TECHNOLOGY DIGEST

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RAIL-DEFECT TEST FACILITY: A TOOL FOR EVALUATING DEFECT-DETECTION TECHNOLOGIES

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Summary

The Transportation Technology Center, Inc. (TTCI), has established the Rail Defect Test Facility (RDTF) to further improve rail-defect detection technologies. The facility is located at the Federal Railroad Administration's (FRA) Transportation Technology Center near Pueblo, Colorado, and will provide the railway industry with a controlled environment in which vendors and users can evaluate the performance of detection vehicles. The RDTF also establishes the means to evaluate new technologies against performance of current detector-car technology and operating methods. In addition, the facility will provide a common ground for operator training over known defects.

Construction of the RDTF was funded through a cooperative program funded and administered by the Association of American Railroads (AAR) and the FRA. The program is directed at improving the reliability of rail-flaw detection technologies. As initially constructed, the facility is more than 1,800 feet in length and includes both tangent track and a 5-degree curve. The rails contain more than 70 defects that were originally detected during routine inspections of revenue-service track. After removal from service, the defects were shipped to TTCI, documented as to defect type and size, and then installed at the RDTF.

The RDTF defect layout and makeup can be reconfigured as needed. Future considerations include extending the track length and increasing the number of defects. Ongoing evaluations include benchmarking the performance of existing rail-defect detection vehicles. The facility is available for proprietary use for the evaluation of alternate technologies and for operator training.

This is the first of a two-part Technology Digest addressing rail-flaw detection. This digest addresses the construction of the RDTF as an industry tool. A companion digest will detail results of benchmarking evaluations performed with existing North American rail-flaw-detection technologies at the RDTF.

Suggested Distribution:

- ❑ Maintenance of Way
- ❑ Planning & Analysis
- ❑ Track Maintenance
- ❑ Safety

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INTRODUCTION AND CONCLUSIONS

Internal defects in rails occur as a consequence of the rail manufacturing process and the accumulation of fatigue under repeated loading. In-track inspection of the rail to detect defects before they progress to complete failure is thus very important to safe and efficient railway operations. Results of the rail-defect inspection workshop held in July of 1997 identified the need for a standard site to test and evaluate systems that detect rail defects. Establishing a standard allows performance comparisons of new and improved inspection techniques and methods that are being pursued to increase railroad safety, inspection productivity, and to reduce track occupancy.

The Rail Defect Test Facility (RDTF) is located on a gauntlet track, as shown in exhibits 1 and 2, constructed in 1997 in a cooperative effort between the Association of American Railroads (AAR) and Federal Railroad Administration (FRA). The facility provides member railroads, the FRA, and industry suppliers a tool to assess the effectiveness of detection technologies over known defects in a controlled environment. Rail that contains defects has been supplied by AAR member railroads. The defects were found during in-service rail-flaw inspections performed by railroad inspection crews or rail-inspection subcontractors. The test facility is maintained by Transportation Technology Center, Inc. (TTCI), and is available to member railroads, the FRA, research organizations including universities, and equipment manufacturers involved in developing and inspecting rail for flaws.

Exhibit 1. Tangent Section of the Rail Defect Test Facility

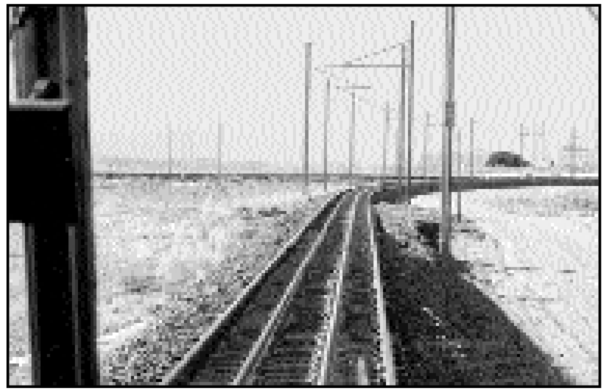

Exhibit 2. Curved Section of Track on the Rail Defect Test Facility

DESIGN CONSIDERATIONS

A number of vendors and railroads already possess rail-defect test tracks for their own use in personnel training and vehicle evaluation; however, these tracks are proprietary to the individual companies. To develop the RDTF as a useful industry tool, member railroads and vendor representatives were contacted to identify desirable features of the proposed track to be built at TTC. The intent was to construct a facility that offered a wide range of features not readily available to the industry, and make it accessible to all vendors and users.

Major features identified for a rail-defect test and training site included:

- Ability to incorporate a large number of defects.
- Ability to test detector cars at speeds up to 40 mph.
- Easy change-out of rail that contains defects.
- Elimination of other rail traffic that could affect defect growth.

- Ability to change rail stress to simulate environmental conditions, such as hot or cold weather.

To reduce construction costs the RDTF was located on the existing Balloon Track at the FRA's Transportation Technology Center. By constructing the facility as a gauntlet and sharing tie support with the existing track, costs of subgrade, ballast, and other support were eliminated. The gauntlet configuration allows other rail traffic to pass over the "mainline" rails without causing undo flexing of the test rails. For the initial facility a length of up to 2,000 feet was considered. To allow rail expanders to be installed between the mainline running rails and the gauntlet test rails, the mainline rails were shifted approximately 6 inches on the existing ties. Rail expanders will be utilized for altering longitudinal rail-stress conditions. Future extensions will not shift the mainline track, resulting in less than 1 foot of lateral clearance between rails.

FACILITY DESCRIPTION

The rail was evaluated for internal and external discontinuities using visual, ultrasonic, radiographic, and other non-destructive evaluation methods as required. The discontinuities found during evaluation have been categorized by type, size, and location and entered into a rail-flaw database. The rail installed into the RDTF has also been entered into a database that lists what railroad the rail was supplied by, where the discontinuity is located in track, the size of the discontinuities at initial installation, and the size of the discontinuities at periodic inspections after installation. The RDTF installation has been a joint effort between the AAR member railroads, the FRA, and TTCI. The use of this track for research and test purposes is recommended for technology enhancement and system-capability verification.

The RDTF is approximately 1,890 feet and includes both tangent and curved track. Rail installed into the RDTF ranges from 119-pound to 140-pound rail sections. The rail has been joined using electric flash-butt welding, thermite welding, or joint bars. The majority of the rail is worn and a best-effort approach was used in matching profiles from one rail to the next. Discontinuities supplied to date include transverse defects (TDs), defective field welds (DFW), vertical split heads (VSH), horizontal split heads (HSH) and bolt-hole cracks (BHC). The TDs are primarily detail fractures with compound fissures. External discontinuities supplied to date include shelling, flat spots, slivers, flaking, and chips.

Exhibit 3 lists the more than 70 discontinuities initially installed. A random installation of the rail was performed to prevent set patterns for defect locations. A typical shell is shown in Exhibit 4, and a detail fracture under a shell is shown in Exhibit 5. The track is designed so that rail sections can be repositioned periodically to change defect loca-

Discontinuity Type	Number of Discontinuities
Transverse defects	42
Defective welds	4
Horizontal slit heads	4
Vertical split heads	1
Bolt-hole cracks	2
Crushed heads	10
Shells	18

Exhibit 3. List of Discontinuities Currently Installed in the RDTF at TTC

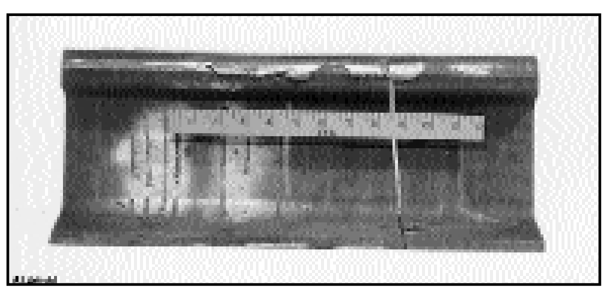

Exhibit 4. Shelling on Rail

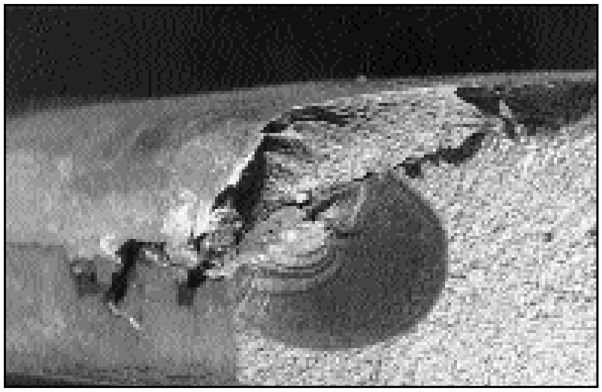

Exhibit 5. Detail Fracture under a Shell

tions. The track can also be modified to represent areas of tension and compression to simulate both warm- and cold-weather inspection environments. These environments are a concern with defects appearing differently during states of compression or tension; these can be controlled on the RDTF.

Benchmarking evaluations of six different hi-rail ultrasonic inspection vehicles were performed between February and May 1998. The evaluations were performed by three North American rail-flaw contractors to provide a baseline characterization of current capabilities for detection of known discontinuities on the RDTF. Results of these initial benchmarking tests will be reported in a companion TD. The major purpose of the benchmark evaluations was to provide a baseline with which to compare new technologies or improvements in current technology.

FUTURE ENHANCEMENTS TO THE RDTF

The RDTF is a tool used to provide consistent evaluation of rail-flaw technology over discontinuities typical to the railroad industry. The benchmarking evaluations on the RDTF were performed with the cooperation of member railroads and vendors supplying rail-inspection services. During these evaluations a number of improvements to the RDTF have been suggested. These include:

- Extend the length of the facility.
- Add additional defect types based on benchmarking test results and improve the mix of defects to reflect those found in service.
- Extend the length of non-defective rail between defects.

ACKNOWLEDGMENTS

The RDTF has been constructed with the cooperation of a number of agencies and personnel. Funding was provided by the cooperative AAR and FRA programs. Technical direction has been received from the railroad-industry advisory group consisting of representatives from the Burlington Northern Santa Fe, Canadian Pacific, Conrail, CSX, Norfolk Southern, and Union Pacific railroads. These railroads supplied test rail and rail-flaw evaluation expertise. Herzog, Pandrol Jackson, and Sperry supplied test cars and test personnel for evaluations on the RDTF.

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A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, MAY BE AVAILABLE AT A LATER DATE THROUGH AAR/TTCI, PUBLICATIONS, P.O. Box 79780, BALTIMORE, MD, 21279-0780.