Rail Safety in North America

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President - TTCl
Freight Railroads in North America

- BNSF
- CN
- CP
- CSX
- FXE
- KCS/KCSM
- NS
- UP
- Other RR

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Carrying the Things that America Depends On – Number of Carloads in 2014

- Intermodal
- Coal: 5824630
- Chemicals: 1562440
- Crushed stone, sand, gravel: 1175603
- Grain & other farm products: 1109960
  - Motor vehicles & parts: 876790
  - Food & grain mill products: 816136
  - Petrol. & petrol. Products: 798519
  - Primary metal products: 556402
- Stone, clay & glass products: 420302
- Scrap materials: 390846
- Metallic ores: 360733
- Pulp and paper: 318424
- Nonmetallic minerals: 259830
- Not elsewhere classified: 243502
- Coke: 198245
- Lumber and wood: 182994
- Primary forest products: 81479
Railroads’ Scale Enables Efficiency Elsewhere in Economy

♦ One railcar of coal = electricity for 60 homes for a year.

♦ One railcar of wheat = 258,000 loaves of bread.

♦ One railcar of corn = 37,000 chickens or 480,000 bags of Fritos.

♦ One railcar of fertilizer = 1,400 acres
Why Freight Rail?
Big Environmental Benefits

♦ In 2014, RRs moved a ton of freight an average of 479 miles per gallon
♦ RRs are 4 times more fuel efficient than trucks
  ● Reduces greenhouse gases by 75%
♦ One train = hundreds of trucks
  ● Cuts highway congestion
  ● Reduces pressure to build new highways.
**Safe and Getting Safer**

### Rail Accident & Injury Rates Have Plunged

- **RR Employee Injuries***
  - 1980-2014: ↓ 84%
  - 1990-2014: ↓ 76%
  - 2000-2014: ↓ 47%

- **Train Accidents**
  - 1980-2014: ↓ 80%
  - 1990-2014: ↓ 52%
  - 2000-2014: ↓ 45%

*Injuries and fatalities per 100 employee equivalents. **Train accidents per million train-miles. Source: FRA

### RRs Are Safer Than Most Other Industries

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<tr>
<td>RRs</td>
<td>↓ 84%</td>
<td>↓ 76%</td>
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<td>Air Transp.</td>
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<td>Manuf.</td>
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<td>Trucking</td>
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<td>Food &amp; bev. stores</td>
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<td>Agric.</td>
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<td>All private industry</td>
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<td>Constr.</td>
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<td>Water transp.</td>
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Data are 2013. Source: Bureau of Labor Statistics

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The Association of American Railroads

♦ Set industry standards
♦ Represent the railroad industry before Congress, regulatory agencies, etc.
♦ Collect and distribute statistical data
♦ Public affairs
♦ Research and evaluate new technologies
♦ Provide information technology services
History of Transportation Technology Center (TTC)

♦ Formally dedicated as High Speed Ground Test Center-May 17, 1971

♦ Developed and operated by Federal Railroad Administration (FRA) and Urban Mass Transit Administration (UMTA), now Federal Transit Administration (FTA)

♦ AAR assumed care, custody, & control at TTC – October 1982

♦ AAR Research & Test Dept. consolidated at TTC - 1995-97

♦ TTCI formed January 1, 1998

<table>
<thead>
<tr>
<th>TLRV</th>
<th>Tracked Levitated Rail Vehicle</th>
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<tr>
<td>LIMR-V</td>
<td>Linear Induction Motor Rail Vehicle</td>
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Wholly owned subsidiary of the Association of American Railroads

Located in Pueblo, Colorado

Operates the Transportation Technology Center on behalf of the Federal Railroad Administration

Focus on research, development, testing and training for the rail industry

270 Employees

52 square mile facility with 48 miles of track

Full-size laboratories capable of testing rail cars

Brings $38 annually to Southern Colorado
What Does TTCI Do?

♦ Basic Products and Services
  ● Research
  ● Consulting
  ● Testing
  ● System Engineering
  ● Inspections
  ● Training
  ● Technical Support

2014 Revenue

- Commercial 31%
- AAR Research 27%
- FRA/Other Gov't. Research 24%
- AAR Services 18%
Engineered Facilities for Dynamic Testing

**High Tonnage Loop (HTL)**
- 2.7-mile loop, three 5° curves, one 6° curve
- Main use – HAL studies
- Test bed for various premium track components
- 25 MGT/month in controlled environment

**Wheel/Rail Mechanism Track (WRM)**
- 7.5°, 10°, and 12° curving performance tests
- Dynamic curving tests
- Lubrication studies

**Transit Test Track (TTT)**
- 9.1-mile loop
- 80 mph max speed
- DC electrified third rail
  - Up to 1150 volts
  - Up to 12,000 amps

**Railroad Test Track (RTT)**
- 13.5-mile loop
- 1°-15’ curve and four 50’ curves
- Maximum speed 165 mph
- 12.5-, 25-, and 50-kV overhead catenary

**Precision Test Track (PTT)**
- Multi-use track for railcar testing
  - Pitch and bounce
  - Twist and roll
  - Yaw and sway
  - Car impact
  - Miscellaneous studies
Full-Scale Laboratory Testing

- Vibration Test Unit
- Simuloader
- Impact Wall
- Squeeze Fixture
Revenue Service-Like Test Facilities

- Revenue service like environment
- Controlled conditions
- Known defects left in track or rolling stock
- Current facilities
  - Precision Test Track
  - Bridge Test Bed
  - High Speed Adjustable Perturbation Slab
  - Rail Defect Test Facility
  - Positive Train Control
  - Open Inspection of Track Components
Facility for Accelerated Service Testing
Investigate performance of improved track components and maintenance procedures under accelerated HAL service environment

- New rail steels to increase rail wear & fatigue performance
- Higher strength crossties
- Advanced special trackwork designs
- Proof of concept and prototype evaluation of new technologies
  - Test bed for advanced inspection technologies
  - Integrated freight trucks, wheel steels

TTCI’s HAL Loop has carried 4 Billion Gross Ton Miles!
HAL Key Track Technology Enablers

♦ Improved Rail Materials and Maintenance Methods
  ● Cleaner and harder rail steels
  ● Running surface profile and friction control

![Service Life of Mainline Rail](chart.png)
FAST Bridge Tests

♦ Service Life Evaluation
  ● Spans under test at FAST have over 100 years of service

♦ Inspection Techniques / Fitness for Service Assessment
  ● Considers a broad spectrum of factors contributing to safe service life
  ● Onboard inspection systems

♦ Maintenance and Repair Techniques
  ● Reliability, durability and efficiency evaluated

♦ Advanced Designs and materials
  ● Cutting-edge composite structures
Improved Truck & Wheel Performance

♦ M-976 Trucks
  - Adapter pads
  - Allow more radial alignment of the wheelsets in a curve; this reduces steering forces at the wheel / rail interface
  - Reduces wheel wear
    ▲ Average 20 % increase in wheel life
Passenger Car Crash
Worthiness Improvements
Video on Passenger cars

Conventional Equipment 1/31/02

Crash Energy Management Equipment 3/23/06
Tank Car Testing
FRA Full-Scale Tank Car Crash Testing

Validate ........ Evaluate ........ Simulate
Test Set Up
Testing at TTCI’s Impact Wall
Time = 0.52
Contours of Effective Plastic Strain
max int. value
min = -0.006212409, at elem# 143490
max = 0.516112, at elem# 72229

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Model Examines Multiple Scenarios

Time = 0.25

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Fiber Optic Distributed Acoustic Sensor
Fiber Optic Distributed Acoustic Sensor

Distributed over a distance
Fiber Optic Distributed Acoustic Sensor Overview

Stress Force Caused by Acoustic Wave

Coherent Light

Strain

Coherent Phase-Modulated Light
Fiber Installation on HTL

- Bridges with various sensor configurations
- Detection Equipment Bungalow
Fiber Optic DAS – Train Monitoring
Fiber Optic DAS – Track Monitoring

Train passing over rail joints

TIME
DISTANCE
Example of Fiber Optic Signature from a Rail Break

Rail Break

Rail Break Repaired
Fiber Optic Distributed Acoustic Sensor

♦ Possible Uses
  ● Train Location
  ● Train Velocity
  ● Train Length
  ● Rock/Snow Slides
  ● Bridge Integrity
  ● Intrusion
  ● High impact wheels
Hazardous Materials
Emergency Response Training
Training - Security and Emergency Response Training Center (SERTC)

♦ In operation at TTC since 1985
♦ Hazmat response for Surface Transportation
   ● Focus on Rail and Highway
♦ Approximately 55,000 students trained
   ● Railroad
   ● Chemical and petroleum
   ● Local, State and Tribal First Responders
♦ “Graduate level” program
♦ Emphasis on preparedness and response
♦ See www.sertc.org for more information
Adult Learning at SERTC

♦ Classes use a “4-Phase Approach” that include at least 50% hands-on work

● Theory, best practice, classroom lecture
● Cut-away training aids and hands-on work
● Techniques yard – field transfers and containment
● Response exercises using full-scale staged incidents
SERTC Facility at TTCI

♦ Mixed freight derailment
  • 43 cars and one locomotive

♦ Highway equipment
  • Diesel, gas, propane, anhydrous ammonia, mixed hazmat freight

♦ Numerous rail and highway valves, fittings and cutaways in Highbay

♦ “Domehenge” uses pressurized air, water and smoke to simulate leaks
Historic SERTC Course Offerings

♦ Tank Car
♦ Highway
♦ Intermodal
♦ Hazmat/WMD Technician
♦ Tactical Hazmat Operations
♦ Leadership and Management
New Offering - Crude by Rail Training

♦ 19 Car Derailment
  ● 3D fire, impingement and pool fires

♦ Boil over Car
  ● Demonstrates characteristics of crude

♦ Teaches appropriate decision making for crude oil fires
Ways to Sign Up for On-Site Training

♦ Classes sponsored by DHS/FEMA
  ● Register your interest at www.sertc.org
  ● Need approval from State Authorizing Agent
    ▲ SAA will provide an authorization number
    ▲ You will be allowed to register with an authorization number

♦ Classes sponsored by Railroads
  ● Register your interest at www.sertc.org
  ● Contact your Railroad Hazardous Materials Officer for more information on sponsorship

♦ Open enrollment classes
  ● Sign up at www.sertc.org