Vision:
To be the worldwide provider of choice for high-value rail transportation technology development, testing, standards, and training.

Mission:
Accelerating the use of clean, safe and efficient technologies by railways worldwide.
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Board of Directors

Roy Allen — Transportation Technology Center, Inc.
George Binns — National Railroad Passenger Corporation
David Brown — CSX Transportation Inc.
David Ebbrecht — Kansas City Southern Railway Co.
Sameh Fahmy — Canadian National Railway Company
Lance Fritz — Union Pacific Railroad
Edward Hamberger — Association of American Railroads
Michael Howe — C.P.A.
Carl Ice — Burlington Northern Santa Fe, LLC
Mark Manion — Norfolk Southern Corporation
William Millar — American Public Transportation Association
Thomas Simpson — Railway Supply Institute
Brock Winter — Canadian Pacific Railway

Note: Dennis Duffy (Union Pacific Railroad) and Carl Harrison (Kansas City Southern Railway Co.) served on the Board earlier in the year.
TTCI Officers

LEADERSHIP

Roy A. Allen  
President

Semih Kalay  
VP Technology

Jim Lundgren  
Sr. Assistant VP Products, Training, Business Development

David Meeks  
VP and Chief Financial Officer

Lisa Stabler  
VP Operations and Training

Albert Reinschmidt  
VP Commercial Programs
As the world economy began to improve in 2010, so did business for TTCI. In fact, it was one of our very best years financially. The record attendance of around 420 delegates at the annual two-day AAR Research Review in Pueblo in March proved to be a good indicator for a successful year.

One of the big reasons for the good business performance was that 2010 was the first full year for TTCI to use funding from the federal cooperative agreement award under the National Domestic Preparedness Consortium program to train qualified responders at the Security and Emergency Response Training Center.

We also were busy achieving breakthroughs in a number of technologies including train control. After conducting a detailed safety analysis, TTCI demonstrated to the Federal Railroad Administration (FRA) Office of Safety that a de facto safety requirement associated with braking algorithms used in the implementation of Positive Train Control (PTC) systems could be relaxed. TTCI proposed a new requirement that will still maintain safety at the highest internationally recognized level for train control systems, but the operational problems associated with the old requirement will be significantly reduced. This breakthrough will have a significant impact on the railroads’ ability to meet the 2015 mandated date for implementation of PTC. We thank the FRA Office of R&D for supporting the development of sound PTC braking algorithms.

Another significant breakthrough occurred this year when the AAR, TTCI, and the railroads obtained an extensive waiver from the FRA Office of Safety
allowing wide-scale implementation of flange bearing frog crossing diamonds in freight track. This is the culmination of extensive research carried out by TTCI beginning in the mid-1990s followed by years of monitoring safety in revenue service. The majority of the research was completed some 10 years ago, but sometimes radically new technologies take time to be fully implemented.

And sometimes, even when the results of research get implemented quickly, the full extent of the value of that research takes a long time to surface. A case in point is the rail life research and testing undertaken by AAR/TTCI, railroads and manufacturers in the late 20th century. A rail life post audit conducted by an independent consulting firm in 2010 demonstrated that research achieved total industry savings through extending rail life, in the 1994 to 2009 time period, of approximately $2.7 billion. During this time period, rail life on some curves has improved by as much as 69 percent.

TTCI also was asked to support MotivePower, Inc. (MPI) in another pioneering effort, in this case for MPI to receive the first federal qualification of a locomotive for operation above 90 mph without the use of instrumented wheelsets. TTCI’s computer simulation work for MPI is proving to be crucial to its goals.

Yes, 2010 was indeed a busy year and very rewarding both from a business viewpoint and, more importantly, because of the technology breakthroughs that were achieved.

Record-breaking attendance at the 2010 Annual Review

Over 400 delegates attended the 15th Annual AAR Research Review and Track Walk tour in March.
Using an improved and radical design concept, the Transportation Technology Center, Inc. has given the industry a way to eliminate some of the highest vehicle and track dynamic loads that occur today.

After 16 years of research, testing, development, and limited revenue service trials under an earlier waiver, the Association of American Railroad (AAR) member railroads were granted a waiver of current track safety standards in 2010 for flange bearing frog (FBF) crossing diamonds by the Federal Railroad Administration. The waiver allows wide-scale implementation of FBF crossing diamonds in freight tracks.

AAR member railroads estimate that there will be two to three dozen installations in 2012, with the anticipation that most traditional diamonds in mainline track will be replaced by FBF crossing diamonds in the future.

The main advantage of this type of crossing diamond is the reduction in dynamic loading to both the track and vehicles. This is accomplished by eliminating all locations where the wheel is unsupported. In a conventional frog, these occur at the flangeway gaps. In a FBF, the wheel is supported on the flangeway floor.

Successful operation of the 315,000-pound car test train at the Facility for Accelerated Service Testing over prototype FBF crossing diamonds was followed by 4 years of revenue service tests at locations on CSX and BNSF railways. These tests proved conclusively that flange bearing operations can be conducted safely and efficiently. No accidents and no flange bearing related wheel removals occurred during these tests.

FBF crossing diamonds will improve the performance of the railways by reducing the stress state of track and equipment. The lower dynamic load environment will result in longer component service lives, fewer in-track component failures, less crossing diamond maintenance, and fewer condition-related speed restrictions.
Under contract to the Federal Railroad Administration (FRA), Transportation Technology Center, Inc. (TTCI) developed a revised safety requirement by which the negative impacts of Positive Train Control (PTC) braking enforcements on railroad operations can be reduced.

Current PTC enforcement braking algorithms (EBA) can negatively impact the efficiency of train operations because of their conservative designs. A significant reason for this conservativeness is the de facto safety requirement for a train to stop short of its PTC “target” 99.9995 percent of the time. This leads to many trains stopping well short of the target and creates operational problems for the railroads.

To reduce the negative operational impacts, TTCI conducted a safety analysis and demonstrated to the FRA Office of Safety that the requirement is far more conservative than necessary to achieve a very high level of safety effectiveness.

The analysis showed that reducing the safety requirement probability limit to 99.5 percent significantly reduces the negative impacts of braking enforcements on railroad operations while meeting Safety Integrity Level (SIL) 4, which is the highest level for train control systems.

Based on this analysis, TTCI continues braking algorithm development using the newly derived requirement. TTCI’s revised algorithm will adapt to the braking characteristics of the train and reduce the offset inherent with the worst-case assumptions built into the current algorithm. Consequently, the current negative operational impacts of PTC braking enforcements will be reduced.

In related work, TTCI developed an alternative methodology for validating EBAs. The methodology combines the use of thousands of simulations with limited on-track testing. The FRA Office of Safety has looked favorably upon this alternate methodology, which will significantly reduce the railroads’ EBA validation efforts, greatly increase the number of test scenarios achievable, and lead to significantly decreased negative impacts of PTC systems on railroad operations.
With substantial support from TTCI engineers, MotivePower, Inc. (MPI) pursued federal qualification for Northeast Corridor operation of new MP36PH-3C locomotives in 2010.

MPI selected TTCI to assist in this pioneering effort to receive the first federal qualification of a locomotive for operation above 90 mph without the use of instrumented wheelsets (IWS). TTCI engineers performed NUCARS® modeling that is critical to the qualification process. Wheel/rail interaction forces are determined from model results rather than direct measurements with IWS. This effort is likely to become the model for other manufacturers who seek high-speed rail vehicle qualification without testing using IWS.

Maryland Transit Administration will operate the locomotives on Maryland Area Regional Commuter service at speeds up to 100 mph. The MP36 locomotives will run from Washington D.C. to the north border of Maryland.

TTCI engineers supported the test program on the Northeast Corridor with instrumentation and data collection in addition to the NUCARS® modeling.

The remaining steps in the process are final adjustment of the models to reflect test results and demonstration that wheel/rail forces are within federal regulation limits.
The value of industry-wide research led by TTCI was highlighted in a rail-life post audit performed by an outside consulting firm in 2010. The results showed that TTCI research contributed towards an estimated reduction of the amount of mainline rail replaced from 1994 to 2009 at approximately 2,800 track miles and total industry savings from extending rail life at approximately $2.7 billion.

The net present value (NPV) of this reduction to the rail industry as of 2009 is approximately $2.2 billion, accounting for the change in the amount of rail replaced and the depreciated value of existing rail.

During this period, the NPV of the additional operating benefits resulting from reductions in train delay from rail replacement and defect repair was predicted to be approximately $400 million. The NPV of accident savings for track-related derailments and other accidents was predicted to be $58 million. Thus, the NPV of total industry savings from extending rail life was predicted to be approximately $2.7 billion.

TTCI has been actively involved in the rail industry's research in improving rail life. TTCI's Facility for Accelerated Service Testing has played an important role in enabling improvements to rail life through supporting tests of improved rail and other track components, as well as through testing innovative maintenance practices.

Surveys of rail life performed as part of this study show that rail life increased approximately 12 percent on tangent track, and from 24 percent to 69 percent on curved track, depending on degree of curvature between 1994 and 2008.
TTCI was one step closer in 2010 in finding the optimal brake rigging system.

TTCI tested nine different brake rigging configurations, both statically and in motion, while measuring brake shoe forces. Rigging systems tested included swing hanger beams, unit beams with modified end extensions, a 4-bar linkage system, and standard unit beams for comparison.

Static shoe force testing showed a significant benefit in the swing hanger brake arrangements. All of the brake systems tested provided better brake force distribution as the brake application magnitude increased. The optimal brake rigging system would provide each wheel in the car with the same level of brake shoe force to minimize wheel temperature variation and thermal mechanical shelling.

While measuring brake shoe force on a stationary car is common, measuring brake shoe force of a car in motion is more difficult. To do this, TTCI developed instrumented brake shoes capable of measuring brake shoe normal force on a car in motion. These shoes are compatible with any AAR approved brake head, allowing for quick configuration changes.

Dynamic testing was conducted on TTCI’s Wheel/Rail Mechanism Loop.
A railroad is considering changing its ballast shoulder width specification as a result of significant findings found by TTCI during an evaluation of the lateral strength of its heavy-haul mainline track.

The tests produced two significant findings: (1) no appreciable track panel shift was measured on the existing concrete tie track with highly consoli-dated ballast under the applied loading, indicating high lateral track strength and (2) no reduction in lateral strength occurred from reducing the ballast shoulder width from the existing 18-inch standard to 8 inches.

Tests were performed because of concerns that transient vehicle forces generated by long heavy trains could potentially cause lateral movement of the track panel. The tests involved measuring the lateral displacement of the track panel under static net-axle vertical and lateral loads of 40,000 pounds applied by TTCI’s Track Loading Vehicle.
A number of sites on the Norfolk Southern (NS) and BNSF railways were inspected by TTCI in 2010, under the auspices of the Association of American Railroads’ Track Substructure Strategic Research Initiative, revealing that excess water in the ballast layer generally caused by low permeability of the fouled ballast shoulder material was the root cause of localized ballast deterioration and poor ballast performance.

A test of long-term remediation techniques will be implemented in 2011 at one of the NS sites.

In 2010, TTCI began heavy axle load testing on a 1912 steel bridge span donated by NS. Initial testing quantified the importance of maintaining internal bracing.

The span is representative of thousands of steel girder bridge spans still in use on railroads throughout North America. Longer term testing will quantify the effects of corrosion on fatigue life. Evaluation of various repair techniques is underway, and the span is serving as a test bed for alternative bridge ties for open deck bridges.

The span is installed in the High Tonnage Loop at the Facility for Accelerated Service Testing (FAST), where it is experiencing heavier traffic and loads as compared to its days in revenue service in Indiana.
TCI is developing truck design concepts to improve truck and truck component (particularly wheel) life.

The incidence of high impact wheels has been attributed to high tractions developed across the wheel/rail contact patch during curving. Tests have shown that an improved bearing adapter pad and pad location can considerably reduce these forces.

Asymmetric wheel wear on certain coal cars has been related to abrasive wear of the wheel tread by the shoes and has been associated with a combination of asymmetric truck brake rigging and aggressive brake shoe wear of the wheel tread.

Investigations continue to determine the prevalence on these car types.
2010 VIP Visitors

Secretary of Transportation
Ray LaHood

TSA Administrator
John Pistole

Associate Administrator for Railroad Safety/Chief Safety Officer
Jo Strang

Deputy Assistant Administrator, FEMA
Gail Palmisano

Greyhound Pres./CEO David Leach

Assistant Deputy Administrator for Outreach, National Preparedness Directorate
Andrew Mitchell

Representative
Sal Pace

TTCI Pres. Roy Allen and MOR Chief Safety Officer
Zhixiu Geng

Deputy Administrator, RITA
Dr. Robert Bertini

Railway Technology Working Committee Members
TTCI engineers developed a next generation "keyed" insulated joint in 2010. The joint transfers load from one rail to the other through partially embedded keys in the rails and the joint bars. Each key is capable of resisting over 800,000-pound loads without breaking, virtually eliminating the dependence on adhesive for strength.

TTCI is testing the next generation of thermit railhead repair welds at FAST as part of an AAR Strategic Research Initiative for improved rail welding. Implementation of railhead repair welds in revenue service will allow repair of railhead defects without the need to cut rail thereby maintaining the rail integrity and neutral temperature.

Rail weld manufacturers used results of previous testing conducted by TTCI to incorporate improvements into the welds in the current test.
New Technologies of Trackwire Connections

TTCI is evaluating new technologies at FAST and at two revenue service locations to improve signal wire connection reliability and to reduce installation costs.

Easier installation, resistance to damage from track repair equipment, and capabilities to reinstall over existing locations are features of the technologies being evaluated.

Technology Scanning Program

Engineers and scientists at the University of Illinois at Urbana-Champaign (UIUC) developed a discrete element model for ballast in 2010. This tool allows the industry to model the actual behavior of track ballast as discrete particles and to design improved performance ballasts based on particle size, shape, and texture.

Texas A&M developed a rail fatigue analysis tool which will, among other things, schedule rail grinding to maximize rail life. The model calculates fatigue in the head of the rail and adjusts wear rate (by grinding) to optimize fatigue life.

UIUC, Texas A&M, and Virginia Polytechnic Institute are affiliated laboratories under TTCI’s Technology Scanning program.

The feasibility of autonomous monitoring and repair of bolted connections in railway applications was evaluated by Virginia Tech. In laboratory simulations, switch throw rod bolts were monitored for changes in clamping force. Using shape memory alloy washers, loosened bolts were retightened (i.e., clamping force was restored) by the monitoring system.
ith the January 1, 2011, deadline set forth by the Federal Communications Commission (FCC) for implementing narrowband emissions to increase the number of available channels, TTCI has been adding narrowband and very narrowband emissions in 2010 to all license applications. The mandate resulted in about 1,500 applications from the railroads during the last quarter of the year compared to just over 200 applications in the last quarter of 2009.

Stations making modifications to increase coverage must operate with only narrowband emissions on those frequencies after the deadline. Though the FCC’s mandate was intended to increase the number of available channels, narrowbanding alone will not alleviate radio traffic congestion in metropolitan areas. Narrowband channels at half the previous spacing will cause increased interference to adjacent channels. Additional usable channels will not become available until the railroads begin converting to very narrowband.

TTCI has been studying various channel plans to obtain the greatest spectrum efficiency in congested areas with narrowband and very narrowband channels and will continue to assist the railroads in meeting their narrowbanding goals.
Bombardier’s new ALP 46A locomotive was tested at the Transportation Technology Center in 2010. The new locomotives will provide motive power for New Jersey Transit’s multilevel passenger railcars.

During the course of the test program, Bombardier engineers were able to evaluate the locomotives performance under varying load and track conditions. TTCI operations and facility staff worked closely with Bombardier to ensure test requirements were followed.

TTCI began supporting Kawasaki in 2010 in the acceptance testing of the new M-8 cars.

Testing was performed on Metro North Railroad’s New Haven, Harlem, and Hudson lines. Scheduled testing is to be performed on the Northeast Corridor line from New Haven to New London.
Union Pacific

Aerodynamic Tests

The Union Pacific (UP) Railroad successfully implemented a testing program with TTCI to validate aerodynamic modeling and wind tunnel predictions of an energy saving device for use on double-stack container trains.

A wedge-shaped container was mounted behind the locomotive to reduce aerodynamic drag. This challenging endeavor set out to measure with great precision, relatively small differences in fuel economy. The results proved favorable, and the UP is in process of analyzing the business case for implementation.

PTC Communications Capacity for Metrolink

As a result of a successful study performed by TTCI in 2010 for Metrolink, TTCI has been selected by the U.S. freight railroads (PTC-220 LLC) to use its one-of-a-kind capability to assist in determining optimum PTC radio base station placement and spectrum planning throughout the nation.

TTCI developed initial radio base station coverage limits for PTC implementation on five Metrolink subdivisions. TTCI showed that the message loadings generated by the system components would not exceed the capacity of the radio communication system for any base station under normal variability of train operations.

The study used the Berkeley Simulation Software Rail Traffic Controller (RTC) model for simulating train movements on the rail network combined with a unique TTCI-developed postprocessor that simulates PTC messaging based on train movement outputs from RTC and defined PTC message triggers.
A portable version of TTCI's successful TADS® unit was developed and deployed in 2010.

The unit comes housed in a cargo trailer. At the test location the microphone arrays are temporarily mounted in the ground and the trailer serves as the computer bungalow, complete with lights, heat, and air conditioning.

Scenarios for deployment include temporary scanning of railcars being brought out of long-term storage. Rail traffic not currently covered by permanent detector installations can now be inspected with portable detector systems requiring minimum local facilities.
A base station for a high accuracy global positioning system (GPS) was constructed at the Transportation Technology Center and became operational in 2010.

Far more accurate than conventional GPS, the system offers 10- to 20-centimeter accuracy to users and applications. This improvement may provide a safer, low-cost positioning solution for railroad systems, such as PTC, which requires high accuracy tracking of trains to enhance operational safety.

The system also offers more timely and efficient collection of track feature information needed for generating and maintaining track databases that support PTC operations and other railroad needs.

The system has been in development to assess the feasibility for improving the accuracy of the Nationwide Differential GPS service, using existing infrastructure, to meet the requirements of additional applications while meeting the needs of existing users.
TTCI hosted over 300 agents from Transportation Security Administration (TSA) and other federal agencies in 2010 for a unique hands-on training experience in TSA’s newly constructed classrooms at the Passenger-Rail Services Building. TSA’s new operation is now called the Surface Transportation Security Training Center.

Under an interagency agreement with the FRA, TSA trains both their own inspectors as well as individuals from other government agencies to safely operate in the railroad environment.

Beginning late in 2010, TSA contracted with the Federal Transit Administration, Oklahoma City training operation, Transportation Safety Institute, to provide courses at TTC. With easy access to track, freight, and passenger rail equipment, TTC is the ideal site to prepare federal employees for the task of keeping the rail network safe.
SERTC, the premier hands-on trainer of first responders for the rail and highway surface transportation, expanded its capability of preparing first responders with a $4.8 million National Domestic Preparedness Consortium (NDPC) cooperative agreement in 2010 from Department of Homeland Security-Federal Emergency Management Agency.

Two courses, Tank Car Specialist and Highway Emergency Response, were certified in 2010, allowing local, state, and tribal first responders to train at SERTC under a fully funded grant program. SERTC instructors trained 564 NDPC students in 2010.

SERTC’s courses are offered to a broad base of stakeholders - railroads, chemical manufacturers, petrochemical companies, public safety responders, government agencies, and contract responders - for the entire Western Hemisphere.

While SERTC continues to customize classes for many clients, students also took advantage of one or more of the 10 courses SERTC offers including tank car, intermodal, highway, and incident management. In 2010, 306 railroad and 575 other students trained in one or more of these classes.

SERTC will continue first responder training in 2011 with a second NDPC cooperative agreement.

Performance Based Track Geometry for Transit Agencies

In support of a Transit Cooperative Research Program (TCRP), TTCI and TCRP partnered with Dallas Area Rapid Transit Authority in 2010 to improve vehicle performance and passenger ride quality. The transit industry is moving forward to implement maintenance practices that not only address safety, but ride quality as well.

A combination of PBTG™, which uses neural networks, and NUCARS® modeling techniques was used to investigate the effects of current track design, geometry, and maintenance standards to predict ride quality issues. Phase I results showed that ride quality can be related to track geometry.

PBTG inspection is a new technology that can be implemented on conventional track geometry inspection vehicles. PBTG technology relates measured track geometry to vehicle performance on a real-time basis and can also be used on historic track geometry data in an office environment post processing the data to evaluate the effect of track geometry deviations on vehicle performance.
TTCI continued to work with Kasgro Rail, Corp. in 2010 to obtain certification of their M-290 car under the single car portions of the AAR Standard S-2043 for trains carrying high-level radioactive material.

The car will eventually be used by the U.S. Navy for its carrier refueling program. TTCI helped Kasgro improve the dynamic performance of the car by identifying appropriate suspension changes with computer modeling and then testing those changes on track.

**Certification of Kasgro’s M-290 Car**

**Wheel Rolling Contact Fatigue Study**

In a collaborative research effort, the TTCI, FRA, and Wheel Defect Prevention Research Consortium gained a better understanding of the conditions under which wheel and rail rolling contact fatigue (RCF) occurs.

Wheel/rail contact forces were recorded on a freight car operating in revenue service in 2010 using an IWS and an unmanned data acquisition system. The wheel/rail forces were automatically analyzed and transmitted back to TTCI engineers along with GPS car location information, allowing for near-real-time identification of track locations with suspected RCF. A track inspection team was then quickly dispatched to document RCF on the rails and record other notable conditions.

**Construction Loads for Plastic Composite Ties**

Due to reports by railroads that plastic composite ties were often found to be damaged or cracked in track after installation and before train operations, TTCI instrumented a sample of plastic composite ties and measured their loads during transport, handling, and installation and found that, even though these types of ties pass current tie screening test limits, one time, short-duration bending forces can exceed those applied to ties for proof testing. In addition, impact loads from dropping ties can also exceed current screening test limits.

Results of this FRA-funded project, with support from the member railroads and supply industry, were shared with the American Railway Engineering and Maintenance of Way Association (AREMA) committee on ties for use in future updates to the *Manual for Railway Engineering.*
TCI is helping reduce the headway between trains operating on Metrô’s Companhia do Metropolitano de São Paulo’s (MSP) network in a project in 2010 by optimizing the performance of the train braking systems during the rainy season in Brazil.

In the first phase, TTCI engineers conducted a series of stop distance tests using trains randomly selected by MSP to determine the current braking efficiency of the trains on dry and wet rail conditions. Brake suppliers used the test data for each train type to optimize the performance of the braking systems.

Tests will be repeated in the next phase to document the changes in braking performance.

TCI conducted an extensive evaluation and test program in 2010 of the dynamic behavior of railcars being supplied by Alstom for operation on the Metrô network to ensure safety and efficient operations.

The study consisted of vehicle and track characterization testing and mathematical modeling using TTCI’s simulation software NUCARS®. On-track vehicle dynamic testing was performed in São Paulo, Brazil.

TCI also used the models to evaluate the vehicle/track interaction of the railcars running on hypothetical track and through turnouts within construction tolerances defined in the design and within wear limits and other maximum maintenance tolerances.
Tampere University of Technology, Life-Cycle Management Program

TTCI(UK), Ltd., in direct support to the Tampere University of Technology, Tampere, Finland, continued a successful program in 2010, assisting the Finnish Transport Agency in identifying processes and procedures to establish a highly efficient life-cycle management program to address track and vehicle conditions.

TTCI(UK), Ltd. also helped draft a Rule Book specifying the practices required to assure safe operation over the Finnish railroad network.
China now has 63 TADS® units. The technology has become an integrated part of the Ministry of Railway’s operational safety and freight car maintenance practice.

TTCI continues to enhance its technology by incorporating new algorithms to accommodate unique aspects of the China bogie designs and operating conditions. This in turn enables TTCI to engineer the benefits into TADS® for other customers in North America and worldwide.

The wayside monitoring system provides early-stage warnings for defective railcar wheel bearings in real time and sends reports to a centralized database.
TTCI evaluated two new wheel designs in 2010 for Indian Railways (IR). The first wheel design was for IR’s new fleet of 25-tonne axle load freight wagons. The second wheel design was for electric multiple unit passenger rolling stock. TTCI conducted tests to verify that the wheel designs met the IR specifications for chemical composition, tensile strength, and hardness profile.

A series of tests also were carried out using TTCI’s brake dynamometer to ensure that the wheels could withstand the mechanical and thermal loading caused by train operations and train braking.

The wheels were produced by the Rail Wheel Factory (RWF) located in Bangalore, India. RWF manufactures wheels, axles, and wheelsets for freight wagons, passenger rolling stock, and locomotives for IR as well as other international clients.
TCI’s Communications and Train Control Business Unit is helping railroads comply with the Rail Safety Improvement Act of 2008, which mandates PTC implementation across most of the nation's rail lines by the end of 2015.

C&TC activities in 2010 included PTC system, communications, radio frequency (RF) spectrum and safety consulting, training, research into technologies to improve PTC system performance, and testing a PTC system on site.

TTCI is preparing the C&TC Test Bed for testing the PTC 220 MHz radios and is implementing a complete Interoperable Train Control (ITC)-compliant PTC system on site. The C&TC group was selected by PTC-220 LLC to perform the coordination of the Class 1 railroads' 220 MHz RF spectrum over the next few years.

TTCI’s Performance Monitoring Business Unit experienced another good year with the sale of additional TADS® units and load measuring IWS in North America and China.

BNSF Railway took delivery of three new TADS® units in 2010 including one portable system that will be used to assess the condition of bearings of cars as they are released from storage to ensure that the cars return to service free of bearing defects. The China Ministry of Railways took delivery of 10 additional units in 2010.

TTCI produced IWS for Kawasaki to be used for acceptance testing of the M-8 cars for Metro North and produced a design for a 400 k/hr IWS for use on high speed trains in China.
TTCI’s High Speed Rail Business Unit got off to a good start in 2010 with the award of four new projects from the Federal Railroad Administration.

TTCI was tasked to identify the testing requirements, develop a testing strategy, and define the testing facilities required for evaluating high speed rolling stock. A major output of the research will be recommendations on the construction of additional testing facilities at TTC to satisfy the testing requirements.

Security and Emergency Response Training Center

SERTC instructors trained a total of 1,784 students in 2010, including 306 from member railroads. SERTC trained 564 NDPC students as part of a $4.8 million NDPC cooperative agreement from DHS, FEMA. This was the first year that SERTC trained local, state, and tribal first responders as a member of the NDPC.

The Tank Car Specialist and Highway Emergency Response courses were certified in 2010, allowing local, state, and tribal first responders to train at SERTC under a fully funded grant program.
TTCI’s internally funded research and development program in 2010 focused on the enhancement of existing vehicle dynamics analysis software, enhancement of TTCI’s performance monitoring systems, and the development of PTC support and analysis tools.

NUCARS® was enhanced with improved capability and accuracy for calculating the wheel/rail forces in switch points and other special trackwork. A new connection element was developed for simulating large sliding motions and consequent forces that can occur between the span bolsters and carbodies of very large and long multi-axle specialty heavy equipment flatcars and Schnabel type cars, and TTCI’s PTC network simulator/communications load model now has the capability to generate Advanced Civil Speed Enforcement System (ACSES) messages (in addition to ITC messages) and to interface with the lab for testing radios with PTC messages.

Upgrades in the Rail Dynamics Laboratory

TTCI and FRA invested over $200,000 in upgrades to the test machines in the Rail Dynamics Laboratory. Upgrades included rebuilding the hydraulic power supplies used for the Vibration Test Unit, the Simuloader, and the Bolster and Side Frame Fatigue Test Machine. The upgrade to the heat exchange system used to provide cooling to these test machines also began in 2010.
TTCI’s Safety Resource Team contributed to many successes in 2010. The lost time frequency rate was reduced significantly from 1.9 in 2009 to a lost time frequency rate of .94 in 2010, CPR/AED employee certifications climbed to 80 percent, over 150 safety hazards were corrected, and TTCI received a thumbs up review by the Hartford Insurance and MARSH brokers after their annual site inspections.

High marks were given by TTCI employees attending QRT’s training program on “knowledge transfer” in 2010. TTCI employees attended lectures and field trips on Locomotives 101, Freight Car Trucks and Components, Locomotive Engines, Fuels & Emissions, and Freight Train Air Brakes given by colleagues with extensive experience in their areas of expertise. QRT also continued its promotion of quality service to TTCI customers.
Improved Perturbed Track Test Zones

TTCI invested over $100,000 in new adjustable tie plates in 2010 for use on the AAR Chapter 11 perturbed track test zones at TTC. The new tie plates will improve the accuracy of the perturbation shapes and reduce the time and effort required to maintain them. The dynamic curve test zone will be the first to be equipped with the new tie plates in early 2011.

Energy Management

TTCI initiated a plan in 2010 to better understand the power consumption and demand of the site. High-tech metering was installed in strategic locations to provide accurate costs of site operations. This will drive business decisions on operations as well as provide TTCI the data for energy and environmentally friendly investments.

Other Investments

TTCI invested nearly $1.8 million in capital equipment and leasehold improvements in 2010. Major investments included:

**SERTC Training Equipment**
TTCI made significant investments in training equipment for SERTC in order to accommodate the increase in students resulting from being a member of the NDPC.

**Equipment and Machinery**
TTCI expanded its capabilities and improved its overall efficiency with the purchase of new computer workstations, local area network servers, a new high-precision vertical mitering band saw, a 3-axis precision surface grinder, a new rail web grinder, and a rail puller, rail shear, rail drill, and hydraulic rail saw.

**Data Collection Systems**
TTCI designed and constructed additional unattended data acquisition systems and purchased additional instrumentation equipment used to support domestic and international testing programs.