52. E.E. Papalexakis, R. Jiang, M. Gutierrez, D. Ahn, P. Xu, C. Tarawneh, and J. Chen, "Tensor Mining of Public Railroad Accident Reports," IHHA-WCRR 2025 Joint Conference	Conference	Accepted	Presented

3.2 Website(s) or other internet site(s)

3.2.1 Main Website

The main UTCRS website is located at: https://www.utrgv.edu/railwaysafety/. The UTCRS website is intended to reflect the full spectrum of research, education, workforce development, technology transfer, outreach activities, trainings, and student opportunities and programs available at UTCRS. During this reporting period, the following changes were made to the website: (a) updated list of publications, (b) uploaded new reports, (c) updated photo galleries, and (d) updated registration information for summer STEM camps and teacher STEM workshop.

It should be noted that links for completed project reports uploaded to our website are also submitted to the Transport Research International Documentation (TRID) database for indexing, to increase visibility and access to the information, and facilitate technology transfer to the transportation industry globally.

3.2.2 Online Database for Bearing Test Data

UTCRS continues to maintain and upgrade its publicly accessible portal for bearing test data, which is available at http://utcrsdatabase.ad.utrgv.edu/. This searchable database allows direct access to raw data from over 12 years of research. The new version has automated real time upload of data from tests in progress. The database is already attracting users, and has resulted in a new collaboration with Oracle North America, who are using data to demonstrate the effectiveness of their MSET2 (Multivariate State Estimation Technique 2) machine learning technology for automated analysis of vibration data.

3.2.3 Facebook and LinkedIn Pages

UTCRS maintains a Facebook page (https://www.facebook.com/utcrailwaysafety/) and a LinkedIn page (https://www.linkedin.com/company/3729566/admin/dashboard/) with news, photographs, and center events and activities undertaken by the UTCRS, particularly about summer camps and other outreach events and conferences. It is intended to provide the public with general information about the UTCRS.

3.3 Technologies or techniques

Most UTCRS projects and publications are oriented toward deliverable products or actionable data. To avoid repetition, recent technologies and techniques developed by UTCRS are listed in Section 4.

3.4 Inventions, patent applications, and/or licenses

[1] "Non-Contacting Energy Harvester for Railroads," provisional application 63/917,852 was submitted on 11/14/25 based on work supported by UTCRS-UNL.
[2] "Autonomous Railroad Intrusion Detection System with UAV Imagery", previously reported by UTCRS-USC as provisional, is now U.S. Patent Application No. 63/918,082.
[3] (USC) "In-Motion System for Track Stiffness Change Detection," Provisional Patent Application: USC ID No. 1765
[4] (USC) Patent Application 63/603,182 "Portable Railroad Grade Crossing Monitoring System" is now being offered for licensing at (http://techfinder.sc.edu/technology/55198).
[5] (USC) Patent Application 63/565,581 "Rail Surface Defect Detection from Onboard Vibration Sensors."
[6] (UTRGV) Ongoing licensing agreement with Hum Industrial Technologies, Inc., for UTCRS-UTRGV patented sensor technology.

3.5 Other products

During the reporting period, UTCRS supported students produced (a) 4 Master's theses, and (b) 2 Doctoral Dissertations. Moreover, TAMU has an ongoing agreement with MxV Rail to transfer rail buckling models and relevant testing and validation data.

4. OUTCOMES

4.1 Research

This section highlights recent outcomes from selected UTCRS projects. For more detailed information, see our Final Reports which are available at the center website (http://www.utrgv.edu/railwaysafety) and uploaded to the Transport Research International Documentation (TRID) database. During the current reporting period, the following new technologies and techniques were developed:

4.1.1 Onboard Sensing

- A new onboard load sensor prototype developed by UTCRS for Hum Industrial for Class F bearings using metal-polymer adapter pads. This technology entered field tests on cars operated by the Rio Valley Switching Company in December 2025. The sensor enables continuous monitoring of railcar weight to facilitate loading, detect loss of product, and get warnings of major load shifts.
- A second onboard load sensor prototype developed by UTCRS for Hum Industrial, designed for adapters used in Australian service, entered field tests in Australia in October 2025. This pilot field test is ongoing and has resulted in the rail company requesting eight more railcars be outfitted.
- New tabular data showing equivalent values of vibration strength for different sensor placements. Due to a wide variety of adapter types used in industry, it is often necessary to reposition sensors. This data allows sensors developed for one adapter type to be used accurately in new configurations. This work will be shared at the rail-focused INNOVARail Conference in May 2026.
- A new, reduced size wireless vibration and temperature sensor that is a functional equivalent of the current Hum Boomerang but miniaturized to about one-fifth the volume to allow more versatile placement and rapid magnet-based attachment. During this reporting period, full functionality and data collection were demonstrated in the UTCRS-UTRGV laboratories.

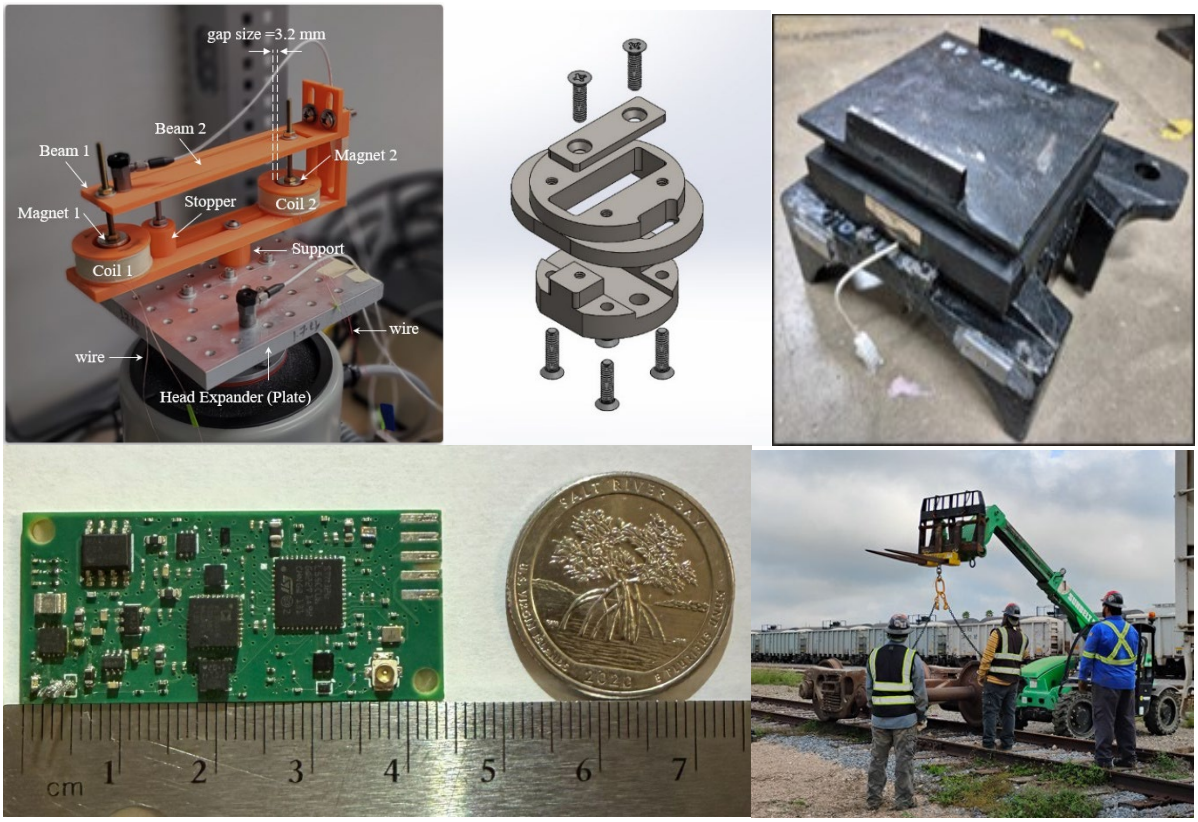

Figure 2 – UTCRS Research Highlights. *(First Row): Prototype of an electromechanical energy harvester to be mounted on railroad bridges; Exploded view of new onboard load sensor transferred to industrial partner; New load sensor embedded in a customer bearing adapter and pad. (Second Row): Miniaturized version of wireless vibration sensor, one-fifth volume of current commercial design; Installation of UTCRS equipment at Rio Valley Switching Company.*

4.1.2 Rail Condition Monitoring and Modeling

- A new, non-contact method for measuring rail neutral temperature and rail stress by UTCRS-USC, to be presented at INNOVARail Conference in May 2026.
- New techniques for detecting changes in rail stiffness, also to be presented at INNOVARail 2026.
- New computational methods for more accurate prediction of rail buckling and cracking, conducted by UTCRS-TAMU in collaboration with MxV Rail.

4.1.3 Energy Harvesting

- Two new prototypes of energy harvesting devices that may power remote rail infrastructure monitoring devices. One developed at UTRGV directly harvests vibrations on bridges; another developed at UNL works off magnetic attraction to passing railcar wheels.
- New performance data on photovoltaic harvesting for wireless onboard devices under challenging conditions of shade, fouling, and abrasion. This data directly motivated design changes to enclosures and photovoltaic cells at Hum Industrial, and should enable substantial improvements in reliability, edge-computing capability, and sensor longevity.

4.1.4 Reconditioned and Inactive Bearings

UTCRS previously reported work in progress on studies of reconditioned bearings and inactive bearings. The test runs have now been completed, with future work awaiting (a) inactive bearings currently in a long-term exposure to weather at UTCRS, and (b) new industry-provided samples of inactive bearings.

- The reconditioned bearing study has shown that certain categories of subsurface defects remaining after the raceway surface is reground can lead to early failure. The work has resulted

in new reconditioning criteria that recommend the use of eddy current non-destructive testing (NDT) as the preferred method for screening. This work has been widely disseminated in reports available online, conference presentations, and presentations by the UTCRS Director to key stakeholders. MxV Rail, Class I railroads, and bearing manufacturers were partners in this work.

- The inactive bearing study demonstrated instances in which long periods of bearing inactivity without rotation led to degradation of lubricant and seals. Damage to seals increases the risk of water ingress and severe damage to the raceway surface. This study, carried out at UTCRS-UTRGV in consultation with NTSB, and supported by bearings provided by CSX Transportation, was limited in size but has proven the existence of the effect and the need for a larger scale study.

4.1.5 Applications of Artificial Intelligence (AI) in Rail Safety

Artificial intelligence, specifically deep learning through convolution neural network architectures, has potential for monitoring and identifying potential hazards. Results from this reporting period include:

- A paper for INNOVARail 2026 which will present a method for extracting railcar velocity from vibration signatures, which is essential for low power sensors without GPS capability.
- New tensor method machine learning algorithms that can automatically mine public sources, including accident reports and news items, to obtain accident data.
- New results on using AI to recognize grade crossing hazards, presented at the 2026 Construction Research Congress (CRC).

4.2 Education, Workforce Development, and Community Engagement

4.2.1 Transportation-Related College Courses Offered

For the October 2025 – March 2026 period, UTCRS-affiliated faculty reported teaching:

- University of Nebraska Lincoln (UNL): 1 graduate course, 1 graduate/undergraduate course.
- University of South Carolina (USC): 3 graduate courses, 3 undergraduate courses.
- University of Texas Rio Grande Valley (UTRGV): 1 graduate course, 3 undergraduate courses.

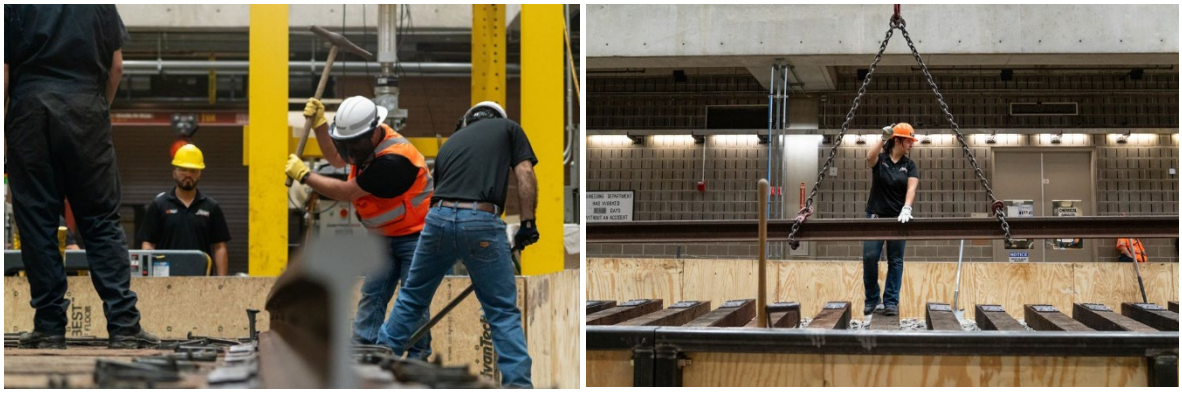

Figure 3 – Workforce Development *– March 2026 - BNSF Railway engineers trained UTRGV students on rail installation techniques. (Left) BNSF engineer demonstrates proper technique for driving a spike; (right) UTCRS student Teresa Salazar Flores supervises lowering of a 40-ft rail segment into place.*

4.2.2 Workshops and Seminars

UTCRS offers both on-campus and online workshops and seminars open to students and faculty. Since June 2023, UTCRS has offered many on-campus workshops given by industry experts, including personnel from CSX, Trinity Rail, BNSF, NTSB, Herzog, MxV Rail, Hum, Signal Training Solutions (STS), and the Brotherhood of Railroad Signalmen (BRS). Recent and scheduled events include:

- In Spring 2026, UTCRS students received direct training in rail installation (see Figure 3) from BNSF Railway engineers during the build of our new 40-ft track panel.

- As mentioned earlier, BRS and UTCRS-UTRGV have scheduled a workshop to be offered at the 2026 INNOVARail Conference on May 26, 2026, titled "Beyond Detection: Combining Wayside Systems Predictive Monitoring and Human Oversight to Prevent Derailments."
- On May 30, 2026, UTRGV will host the 2026 STEM Teacher National Workshop, in which participants will learn how to incorporate Transportation Engineering curricula in the classroom as a way to deliver STEM concepts to students of all grade levels.
- During the reporting period, UTRGV research students presented six seminars as part of their thesis requirements. These covered wireless load sensors for railcars (two seminars), RF propagation on railcars, energy harvesting on railroad bridges, effects of lateral loading on freight car bearings, and performance of recondition railcar bearings.

4.2.3 Student Employment as Researchers

Most research projects had industry and federal partners, giving students direct connections with working engineers and professionals, which has helped them develop technical expertise that are rarely found in new college graduates. Table 5 summarizes the number of students employed at UTCRS.

Table 5 – Student Researchers Employed at UTCRS (This Reporting Period)

Student Researcher Classification	From All Sources	Federal Funds
Undergraduate Research Assistants	41	40
Masters' Research Assistants	25	15
Doctoral Research Assistants	27	20
Totals	**93**	**75**

4.2.4 Internships and REUs

Each summer, UTCRS facilitates the selection of UTRGV undergraduate student participants in a Research Experience for Undergraduates (REU), as well as placement of students in rail industry internships. For Summer 2026, the following eleven placements have already been arranged:

- Three REU students at Texas A&M University (Texas Transportation Institute)
- Three internships at MxV Rail (AAR affiliated rail research facility)
- Two internships at Wabtec (leading provider of rail equipment)
- Two internships at Hum Industrial (manufacturer of onboard railcar sensor equipment)
- One internship at ENSCO/TTC (FRA operated rail research facility)

4.2.5 Bridge to Engineering (B2E) Program

Each summer, UTCRS hosts students making the transition from a two-year pre-engineering program at South Texas College (STC) to upper-level engineering at UTRGV. They receive research employment, mentoring, and tuition support. This summer, we will welcome the fourth cohort of this program with 8 new students joining the UTCRS. To date, this program has successfully onboarded 21 STC students (7 in 2023, 8 in 2024, and 6 in 2025) who transitioned to UTRGV engineering programs, with 8 graduating with their bachelor's degrees already, and 4 continuing with their graduate studies starting this summer 2026.

4.2.7 STEM Summer Camps and Teacher Workshops

Each summer, UTCRS conducts STEM Summer Camps for K-12 students from across the Rio Grande Valley. Students participate in specially designed week-long STEM camps related to transportation engineering with focus on engineering design, programming, robotics, automation, and sensor technologies. The camps foster teamwork and confidence building in all activities. Teacher workshops are run in conjunction with the camps, focusing on ways that teachers can integrate transportation-related topics into STEM teaching. Planning for the Summer 2026 camps including hiring of instructors is nearly complete, and registration is in progress with 925 slots already reserved, and final attendance expected to exceed 1000.

5. IMPACTS

5.1 What is the impact on the effectiveness of the transportation system?

As stated in Section 1, the UTCRS goal is to reduce the number of accidents and equipment failures experienced in rail transportation systems. The projects supported are intended to address a wide variety of safety issues including collisions at grade crossings and on the rail right-of-way, track movement and damage, and bearing and wheel failure. The long-term impact will be a reduction in injuries, fewer service stoppages and interruptions to operations, and more cost-effective maintenance practices.
Here are some examples of specific advances just in the current reporting period:

- More effective bearing reconditioning: UTCRS results presented to the AAR, Class I railroads, and reconditioning facilities led to adoption of new techniques and guidelines to determine bearing suitability for reconditioning. During this reporting period, a major reconditioning facility switched their non-destructive testing (NDT) to eddy current testing based in part on UTCRS findings.
- More effective loading procedures: UTCRS has developed onboard load sensors that can weigh railcars in real time. In addition to preventing overload hazards, these sensors can also facilitate loading cargo at remote locations without scales. During this reporting period, two field tests in Texas and in Australia were completed, and the results have already resulted in recommended design modifications as well as upgraded calibration procedures.
- Longer sensor life: UTCRS has developed new harvesting and recharging strategies for wireless onboard sensors that exceed the breakeven point and thus allow sensors that are not limited by battery life. During this reporting period, our industry partners redesigned their sensor enclosure and specified new photovoltaics based specifically on charging studies completed at UTCRS.

5.2 What is the impact of technology transfer on industry and government entities, on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

New practices: The UTCRS is working on two projects that are of great interest to the NTSB as they relate to the investigation concerning the East Palestine, OH, train derailment. One project is investigating the effect of long periods of inactivity on railroad bearings in service, and the other is investigating the efficacy and performance of reconditioned bearings. The results of both projects contributed to the investigation report that was prepared by the NTSB. These projects bring together NTSB with rail industry partners MxV Rail and Timken, a Class I Railroad (CSX Transportation), and the UTCRS. The results impact procedures used to recondition railroad bearings, and operation protocols regarding bearing inactivity in freight rail revenue service. The UTCRS is the only center performing these studies and the results are disseminated through publications, presentations, reports, seminars, webinars, guest lectures, and workshops.
Start-up company: Sensor technologies that were developed by the UTCRS during the MAP 21 UTC Competition were licensed by a start-up company, Hum Industrial Technology, Inc. Products based on UTCRS research are now in commercial service, and Hum's product engineer is a UTCRS alumnus.

The collaboration with Hum has transitioned to the current UTCRS UTC grant, with deployments on railcars operated by several Class I and short line railroads, and partnership in our new FRA CRISI grant. UTCRS serves as Hum's research and development division and is engaged in sensor optimization and enhancement, development of energy harvesting systems to prolong service life, data analysis, addition of new sensing capabilities, and design and fabrication of the next generation of sensors.

5.3 What is the impact on the body of scientific knowledge?

During this reporting period, UTCRS personnel submitted for publication and/or published 52 papers on a wide range of technical topics. Examples include: (a) New computational models for fracture and buckling of railroad tracks, (b) New autonomous systems to inspect rail geometry and detect changes, and (c) Key results on the performance of reconditioned bearings and lubricant degradation in inactive bearings.

Table 4 provides a list of scientific and technical publications by UTCRS researchers that transfer the knowledge and technology developed to the rail industry specifically, and the public in general.

5.4 What is the impact on transportation workforce development?

Since its inception, the UTCRS has directly employed hundreds of undergraduate and graduate students in its research activities. Students develop valuable skill sets through hands-on projects relevant to the railroad industry, making them workforce ready upon graduation. Students receive direct, hands-on training in rail specific skills like bearing assembly, disassembly, testing and inspection; mounting bearings on axles; mining databases of onboard sensor data to identify potential failures; track inspections and rail neutral temperature; track condition monitoring and rail geometry; rail fracture and buckling; rail grade crossing monitoring; and data analysis through artificial intelligence and machine learning tools. These trainings are both through employment and through formal workshops offered both by UTCRS personnel and by industry collaborators visiting the center. Thousands of other university students have been engaged through courses taught by UTCRS faculty, workshops and professional development, and community outreach activities. In the longer-term, the UTCRS K-12 outreach efforts are building interest in transportation careers among youth who will enter the workforce over the next 5-15 years. We already have UTCRS research assistants who participated in our earliest (2013-2014) camps as young children. These efforts are also creating a core of teachers and counselors who are aware of transportation career opportunities. Moreover, our graduates are finding employment within the rail transportation industry.

6. CHANGES/PROBLEMS

6.1 Changes in approach and reasons for change

Proposal Review Process: Our process for soliciting and reviewing project proposals was changed significantly for 2026CY proposals, based on guidance from both the USDoT UTC leadership and our External Advisory Board (EAB). The call for proposals emphasizes tangible products, transferable technology, and actionable results. The proposal template now includes a quad chart to facilitate review and an executive summary table. The EAB is using a new rubric to evaluate proposals.

Redirected or Extended Research Projects: One of the 2024CY projects, "FAST® Loop Comparison of Onboard Condition Monitoring Versus Wayside Detection," has been redirected due to inability to get all project partners ready for the available window at MxV Rail. The revised plan is to demonstrate part of the project on a local short line (data collection completed April 2026, analysis in progress) and move other parts of the project to alternate venues and use other funding sources. Three other projects are on no cost extension to complete data collection and reporting.

6.2 Actual or anticipated problems or delays and actions or plans to resolve them

Nothing to report.

6.3 Changes that have a significant impact on expenditures

Nothing to report.

6.4 Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards

Nothing to report.

6.5 Change of primary performance site location from that originally proposed

Nothing to report.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.