

## Exhibit F - UTCRS

UTC Project Information	
Project Title	Ultrasonic Tomography for Infrastructure Inspection
University	Texas A&M University (TAMU)
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Funding Source(s) and Amounts Provided (by each agency or organization)	Federal Funds (USDOT UTC Program): \$104,653 Cost Share Funds (TAMU): \$54,909
Total Project Cost	\$159,562
Agency ID or Contract Number	DTRT13-G-UTC59
Start and End Dates	January 2014 — December 2016
Brief Description of Research Project	The structural integrity of railroad infrastructure is critical in order to address structural repair needs in a timely fashion and ensure rail safety. This includes the regular inspection and maintenance of railroad tunnel linings and timber beams and ties. Since tunnels are naturally in an aggressive environment that is not conducive to lane closures, early detection that leads to preventive maintenance is a necessity. The occurrence of damage and deterioration in railroad timber beams and ties can lead to failure of the components and, in the worst case, derailment of the train. According to the Federal Railroad Administration, wide gages due to defective/missing crossties accounted for the highest percentage (17.1%) of all railway accidents in the US from 2008-2011 (FRA, 2011). It is therefore crucial to detect damage at an early stage so that, by taking appropriate measures, failure can be prevented.
	(UST) to examine the interior of wooden beams and crossties as well



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	as railroad tunnel linings on-site. The Ultrasonic Tomographer employs a matrix (4x12) of low-frequency, shear transducers that generate shear waves through the depth of a specimen under test. The waves are reflected by internal discontinuities and changes in medium (such as concrete, air, and steel). This behavior is utilized to map voids, delamination, cracks, and other defects, as well as structural depth and reinforcement presence. The waves are sequentially emitted and received by 66 paired transducers per single scan, causing repeated reflections and patterns to stand out for inspection. Through the use of dry-point-contact piezoelectric sensors, the transducers do not require the use of a coupling agent, making it practical for on-site applications. The recorded signals undergo automated signal processing to identify the existence, location, and size of the potential discontinuities. The UST technique can be used to map entire 3D images of concrete sections as well as single-point evaluations.
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	Pending project completion.
Impacts/Benefits of Implementation (actual, not anticipated)	Pending project completion.
Web Links <ul> <li>Reports</li> <li>Project website</li> </ul>	http://portal.utpa.edu/railwaysafety/research/infrastructure/projects /2014/ultrasonic-tomography