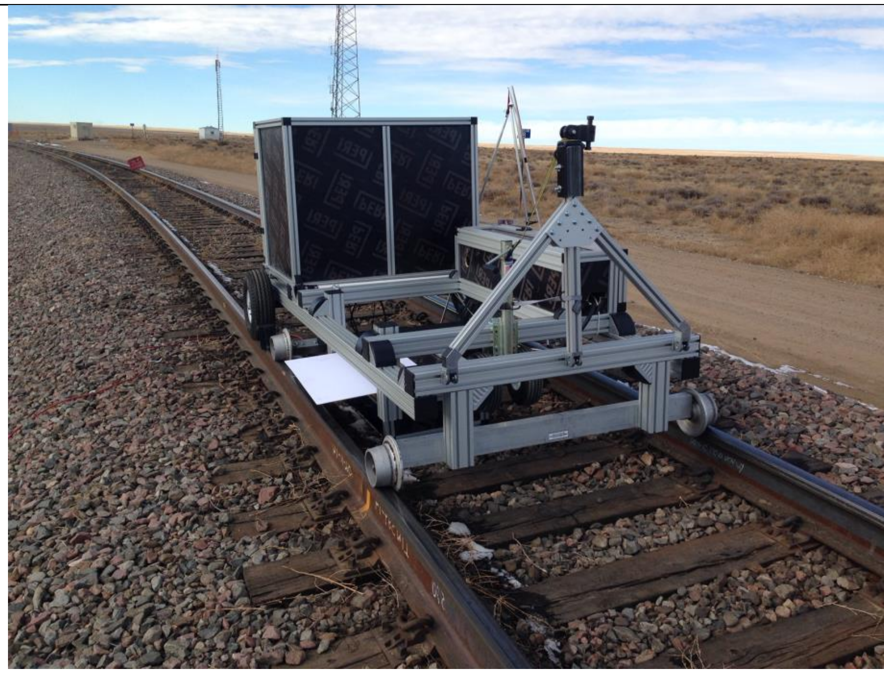
UNIVERSITY TRANSPORTATION CENTER FOR RAILWAY SAFETY

Exhibit F - UTCRS

UTC Project Information	
Project Title	Rail Neutral Temperature In-Situ Evaluation
University	Texas A&M University (TAMU)
Principal Investigator	Stefan Hurlebaus, Ph.D., Civil Engineering (PI)
PI Contact Information	3135 TAMU College Station, TX 77843-3135 Office (979) 845-9570 shurlebaus@tamu.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	Federal Funds (USDOT UTC Program): $104,653 Cost Share Funds (TAMU): $54,911
Total Project Cost	$159,564
Agency ID or Contract Number	DTRT13-G-UTC59
Start and End Dates	January 2014 – December 2016
Brief Description of Research Project	Continuous welded rails (CWR) are rails that are welded together to become long continuous members that are fixed at both ends. When the ambient temperature significantly increases or decreases from the rail neutral temperature (RNT), the temperature at which the rails experience zero stress, the metal can expand and cause the rails to buckle, or contract and cause the rails to fracture. These effects can, in a worst-case scenario, result in train derailment. However, even installing CWR at a median ambient temperature does not guarantee that a rail will not buckle or fracture in the future, and it is sometimes necessary to reinstall the entire rail. A means of preventing these faults is to measure RNT and longitudinal rail stress of CWR to determine if the reinstallation of the entire rail is warranted to increase safety. Several methods for measuring RNT and longitudinal stress exist, but they each have various pitfalls. RNT is traditionally determined by cutting the rail, measuring the gap, performing calculations, and re-welding the rail, but this method is destructive and labor intensive.

	Nondestructive methods exist, but they can be costly, are not always accurate, and may require contact with the rail. The technique being created is a nondestructive and noncontact method of measuring RNT and longitudinal stress. This technique uses a pulse laser to generate Rayleigh waves, which can be used to determine the longitudinal stress on the rails, and the RNT can be calculated using the relationship between the longitudinal stress, ambient temperature, and material properties. Rayleigh wave polarization is more sensitive and more robust than Rayleigh wave speed; thus, it results in more accurate and more precise measurements.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	The first objective of this research was to further test the method of measuring the longitudinal stress in rails using Rayleigh wave polarization. This technique has proven effective in a controlled laboratory environment; however, it had to be proven as a robust method before finding any success in the field. To this end, a study was performed on the effects of rail condition on the Rayleigh wave polarization measurement. This study found that a rail's surface condition affects the measurement results more than the rail's composition or history. Other factors affecting the measurement could include temperature, non-uniform internal stresses, and edge defects caused by using small rail samples. With these facets of the polarization measurement technique examined, a series of guidelines have been established that allowed this measurement to be recreated outside the laboratory. These essentials, including the use of a fully noncontact stress measurement technique, maneuverability on or off the tracks, minimal downtime between measurements, modular framing, and protected and easily accessed instrumentation, have been expressed through an iterative 3D modeling process. A design for a full-scale prototype has been developed that adheres to the above guidelines. The second objective of this research was to provide an apparatus to simplify the measurement process. Endeavors included the construction of the full-scale functioning prototype (Figure 1). This prototype enabled measurements previously carried out only in the laboratory to be performed in the field. This accessibility allowed the measurement of a wider range of rails.

	 Figure 1: Rail Stress Measurement Prototype
Impacts/Benefits of Implementation (actual, not anticipated)	This rail stress measurement prototype was initially developed as a stop-and-go measurement device; however, the apparatus can be easily upgraded to a fully mobile stress measurement system. The method of measuring stress was developed so that the same technique can be used to determine the condition of the rail at the time of installation, and then monitored at any time during the lifespan of the rail. Some obstacles, such as the LDV heads interfering with rail clearance restrictions, was resolved for an in-motion system. Other factors like instrument vibrations and laser misalignments induced by vehicle motion, which are inherent in a mobile measurement situation, will need to be accounted for as the in-motion system develops. The work performed for this project has also resulted in a Master's Thesis listed below ➢ Hurley, S. J., "Development of a Longitudinal Rail Stress Measurement Device," Master's Thesis, Texas A&M University, December 2014. [Link to PDF (4.5 MB)]
Web Links • Reports • Project website	http://www.utrgv.edu/railwaysafety/research/infrastructure/evaluation-of-rail-neutral-temperature/index.htm