

FTA National Research Programs

Federal Transit Administration

"Delivering Solutions that Improve Public Transportation"



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Introduction

Introduced on September 30, 2005, the Federal Transit Administration's (FTA) new Strategic Research Plan set forth five new Strategic Research Goals. Placed first amongst these goals, at the request of the Transportation Research Board's Transit Research Analysis Committee (TRAC), is for FTA to provide transit research leadership.

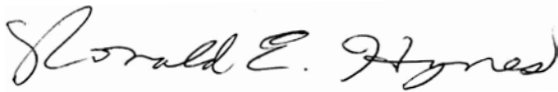
In support of this goal, I am pleased to present to you FTA's Annual Research Report for FY06. This report highlights many of the achievements FTA has made this past year in support of our Strategic Research Vision to "Deliver Solutions that Improve Public Transportation." Organized by goal area, the report describes our accomplishments in the areas of:

- Providing Transit Research Leadership (Goal 1)
- Increasing Transit Ridership (Goal 2)
- Improving Capital and Operating Efficiencies (Goal 3)
- Improving Safety and Emergency Preparedness (Goal 4)
- Protecting the Environment and Promoting Energy Independence (Goal 5)

The success of FTA's National Research Program over the past year is a testament to the hard work and quality of the researchers and support staff. By working closely with customers and stakeholders, FTA will continue to develop and execute a comprehensive transit research program that delivers results to the American public and provides real solutions to the transit industry.

Given the large number of projects under development at FTA at any point, this report can only highlight some of the projects underway. I encourage you to visit the Research, Technical Assistance and Training section of FTA's website at <http://www.fta.dot.gov/research> to learn more about our programs.

Sincerely,



Ronald E. Hynes

Acting Associate Administrator for
Research, Demonstration, and Innovation

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The Strategic Framework

Prepared by FTA's Office of Research, Demonstration, and Innovation (The Research Office), the Federal Transit Administration (FTA) National Research Program Annual Research Report serves as a report card for our strategic research program. This report provides information about FTA's research accomplishments for 2006 by providing some highlights of specific programs, projects, and completed reports organized by FTA's research goals.

Federal Transit Administration Vision, Mission, and Goals

Set forth on September 30, 2005, FTA's [*Strategic Research Plan*](#) sets the strategic framework for FTA's research priorities and serves as our "touchstone" for investing scarce public funds in relevant and useful research projects that will improve our nation's public transportation systems.



FTA's research program directly supports the strategic goals of FTA and United States Department of Transportation (DOT), and helps FTA achieve its mission of delivering solutions that improve public transportation.

Multi-Year Research Program Plan

The *FTA Multi-Year Research Program Plan (FY 2007 – FY 2011)* provides descriptive summaries of existing FTA research projects for FY07 through FY11 and links these projects to the goals and objectives of FTA's Strategic Research Plan. It further identifies future transit industry research needs aligned with FTA's research goals, and it describes new research areas that FTA will consider for funding during the next five years.

FTA Strategic Research Goals	FTA DOT Strategic Goals
Provide Transit Research Leadership	Organizational Excellence – Advance the Department's ability to manage for results and innovation.
Increase Transit Ridership	Reduce Congestion – Advance accessible, efficient, intermodal transportation for the movement of people and goods.
Improve Capital and Operating Efficiencies	Global Connectivity – Facilitate a more efficient domestic and global transportation system that enables economic growth and development.
Improve Safety and Emergency Preparedness	Safety – Enhance public health and safety by working toward the elimination of transportation-related deaths and injuries.
	Security Preparedness and Response – Balance homeland and national security transportation requirements with the mobility needs of the nation for personal travel and commerce.
Protect the Environment and Promote Energy Independence	Environmental Stewardship – Promote transportation solutions that enhance communities and protect the natural and built environment.

Highlights and Expectations

This annual report is prepared for transit agencies, congressional committees and staff, transit business leaders, public transportation researchers, DOT modal administrations, and FTA staff. Highlights from 2006 include accomplishments in leadership and completion of research products. Expectations for 2007 begin with increasing rail research and initiating the projects selected under the National Fuel Cell Bus Program and the Mobility Services for All Americans Program.

Highlights from 2006

A major focus of efforts in 2006 was to ensure that FTA provides transit research leadership.

- FY06 marked the initiation of the new FTA Strategic Research Plan outlining FTA's Strategic Research Goals and accompanying objectives
- FTA completed the Office of Management and Budget's (OMB) Program Analysis Rating Tool process, receiving the highest ranking possible — an "effective" rating with a score of 95 out of 100
- FTA completed the first [*FTA Multi-Year Research Program Plan \(FY 2007 – FY 2011\)*](#)
- FTA is reintroducing Annual Research Reports with this document
- FTA has set forth new research project management guidelines for FTA staff
- FTA exceeded its goal of ensuring that 90% of research projects were on time and within budget

FTA made important strides in implementing the Safe, Accountable, Flexible, and Efficient Transportation Equity Act — A Legacy for Users (SAFETEA-LU) programs.

- FTA competitively selected three consortiums for the National Fuel Cell Bus Program that will invest \$49 million over the life of SAFETEA-LU. These nonprofit organizations will participate in the National Fuel Cell Bus Program's research efforts: the Center for Transportation and the Environment in Atlanta; the Northeast Advanced Vehicle Consortium in Boston; and Westart/CALSTART of Pasadena, California.

FTA is on target to deliver, by 2010, 30 major research products, innovations, and techniques that support FTA strategic research goals. In 2006, FTA:

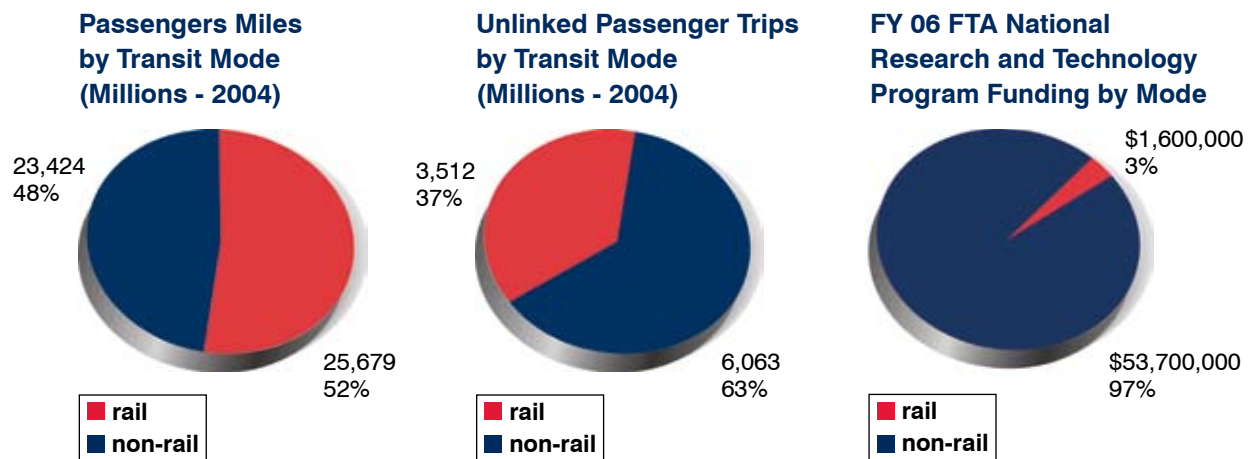
1. Completed the [*Advanced Public Transportation Systems: The State of the Art Report*](#)
2. Produced the [*Non-Rail Vehicle Market Viability Study*](#)
3. Developed Crash Energy Management Specifications for Commuter Rail Cars
4. Published a [*Disaster Response and Recovery Resource for Transit Agencies*](#)
5. Identified factors affecting light rail capital costs in an [*Analysis of Capital Cost Elements and Their Effect on Operating Costs Report*](#)
6. Identified technologies to improve accessibility in the [*ITS Applications for Coordinating and Improving Human Services Transportation: A Cross-Cutting Study*](#)

Expectations for 2007

FTA intends to continue to examine how it can better provide transit research leadership for the transit research community. As part of this effort, the Research Office will produce the FY08 – FY12 Multi-Year Research Program Plan. FTA will also review its current Strategic Research Plan to ensure that it fully supports DOT's new Strategic Plan, "New Ideas for a Nation on the Move," FY06 – FY11.

In addition:

- FTA research will support the Department's Congestion Relief Initiative outlined in the May 2006 *National Strategy to Reduce Congestion on America's Transportation Network*.
- FTA will seek to ensure that it has the appropriate expertise and project portfolio to conduct research that supports the rail transit sector. While approximately 37% of unlinked passenger trips are by rail and approximately 52% of passenger miles are by rail, in FY06 only one of 45 earmarks focused on the rail sector. In total, in FY06, only \$1.6 million, or 3%, of National Research and Technology Program funds were spent exclusively on the rail sector.



Source: 2006 APTA Public Transportation Fact Book (pp 12-13)

- FTA will begin to implement the projects selected under the National Fuel Cell Bus Program.
- FTA will select and implement the demonstration sites of the United We Ride/Mobility Services for All Americans Program.
- FTA will continue efforts to promote and develop U.S. manufacturers and suppliers of transit goods and services under the International Mass Transportation Program (IMTP).
- FTA, through the Transit Cooperative Research Program (TCRP), will fund high-priority transit industry research.

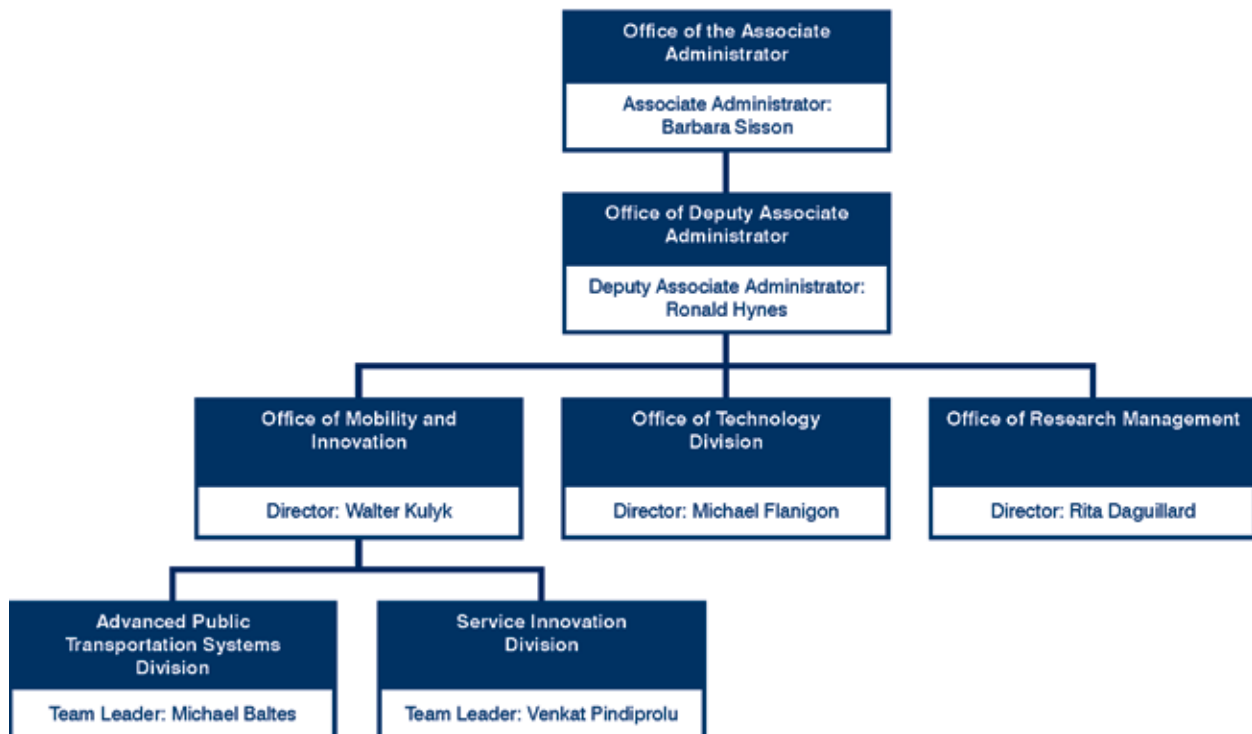
The Office of Research, Demonstration, and Innovation

As the office responsible for maintaining the national perspective for transit research, the Research Office manages and oversees FTA's transit research program and provides the industry and policy-makers with the information and skills to make good business decisions about investment in transit technology, capital, and operations.

Organization

The Research Office has seven divisions to administer and oversee FTA's research agenda and to disseminate results and information.

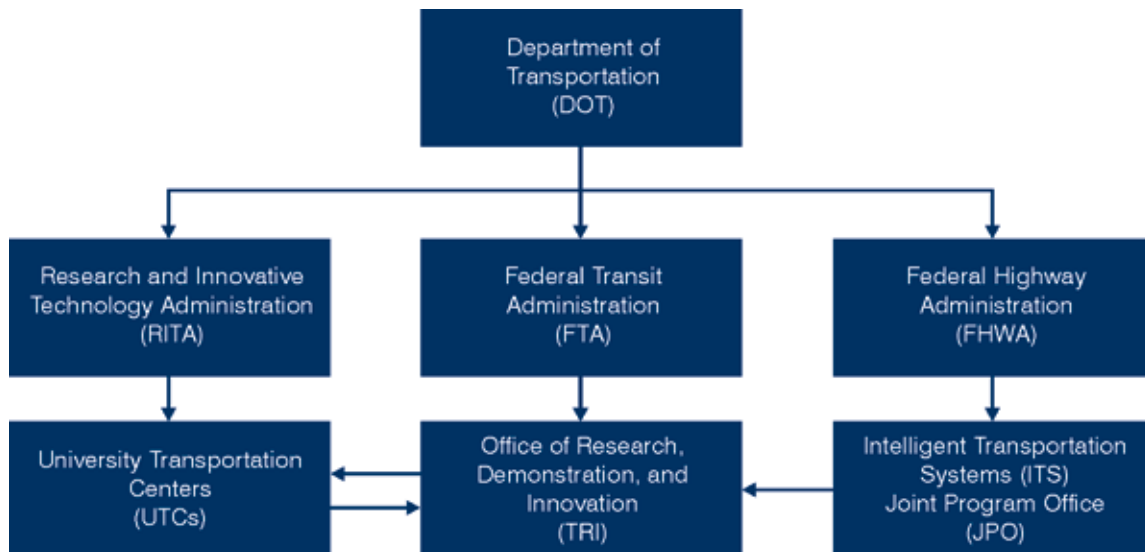
FTA Office of Research, Demonstration, and Innovation



DOT Transit Research Programs

Although the Research Office has primarily been responsible for the national transit research agenda, the research projects are managed across FTA as well as by a variety of other organizations both within and outside the Federal government. The number and variety of organizations carrying out federally-funded transit research assure a diverse program but offer several challenges to FTA leadership.

Within DOT, three modal administrations are directly involved in the transit research program. The DOT Research and Innovative Technology Administration (RITA) administers the University Transportation Centers Program (UTCP) and the Federal Highway Administration (FHWA) through its Intelligent Transportation Systems (ITS) Joint Program Office (JPO), which manages ITS research that benefits both the transit and highway communities. FTA manages many of these ITS projects on behalf of the JPO.



FTA's research programs, as amended by SAFETEA-LU, comprise the following major programs: The National Research and Technology Program (NRTP), the National Fuel Cell Bus Technology Development Program, the Transit Cooperative Research Program (TCRP), the University Transportation Centers Program (UTCP), and the National Transit Institute (NTI).

Progress toward Strategic Transit Research Goals

The FTA Strategic Research Plan provided five specific goals and 17 objectives for a comprehensive national transit research program aligned with industry and public needs and DOT's strategic goals. In 2006, FTA successfully completed research projects for all of these goals. More than 90% of these projects were completed on time and within budget. Descriptions of selected research projects completed in 2006 are provided below, indexed by FTA strategic research goal.

Goal 1: Provide Transit Research Leadership

Goal 1 Objectives

- Ensure transit research supports national goals
- Continue to improve research management
- Facilitate implementation of research results by the transit industry

Transit research is carried out by a number of entities throughout the United States including the FTA, state departments of transportation, transit agencies, universities, and the transit industry. FTA alone, however, has the responsibility for addressing transit research from a national perspective. FTA research programs must be balanced and must support national goals. As it undertakes research, FTA first identifies and analyzes candidate methods and technologies. These methods and technologies are then tested or demonstrated, and evaluated. After demonstration, FTA ensures that results are disseminated to the transit industry.

Besides leading and supporting domestic research, FTA shares international best practices with the U.S. transit industry and provides decision-makers with the tools and information needed to support informed decisions.

FY 2006 Accomplishments

FTA Achieves Highest Rating — Effective — for the National Research Programs under the Program Analysis Rating Tool

FTA's National Research Programs were assessed by the Office of Management and Budget (OMB) under the Program Analysis Rating Tool (PART) process. The tool evaluates programs in four areas: program purpose and design; strategic planning; program management; and program results/accountability. The National Research Programs achieved an "effective" rating of 95 out of 100. "Effective" is the highest rating a program can achieve. Programs rated "effective" set ambitious goals, achieve results, are well-managed, and improve efficiency. Government-wide, only 15% of programs have achieved an "effective" rating.

Reviewing FTA's Research Programs. In 2004, at the request of FTA, the Transportation Research Board (TRB) convened a standing advisory committee, the Transit Research Analysis Committee (TRAC), to advise FTA regarding the federal role in transit research, high-priority opportunities, and cooperative processes to ensure that stakeholders are included in developing the research program. The TRAC was instrumental in assisting FTA in developing the Strategic Research Plan and the Multi-Year Program Plan.

Laying out the Transit Research Agenda. The *FTA Multi-Year Research Program Plan (FY07 – FY11)* provides descriptive summaries of FTA's existing and proposed research products and links them to the goals and objectives of FTA's Strategic Research Plan.

Reporting Research Results. FTA is reintroducing annual reporting on research results with this Annual Research Report for FY 2006.

Improving Research Management. In order to continue to improve research management, FTA issued a new order, FTA O 6200.1, Project Management Guidelines for Research Projects. This order establishes policies and standards for FTA project managers to guide them through all stages of FTA research.

Goal 2: Increase Transit Ridership

Goal 2 Objectives

- Identify best practices and technologies to increase transit ridership
- Identify and overcome barriers to the adoption of ridership enhancement techniques
- Identify solutions to provide public transportation for targeted populations
- Identify cost-effective solutions to provide rural public transportation services

Public transportation ridership has grown by nearly 22% since 1995, faster than highway or air travel. The American Public Transportation Association (APTA) estimates that more than 14 million people take about 31 million trips each weekday.¹ Still, transit's share of the overall "transportation market" remains small. Increasing the number of transit riders is important because transit ridership facilitates a range of societal benefits. These benefits include increasing mobility, improving safety, reducing air pollution, and improving energy efficiency. Research results for 2006 include ridership enhancement techniques, deployment and demonstration of passenger information systems, and advanced parking management systems at transit park-and-ride facilities.

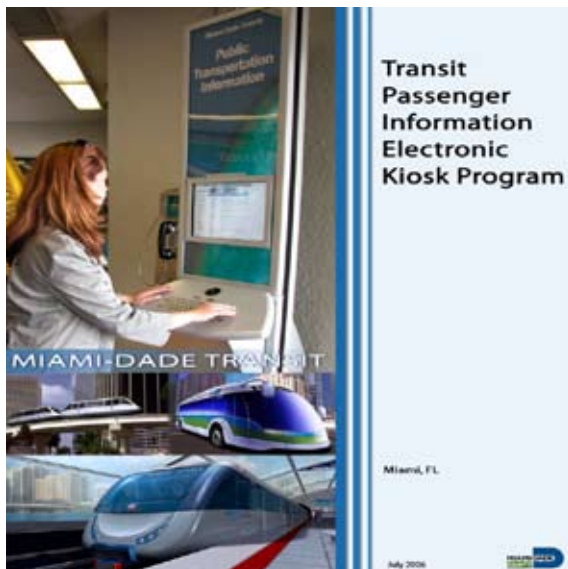
¹ *2005 Public Transportation Fact Book*, APTA (2005), p. viii.

FY 2006 Accomplishments

Identifying Ridership Enhancement Techniques. FTA developed the *Ridership Enhancement Quick Study*² to inform transit agencies of the various ridership enhancement techniques available. The Office of Budget and Policy (TBP) is working with two transit operators to implement ridership enhancement techniques identified in the study.

Improving Accessibility Using Technology. In August 2006, FTA and the ITS/JPO published a final report highlighting *ITS Applications for Coordinating and Improving Human Services Transportation*. This cross-cutting report describes technologies that improve accessibility for the transportation disadvantaged. The study places special emphasis on technologies that improve coordination of agencies, services, functions, or modes because coordination can result in greater efficiency and service delivery improvements.

Developing a New Small Transit Bus. The Small Urban and Rural Transportation Center (SURTC) at North Dakota State University completed a scoping paper outlining the background and goals of the small vehicle development project. This research will ensure that the small transit vehicle market is efficient at serving riders and transit agencies, for example, by developing transit vehicle specifications or a specific transit vehicle to meet the needs of rural transit systems. By implementing these types of vehicles, transit providers will gain efficiencies through increased reliability, greater vehicle maneuverability, and greater fuel economy while offering riders greater comfort and improved ride quality. Both transit agency and manufacturer opinions will be given highest priority as the research work plan continues to mature.



Providing Passengers with Better Information.

FTA is working with Miami-Dade Transit (MDT) to provide customers with an automated trip planning capability including real-time online route and schedule information using electronic kiosks to provide information. In 2006, a marketing campaign was launched along with the purchase of three kiosks. A system-wide 25% increase in transit ridership was recorded in the Miami-Dade area over a period of several months.

Electronic kiosks provide MDT riders with real-time route and schedule information.

² FTA, *Ridership Enhancement Quick Study*, Final Report, 2006. Available at http://www.fta.dot.gov/documents/FTA_finalreportOct6.pdf.

Evaluating Real-Time Passenger Information Systems. FTA developed guidance to help transit agencies with the development and implementation of Real-Time Passenger Information Systems.³ These systems identify to the customers when a bus will arrive at their stop.

Attracting Transit Riders Using Wireless Technologies. To look at new ways of enticing riders to transit and to develop new capabilities for operations, FTA funded the design, installation, and testing of equipment for wireless Internet access aboard Washington State Ferries (WSF) in Puget Sound, WA. The long-term goal for this project is a floating-area network that would blanket each ferry with coverage to provide the kind of high-speed connections needed to run credit card point-of-sale systems in ferry restaurants as well as help automate many on-board paper processes, such as crew scheduling and time cards.



In 2006, several Washington State Ferries acquired wireless service and automation.



Passengers enjoy high-speed wireless connection aboard a Washington State Ferry.

Using Advanced Park-and-Ride Information Systems to Increase Ridership.

Montgomery County, MD tested an advanced variable information sign to support an FTA study on the effectiveness and limitations of real-time parking information systems for transit park-and-ride applications. The variable signs inform motorists about parking availability at

³ FTA, *Real-time Bus Arrival Information Systems Return-on-Investment Study*, August, 2006. Available at http://www.fta.dot.gov/documents/Final_Report_-_Real-Time_Systems_ROI_Study.doc.

appropriate decision points on their route so that they can make informed decisions about where to park. This signage improved user satisfaction and increased the use of a parking lot that was formerly under-utilized.

Individualized Marketing Demonstration Completed.

Individualized marketing programs implemented in Europe had shown promising results. FTA funded a pilot program to assess the impacts of individualized marketing in select U.S. cities - Bellingham, WA; Sacramento, CA; Durham, NC; and Cleveland, OH. The program's purpose was to determine whether marketing designed for individual riders could increase ridership better than marketing efforts already in place.⁴



Real-time information helps motorists decide where to park-and-ride.

Improving Accessibility in Rural and Small Urban Communities.

Project ACTION developed a report that identifies issues and highlights successes of small and rural community transportation providers, *Transportation Services for People with Disabilities in Rural and Small Urban Communities*, which is being widely distributed among disability and service organizations and transportation providers nationwide.

Making Bus Stops More Accessible. Project ACTION's *Tool Kit for Bus Stop Accessibility and Safety Assessment*, contains survey forms to enable transit agencies and others to evaluate bus stop accessibility toward ensuring high-quality, accessible bus stop design. The tool kit was developed through literature reviews, site visits, field tests, and phone interviews with the support of transit agencies and disability representatives.

Advanced Public Transportation Systems: The State of the Art

This report is the latest in a series of state-of-the-art reports, the last of which was published in December 2000. It presents the results of a high-level scan of the extent and character of the adoption and use of advanced technology in the provision of public transportation services in North America. The report provides public transportation professionals with up-to-date information on the current deployment status of transit ITS technologies and emerging transit ITS technological advances and trends. It includes lessons learned based on deployment experiences, and promotes understanding of future trends in Advanced Public Transportation Systems (APTS).

Advanced Public Transportation Systems: The State of the Art, Update 2006, March 30, 2006, 265 pages

⁴ FTA, *Individualized Marketing Demonstration Pilot Program*, Final Report, 2006. Available at http://www.fta.dot.gov/documents/IMDP_Final_Report.pdf.

Commuting in America III. Based on the latest census information, a joint TCRP/National Cooperative Highway Research Program (NCHRP) report, [*TCRP Report 110*](#), tells the story of America's commuting trends and patterns over the last 10 years.

Analyzing the Effectiveness of Commuter Benefits Programs. TCRP completed an evaluation of the effectiveness of a transit benefits program and how the program can be designed and implemented to more effectively meet goals and objectives. The resulting report, [*TCRP Report 107*](#), also summarizes research on the impacts of transit benefits programs on travel behavior and on transit agencies' system-wide ridership, revenues, and costs.

Cost-Benefit Analysis of Providing Non-Emergency Medical Transportation (NEMT).

TCRP examined the relative costs and benefits of providing transportation to non-emergency medical care for individuals who miss or delay healthcare appointments because of transportation issues. The web-only report, [*TCRP Document 29*](#), includes a spreadsheet to help local transportation and social service agencies conduct their own cost-benefit analyses of NEMT tailored to the local demographic and socio-economic environment.

Elements Needed to Create High-Ridership Transit Systems: Interim Guidebook.

[*TCRP Document 32*](#) (web only) is a guidebook that examines types of actions, initiatives, and special projects that offer the potential to improve transit ridership and provides examples of their effective use and impacts. The guidebook is designed to assist transit managers and their staff, policymakers, and key regional stakeholders by describing strategies that have proven successful at producing increased ridership.

Goal 3: Improve Capital and Operating Efficiencies

Goal 3 Objectives

- Identify practices and technologies to control capital costs
- Identify solutions to control operating costs
- Identify methods and technologies to improve transit operational efficiency
- Identify solutions to improve transit infrastructure maintenance
- Improve the capacity of the transit industry and workforce

To facilitate and improve return on investment (ROI), FTA has a goal to improve capital and operating efficiencies. Reducing and controlling capital costs of both infrastructure and vehicles helps ensure that projects are completed on time and within budget. Once a capital investment is in place, ROI is maximized by ensuring that operations are both cost-effective and efficient. Transit operations also face considerable challenges to controlling costs. Primarily due to the addition of new systems and the expansion of existing ones, operating expenses increased nearly 57% between 1991 and 2003 to a total of \$24.2 billion.⁵ Tied to reducing operating costs is improving transit operational efficiencies. The transit industry needs information to make appropriate decisions on service operations, and needs support to build the professional capacity of the transit workforce and the manufacturing industry to meet these challenges.

⁵ 2003 *National Transit Summaries and Trends*, p.14.

FY 2006 Accomplishments

Non-Rail Vehicle Market Viability Study. The U.S. non-rail (bus) manufacturing industry faces extreme challenges today. In the last decade, no fewer than 10 manufacturers have either reorganized or gone out of business. Today, the financial condition of most bus manufacturers is tenuous at best. Presented as a stand-alone report to the FTA, [*The Non-Rail Vehicle Market Viability Study*](#) provides an exploratory evaluation of the viability of the U.S. bus manufacturing industry to meet the demand for fixed-route transit buses. This study is available to all interested readers but includes information particularly salient to federal transportation officials, transit agency representatives, and bus manufacturing industry professionals.

Developing Transit Standards

The American Public Transportation Association (APTA) estimates that implementation of transit standards could result in savings of between \$106 million and \$264 million annually on the cost of new rail and bus vehicles. FTA funds the development and maintenance of cost-effective transit standards and recommended practices and design guidelines to achieve safety, reliability, and efficiency in transit system design and operation. For example, the recently completed Crash Energy Management (CEM) specifications were published and made available for download on APTA's website.⁶

Determining Why Light Rail Costs Are Rising. Rising light rail capital costs are a significant concern for the FTA and for transit agencies. A number of reports have been written examining transit capital and operating costs. FTA analyzed and reported the cost drivers that offer the best opportunity to control capital costs and to reduce operating costs ([*Analysis of Capital Cost Elements and Their Effect on Operating Costs Report*](#)). Transit agencies can use the report to help identify and control cost drivers in capital projects as well as in daily operations.

⁶ www.aptastandards.com has a listing of all published standards including subcategories under the Passenger Rail Equipment Safety Standards (PRESS), Bus Transit Standards, and Universal Transit Farecard Standards (UTFS) Program.



Engine door



A/C door

Light-weight bus doors manufactured with composite materials developed by the Center for Composites Manufacturing.

Lowering the Weight and Costs of Bus Materials. The Center for Composite Manufacturing at the Southern Research Institute (SRI) is developing light-weight, low-cost, high-performance materials for buses. SRI has teamed with North American Bus Industries (NABI) to identify bus components for weight reduction. SRI successfully demonstrated that composites can be fabricated into an integrated, one-piece bus seat and an integrated floor structure. The new Long Fiber Reinforced Thermoplastics battery door exceeded customer expectations and has the advantage of being corrosion-resistant. NABI is currently field testing the composite door. SRI is now working with NABI to develop compressed natural gas (CNG) door panels for the company's rapid transit (BRT) bus.

Research equipment assembly for carbon fiber production



The FTA sponsors a carbon fiber research program to develop low-cost carbon fibers for commercial applications including light-weight body panels and load-bearing structures for transit vehicles.

Lowering the Costs of Carbon Fiber Composite Materials. The University of Tennessee Space Institute (UTSI) established a pitch-based carbon fiber research program to address the high cost of carbon fiber composite materials. Using pitch as the raw material, UTSI is developing low-cost carbon fiber for a variety of commercial applications including transit equipment manufacturing. This year, UTSI was successful in spinning carbon fibers from 28 microns to 10 microns in diameter, which is the target range of commercially made carbon fibers.

National Transit Institute

The National Transit Institute (NTI) provides training, education, and training assistance to the transit industry and related industries. All of NTI's training includes extensive involvement and contact with the transit industry. NTI maintains a broad set of advisory and support committees that provide linkages to industry training needs. In addition to the NTI Advisory Board, NTI currently has four advisory committees in Advanced Technology, Multi-modal Transportation Planning, Management Development, and Workplace Safety and Security. NTI is looking forward to shape a program that will effectively serve the public transit industry during the next four years, the period authorized under SAFETEA-LU. In 2006, NTI delivered 33 training courses to more than 500 attendees. An additional 13 courses are under development.

Overcoming Barriers to Shared Track Usage. The FTA issued the report *Sharing of Track by Transit and Freight Railroads: Liability and Insurance Issues*, which explores the issues of liability and insurance that arise in planning and operating track shared between light rail transit (LRT) and freight railroads. Shared track operations involve some unique risks, and the liabilities associated with these risks can affect their operating plans and costs and whether such services are offered. In addition, FTA continued joint efforts with the Federal Railroad Administration (FRA) and the DOT Intelligent Transportation Systems Joint Program Office (ITS/JPO) to examine the safety and feasibility of concurrent shared track operations of short-line or sparingly-used freight railroads and LRT. Also, they are exploring the market and national business case for such operations.

Promoting U.S. Suppliers and Manufacturers. The International Mass Transportation Program is FTA's primary vehicle to present the U.S. mass-transit industry to foreign mass-transit officials. Although the process of relationship-building between U.S. sellers and foreign buyers in the mass-transit industry takes years, some early successes include a contract for \$3 million, won by a U.S. company dealing in China, which it attributed, in significant part, to FTA's trade mission activity. Another U.S. company expects to finalize a \$2 million contract in South Korea and one for \$500,000 in Ghana. FTA researches international opportunities and provides a web-accessible list of current public transit tenders to help inform U.S. companies about opportunities. The *international tenders list* is published on the FTA and APTA websites.

The Bus Rapid Transit Initiative

FTA continues to research the use of Bus Rapid Transit (BRT). In 2006, BRT-related accomplishments included evaluations, workshops, scanning tours, and a new training course. These efforts also support work underway to update the [Characteristics of Bus Rapid Transit for Decision-Making Report](#). Many of these projects were carried out with FTA funding by the National Bus Rapid Transit Institute (NBRTI) at the University of South Florida.

BRT Evaluations – Final Report

Boston, MA (Phase I and Phase II); Las Vegas, NV; Honolulu, HI; San Pablo, CA

Workshops

- National BRT Workshop (FTA, Hennepin County, ITE) – Eagan , MN
- American Society of Civil Engineers (ASCE) BRT Workshop – Washington D.C., April 2006
- APTA/TRB BRT Workshop – Toronto, CA, August 2006
- Seattle BRT Workshop (FTA Region 10 and King County), September 2006

BRT Scanning Tours/Trade Mission – Final Reports

- China – In April 2006, FTA led a trade mission to China. As part of the mission, the NBRTI prepared [Bus Rapid Transit Developments in China Perspectives from Research, Meetings, and Site Visits in April 2006](#).
- Colombia – In May 2006, the NBRTI also published a report, [Applicability of Bogotá's TransMilenio BRT System to the United States](#).

National Transit Institute – BRT Course

- Revised BRT course, “Characteristics and Planning of Bus Rapid Transit (BRT).” New course material includes the [Characteristics of Bus Rapid Transit for Decision-Making Manual](#). Pilot delivered in September 2006.

Update of the Characteristics of Bus Rapid Transit for Decision-Making

- A comprehensive summary of applications of BRT elements in the United States and in selected sites around the world. Information on the first wave of BRT projects to be implemented in the United States shows the broad range of applications of key elements of BRT – running ways, stations, vehicles, fare collection, intelligent transportation systems (ITS), and service and operating plans. This report also addresses the performance of BRT systems and discusses how combinations of BRT elements contribute to transit system performance including reduced travel times, improved reliability, identity and a quality image, improved safety and security, and increased capacity. [Characteristics of Bus Rapid Transit for Decision-Making](#).

International Activities

- Ongoing efforts to form information sharing partnerships with Korean and Japanese agencies for BRT projects.

Testing New Bus Models. The Altoona Bus Testing and Research Center in Altoona, Pennsylvania, tests buses for safety, structural integrity, performance, maintainability, noise, and fuel economy. A new online database allows users to search, view, and compare information collected in the course of New Model Bus Testing and to download copies of the official [*Bus Testing Reports*](#). Since 1990, approximately 300 buses have been tested. The testing has found more than 7,000 malfunctions that would have increased maintenance costs to the operator. Thirty-eight of these malfunctions were critical enough that they might have caused serious injuries and/or significant property damage.⁷



Cleveland RTA BRT bus on the durability track at the Altoona Bus Research and Testing Center (BRTC).

⁷ Selected bus testing data may be searched, compared, and exported for offline analysis. Complete [*Bus Testing Reports*](#) may be downloaded from the Interactive Bus Testing Database at www.altoonabustest.com.

Partnering to Develop the Transit Workforce. The Transit Technology Career Ladder Partnership Program run by the Community Transportation Development Center (CTDC) is addressing the growing skills gap for hourly waged transit employees. The program is creating new strategies for recruiting, retaining, and training entry-level employees into positions with career ladder potential. As reported in the CTDC's latest *Measuring Up Report*⁸, at the Southeastern Pennsylvania Transit Authority (SEPTA), the combined cost savings were estimated to be more than \$26 million during the first four program years.

Using Archived AVL-APC Data to Improve Transit Performance and Management.

TCRP Report 113 explores the effective collection and use of archived automatic vehicle location (AVL) and automatic passenger counter (APC) data to improve the performance and management of transit systems. Spreadsheet files (available on the web) provide prototype analyses of passenger waiting time using AVL data and passenger crowding using APC data.

Managing Capital Costs of Major Federally-Funded Public Transportation Projects.

In *TCRP Document 31* (web-only), TCRP explored strategies, tools, and techniques to better estimate, contain, and manage capital costs of federally-funded public transportation projects based, in part, on the experience of the case study projects.

A Guidebook for Developing and Sharing Transit Bus Maintenance Practices.

TCRP Report 109 is a guidebook that provides information on how to develop effective transit bus maintenance practices tailored to the local operating environment. Complementing the report is an online Web Board sponsored by the TRB's Committee on Transit Fleet Maintenance.



⁸ Community Transportation Center, *Measuring Up: Assessing the Costs and Benefits of Training in the Keystone Transit Career Ladder Partnership*, Interim Report, February 2006 Update. Available at <http://www.keystonetransit.org/pub/InterimReportFeb2006.pdf>.

Goal 4: Improve Safety and Emergency Preparedness

Goal 4 Objectives

- Identify solutions to improve transit safety
- Identify solutions to reduce criminal activity
- Identify solutions to improve transit emergency preparedness

Transit is one of the safest modes of travel. The National Safety Council's 2004 Injury Facts reports that riding a transit bus is 79 times safer than traveling by automobile. Transit rail passengers are 42 times safer than those traveling by car.⁹ However, in 2004 transit agencies reported 248 fatalities (most not to passengers) and about 18,982 injuries.¹⁰ Thus, safety remains a priority for FTA and transit operators.

Distinguishing between transit safety and transit security is important. Safety involves unintentional events such as crashes. Potential solutions include better operator training and testing, better vehicle design, and better track inspection.

Security involves protection against an intentional act of violence or personal harm from a criminal or terrorist act. By statute, lead responsibility for public transportation security against terrorism threats rests with the Department of Homeland Security (DHS). A Memorandum of Understanding between DOT and DHS describes the roles and responsibilities of the departments.¹¹ FTA works closely with DHS Transportation Security Administration (TSA) to address protection and with DHS Office of Grants and Training (OGT) (formerly the Office for Domestic Preparedness) to address preparedness. Other security threats, such as non-terrorist criminal acts against transit passengers, employees, or property, are addressed directly by FTA. In recent years, emergency preparedness for natural disasters has also become a high priority.

⁹ *Public Transportation Fact Book*, p. xiii.

¹⁰ *Transit Safety and Security Statistics and Analysis Annual Report, Fatalities by Mode and Year*. Available at <http://transit-safety.volpe.dot.gov/Data/samis/default.asp?ReportID=2>.

¹¹ Annex to the Memorandum of Understanding between the Department of Homeland Security and the Department of Transportation on Roles and Responsibilities concerning Public Transportation Security, September 8, 2005.

FY 2006 Accomplishments

Crash Energy Management

FTA, FRA, and APTA developed a specification for Crash Energy Management (CEM) used in a procurement by Metrolink in Southern California. CEM increases the safety of the vehicles by incorporating non-occupant crash zones at both ends of the vehicle. The fleet is therefore less susceptible to loss of occupant volume and more likely to remain on track and in line in the event of a collision. The specification was based on the results of research made available by FRA on work it has undertaken with the Volpe Center to develop prototype crush zone designs. Through full-scale crash testing, FRA demonstrated the effectiveness of CEM concepts in March 2006 at the Transportation Technology Center, Pueblo, Colorado.

Development of a Crash Energy Management Specification for Rail Passenger Equipment, Transportation Research Board Research Record



The photographs show the difference between the conventional train (1/31/02) and a train with CEM features (3/23/06). In both tests, a train led by a cab car collided with a locomotive-led train of equal weight at 30 mph. In the test using CEM equipment, forces were controlled such that the equipment did not derail. Photographs courtesy of FRA.

Improving Bus Crashworthiness. Wichita State University continues to measure transit bus crash dynamics and how bus design affects crash forces that cause injuries to bus occupants. The results will identify interior design choices that lessen injuries to bus occupants in crashes.



Crash simulator sled with test dummies



Setting up to measure passenger impacts

Impact testing to determine safer bus interior designs.

Enhanced 2006 Transit Watch Toolkit. Transit Watch is a nationwide public awareness outreach campaign that encourages the active participation of transit passengers and employees in maintaining a safe transit environment. FY06 improvements included messages pertaining to unattended bags and evacuation procedures, translation of the original Transit Watch materials into Spanish, and development of a “Five-Step Strategy” for enhancing communication with State and Local Citizen Corps Councils.

Transit Safety and Transit Security Statistics. FTA continues to collect statistics from transit agencies reporting into the National Transit Database on safety and security. FTA uses available safety and security data to target the most frequent causes of risk to passengers, employees, emergency responders, and others who use or service public transportation systems.

Transportation Safety Institute. The Transportation Safety Institute (TSI) offers the transit industry 24 different training courses in the areas of transit safety and transit security. In FY06, TSI developed four new courses, which will be offered in FY07.

Transit Safety: Reducing Collisions. DOT’s Intelligent Vehicle Initiative (IVI) came to a close in December 2005 with the publication of *[Saving Lives Through Advanced Vehicle Safety Technology: Intelligent Vehicle Initiative Final Report](#)*.¹² The IVI Program focused on crash prevention and included research on the implications of in-vehicle technologies for operator behavior. For transit, this program developed performance specifications for systems that address forward, rear, and side collisions. Future work is on integrated vehicle-based safety systems, evaluations of side-object detection systems, and lane assistance systems.

Improving Pedestrian Safety at Unsignalized Crossings. The joint TCRP/NCHRP report, *[TCRP Report 112](#)*, examines selected engineering treatments to improve safety for pedestrians crossing high-volume and high-speed roadways at locations without traffic signals.

Disaster Response and Recovery Resource for Transit Agencies

Based on lessons learned from Hurricane Katrina and other events, the FTA has documented practices and procedures to improve emergency preparedness. ***Disaster Response and Recovery Resource for Transit Agencies (Resource)*** provides transit agencies and transportation providers with information and best practices in emergency preparedness and disaster response and recovery. The ***Resource*** also includes links to more specific resources and more detailed information for local agencies, lists of FTA Emergency Response Staff Contacts, and Federal Emergency Management Agency (FEMA) State Emergency Office Contact also includes links to more specific resources and more detailed information for local agencies.

Disaster Response and Recovery Resource for Transit Agencies, August 21, 2006, 41 pages

¹² *Saving Lives Through Advanced Vehicle Safety Technology: Intelligent Vehicle Initiative Final Report*. Available at http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_PR/14153_files/ivi.pdf.

Goal 5: Protect the Environment and Promote Energy Independence

Goal 5 Objectives

- Facilitate development of technologies to improve energy efficiency and reduce transit vehicle emissions
- Identify and overcome barriers to adoption of clean technologies

Transit agencies have increasingly focused on incorporating new fuels and propulsion technologies to make their systems cleaner and more efficient and to reduce fuel consumption. This change is due in part to community pressures and in part to changes in emission standards by the Environmental Protection Agency (EPA) and state agencies such as the California Air Resources Board (CARB).

An FY05 analysis of electric-drive bus technologies carried out for FTA reported that transit agencies' primary interest in cleaner fleets was driven by regulatory and political pressure to reduce emissions or to bring their region into compliance with federal air quality standards.¹³ Specifically, heavy-duty transit bus engines are regulated by EPA for the following pollutants: particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), and hydrocarbon (HC) emissions. These standards become more stringent in 2007 and again in 2010.

Although compressed natural gas (CNG) buses helped meet many of these goals and comprised 11% of the total bus fleet in 2003, many transit agencies have been reluctant to deploy CNG buses because of associated expenses and the performance of these vehicles.¹⁴ Therefore, many transit agencies are interested in finding clean alternatives to CNG, such as ultra-low sulfur diesel (ULSD) with diesel particulate filters and hybrid-electric buses. In recent years, transit bus fleet owners have shown more interest in hybrid-electric buses. Also of high interest, but expensive to date, are fuel cell propulsion buses.

From commuter rail to streetcars, most rail transit is electric drive. Virtually all heavy and light rail and many commuter systems use electricity as the energy source. The same ideas of energy storage and hybrid technologies can be applied to rail transit. Rail transit control and braking systems can also be improved to provide more efficiency. These areas of transit technology are open for development, although, to date, little has been done in this area.

¹³ FTA, *Analysis of Electric Drive Technologies for Transit Applications: Battery-Electric, Hybrid-Electric, and Fuel Cells*, August 2005, pp. 7-8.

¹⁴ *Analysis of Electric Drive Technologies for Transit Applications: Battery-Electric, Hybrid-Electric, and Fuel Cells*, p. 8.

FY 2006 Accomplishments

Examining Alternatives to Foreign Oil. FTA is funding the demonstration of operating performance of Fischer-Tropsch (F-T) synthetic diesel fuel in transit fleet applications and providing transit agencies with real-world data in hot weather (Tulsa, OK) and cold weather (Fairbanks, AK) operating environments. The first phase of the Tulsa Transit Bus Fleet Demonstration is about 95% complete. Preliminary performance data show that F-T engines produce fewer emissions than diesel. Fischer-Tropsch converts natural gas or coal into a synthetic fuel that transit vehicles can use in place of foreign oil.

Hot weather testing in Tulsa, OK



Cold-weather testing in Fairbanks, AK



Synthetic diesel fuel tested by FTA works in all climates.

Determining Transit Vehicle Exhaust Emissions. West Virginia University (WVU) has an emissions research program that provides public transit agencies, engine and vehicle manufacturers, transit industry associations, government regulatory agencies, and other transit industry organizations with information about the exhaust emissions of existing and new technology transit vehicles. In FY06, WVU finished conducting emissions testing on low sulfur diesel, CNG, hybrid-electric, and biodiesel buses at the Washington Metropolitan Area Transit Authority (WMATA).

Demonstrating Biodiesel. FTA's biodiesel demonstration project involves participation by the Missouri Soybean Association, the National Biodiesel Board, Metro St. Louis, MO and the Kansas City Area Transportation Authority (KCATA). The field demonstration currently has eight buses running at St. Louis Metro and 12 buses running at Kansas City Area Transit. Biodiesel offers another opportunity to reduce dependence on foreign oil.

Identifying a Pathway to Hydrogen Fueled Vehicles. CALSTART Advanced Transportation Technologies developed a Hydrogen Internal Combustion Engine Workshop along with two reports (not yet available online): *A Compendium of Hydrogen-Blend and Hydrogen Fueled Internal Combustion Engine Activities* and *A Transition Pathway to Hydrogen Fueled Powertrains for Light, Medium, and Heavy-Duty Vehicles*. CALSTART also published four issues of the nation's only hydrogen bus newsletter, *Hydrogen Bus Source*, in FY06.



Hydrogen Hybrid Internal Combustion Engine (HHICE) bus at SunLine Transit Agency.

Improving Hybrid Vehicles. For FTA and the U.S. Air Force, CALSTART and Mack Powertrain developed an Integrated Starter Alternator (ISAM) hybrid system designed for commercialization across bus, refuse truck, and military aircraft refuelers. This hybrid drivetrain is "one-size-fits-all" and permits downsizing of the engine in a bus configuration. Volvo Ab announced plans to take the hybrids into production.

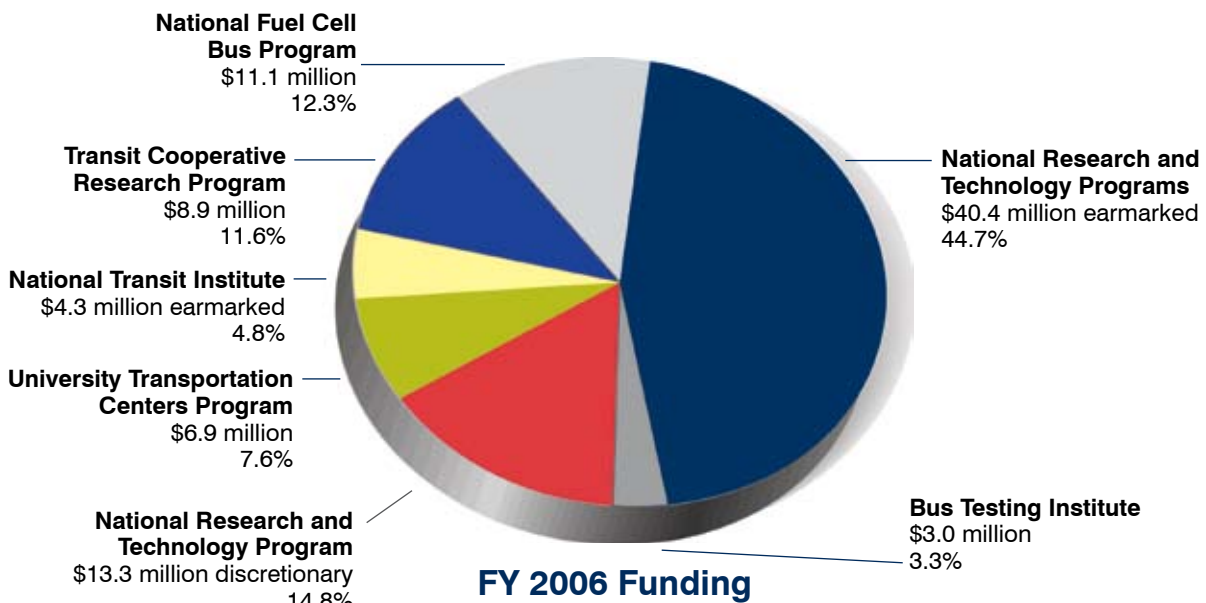
New Plug-in Electric Hybrid Vehicle. The Kansas City Area Transportation Authority (KCATA) began testing a new plug-in electric hybrid paratransit van (Dodge Sprinter). KCATA is part of the On-Grid Hybrid Electric Bus Consortium that designed and built this first-of-its-kind transit vehicle. The Consortium expects fuel savings of more than 25% as well as reductions in emissions. With a much larger battery than ones found in other other hybrids, the vehicle obtains electricity from a city's electric grid when it is plugged in and can travel up to 20 miles on electric-only power.

FY 2006 Funding Charts

FY 2006 Appropriations

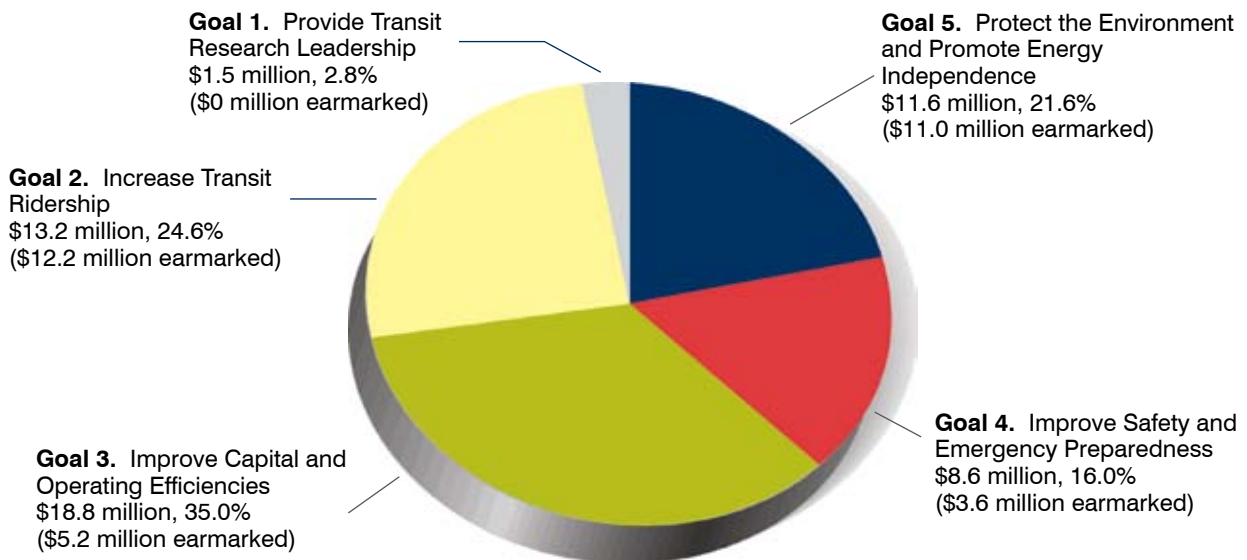
In FY06, Congress appropriated approximately \$73.8 million for FTA's Research and University Research Centers Account. Of this, \$8.9 million was provided for the Transit Cooperative Research Pilot Program (TCRP), \$4.3 million for the National Transit Institute (NTI), and \$6.9 million for the University Transportation Centers Program administered by the Research and Innovative Technology Administration (RITA). The balance (\$53.7 million) is considered the National Research and Technology Program (N RTP), of which \$40.4 million was earmarked for specific projects or programs.

In addition, the Research Office manages the National Fuel Cell Bus Technology Development Program (\$11.1 million) and the Bus Testing Institute in Altoona (\$3.0 million), which are funded out of FTA's capital accounts.



FY 2006 Funding by Strategic Research Goals

FTA's FY06 National Research and Technology Program was approximately \$53.7 million, of which approximately 75% was earmarked for specific projects or programs. The following graph shows funding by FTA's five strategic research goals.



FY 2006 NRTTP Funding by Goal

The \$40.4 million NRTTP-earmarked research funds were divided among projects supporting four of FTA's strategic research goals. More than one third of these research dollars went to research to improve transit capital and operating efficiencies.

The \$13.3 million NRTTP discretionary research funds were divided among projects supporting all five of FTA's strategic research goals.

FTA Research Performance Measures

FTA met all four of its research performance measures in FY06. These four measures were defined as part of OMB's PART process. The goals are designed to be realistic and measurable as well as allow for steady progress.

Transit Ridership. The top 150 operators represent about 96% of transit ridership nationwide. FTA's methodology captures the average change per market. FTA accounts for changes in employment based on a number of studies that document the effect of employment changes on transit ridership.

Average percent change in transit boardings per transit market (150 largest transit agencies); adjusted for changes in employment levels

	2004	2005	2006	2007	2008
Target	2.0	1.0	1.0	1.0	1.5
Actual	0.7	1.9	2.1*		

* Preliminary estimate

Transit fatalities per 100 million passenger-miles traveled

	2004	2005	2006	2007	2008
Target	0.487	0.482	0.477	0.473	0.468
Actual	0.467	0.428	0.344*		

* Preliminary estimate

Transit Safety. Using six months of data from FTA's National Transit Database and four months of commuter rail data from the FRA Rail Accident Incident Reporting System (RAIRS), FY06 safety figures show a decline in the number of fatalities and injuries.

Major research deliverables

	2004	2005	2006	2007	2008
Target	N/A	N/A	6	6	6
Actual	6	6	6		

Research Delivery. FTA remains on track to deliver 30 major research products, innovations, and techniques between 2006 and 2010. FTA tracks deliveries on an annual basis

Research Management Efficiency.

The purpose of this measure is to examine how well FTA manages its research projects

Percent of all research projects that are on-time and on-budget

	2004	2005	2006	2007	2008
Target	N/A	N/A	90%	90%	90%
Actual	87%	92%	91%		

Appendices

Appendix A: Acronyms and Abbreviations

The following acronyms and abbreviations are used in this document.

APC	automatic passenger counter	NOx	nitrogen oxides
APTA	American Public Transportation Association	NTI	National Transit Institute
APTS	Advanced Public Transportation System	NRTP	National Research and Technology Program
ASCE	American Society of Civil Engineers	OGT	Office of Grants and Training
AVL	automatic vehicle location	OMB	Office of Management and Budget
BRT	Bus Rapid Transit	PART	Program Analysis Rating Tool
BRTC	Bus Research and Testing Center	PM	particulate matter
CARB	California Air Resources Board	PRESS	Passenger Rail Equipment Safety Standards
CEM	Crash Energy Management	RAIRS	Rail Accident Incident Reporting System
CNG	compressed natural gas	RITA	Research and Innovative Technology Administration
CO	carbon monoxide	ROI	Return on Investment
CTDC	Community Transportation Development Center	SAFETEA-LU	Safe, Accountable, Flexible, and Efficient Transportation Equity Act — A Legacy for Users
DHS	United States Department of Homeland Security	SEPTA	Southeastern Pennsylvania Transit Authority
DOT	United States Department of Transportation	SNAQS	Southern Nevada Air Quality Study
DRI	Desert Research Institute	SRI	Southern Research Institute
EPA	Environmental Protection Agency	SURTC	Small Urban and Rural Transportation Center
F-T	Fischer-Tropsch	TBP	FTA Office of Budget and Policy
FEMA	Federal Emergency Management Agency	TCRP	Transit Cooperative Research Program
FHWA	Federal Highway Administration	TRAC	Transit Research Analysis Committee
FRA	Federal Railroad Administration	TRB	Transportation Research Board
FTA	Federal Transit Administration	TRI	FTA Office of Research, Demonstration, and Innovation (The Research Office)
FY	fiscal year	TSA	Transportation Security Administration
HC	hydrocarbon	TSI	Transportation Safety Institute
HHICE	Hydrogen Hybrid Internal Combustion Engine	TSP	Transit Signal Priority
IMTP	International Mass Transportation Program	ULSD	ultra-low sulfur diesel
ISAM	Integrated Starter Alternator	UTC	University Transportation Center
ITS	Intelligent Transportation Systems	UTCP	University Transportation Centers Program
ITS/JPO	Joint Program Office	UTFS	Universal Transit Farecard Standards
IVI	Intelligent Vehicle Initiative	UTSI	University of Tennessee Space Institute
KCATA	Kansas City Area Transportation Authority	VERSS	Vehicle Emissions Remote Sensing System
LRT	Light Rail Transit	WMATA	Washington Metropolitan Area Transit Authority
MDT	Miami-Dade Transit	WSF	Washington State Ferries
NABI	North American Bus Industries	WVU	West Virginia University
NBRTI	National Bus Rapid Transit Institute		
NCHRP	National Cooperative Highway Research Program		
NEMT	Non-Emergency Medical Transportation		

Appendix B: FTA 2006 Research Reports

FTA 2006 Research Reports. FTA staff and contractors produce reports to assist grantees and/or to highlight a particular issue in the transit industry. Most reports are available at <http://www.fta.dot.gov/research> unless otherwise noted.

Advanced Public Transportation Systems: The State of the Art, Update 2006, March 30, 2006, 265 pages

Analysis of Capital Cost Elements and Their Effect on Operating Costs Report, November 2005

Analysis of Electric Drive Technologies for Transit Applications: Battery-Electric, Hybrid-Electric, and Fuel Cells, August 2006

Biodiesel Fuel Infrastructure and Distribution Survey (Draft)

Bus Rapid Transit Developments in China, July 2006, available at http://www.fta.dot.gov/documents/China_BRT_Final_Report.pdf

Bus Testing Reports, available at Interactive Bus Testing Database, www.altoonabustest.com

Characteristics of Bus Rapid Transit for Decision-Making Report, August 2004, available at <http://www.nbrti.org/media/documents/Characteristics%20of%20Bus%20Rapid%20Transit%20for%20Decision-Making.pdf>

A Compendium of Hydrogen-Blend and Hydrogen Fueled Internal Combustion Engine Activities, CALSTART

Disaster Response and Recovery Resource for Transit Agencies, August 21, 2006, 41 pages

Evaluation of the South Lake Tahoe Coordinated Transit System (CTS) Project, April 2006, available at http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/14316.htm

Individualized Marketing Demonstration Program, Final Report, 2006, available at http://www.fta.dot.gov/documents/IMDP_Final_Report.pdf

ITS Applications for Coordinating and Improving Human Services Transportation: A CROSS-CUTTING STUDY Improving Service for the Transportation Disadvantaged, August 2006, 68 pages

Mass Transit Crashworthiness Statistical Data Analysis, December 2005, available at http://www.fta.dot.gov/documents/Crashworthiness_Report.pdf

Measuring Up: Assessing the Costs and Benefits of Training in the Keystone Transit Career Ladder Partnership, Interim Report, February 2006 Update, Community Transportation Center, available at <http://www.keystonetransit.org/pub/InterimReportFeb2006.pdf>

National Strategy to Reduce Congestion on America's Transportation Network, May 2006, available at <http://www.fightgridlocknow.gov/docs/congestioninitiativebrochure.htm>

Non-Rail Vehicle Market Viability Study, FINAL REPORT, FTA Project Number: MI-26-7008-05.1, January 19, 2006, 103 pages

PMO Lessons Learned References in Guidelines, available at http://www.fta.dot.gov/publications/publications_1347.html

Profiles of Traveler Information Services, April 2006, available at <http://www.fta.dot.gov/documents/Profilesof511TravelerInformationServices.doc>

Real-Time Bus Arrival Information Systems Return-on-Investment Study, August 2006, available at http://www.fta.dot.gov/documents/Final_Report_-_Real-Time_Systems_ROI_Study.doc

Ridership Enhancement Quick Study, Final Report, 2006, available at http://www.fta.dot.gov/documents/FTA_finalreportOct6.pdf

Saving Lives Through Advanced Vehicle Safety Technology: Intelligent Vehicle Initiative, Final Report, available at http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_PR/14153_files/ivi.pdf

Sharing of Track by Transit and Freight Railroads: Liability and Insurance Issues, September 2005, available at http://www.fta.dot.gov/documents/Shared_Track.pdf

Specification for Metrolink Commuter Rail Cars, Crash Energy Management, 560 pages plus 31 pages of drawings

TCRP Document 29 - available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_webdoc_29.pdf

TCRP Document 31 - available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_w31.pdf

TCRP Document 32 - available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_webdoc_32.pdf

TCRP Report 107 - available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_107.pdf

TCRP Report 109 - available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_109.pdf

TCRP Report 110 - available at <http://onlinepubs.trb.org/onlinepubs/nchrp/CIAIII.pdf>

TCRP Report 112 - available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf

TCRP Report 113 - available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_113.pdf

A Transition Pathway to Hydrogen Fueled Powertrains for Light, Medium, and Heavy-Duty Vehicles, CALSTART

Transportation Services for People with Disabilities in Rural and Small Urban Communities, available at http://projectaction.easterseals.com/site/DocServer/Rural_Solutions_Final_Report_through_Appendix_B.pdf?docID=31025

Toolkit for the Assessment of Bus Stop Accessibility and Safety, available at http://projectaction.easterseals.com/site/PageServer?pagename=ESPA_BusStopToolkit

TSP Handbook, December 2005, available at <http://www.fta.dot.gov/documents/TSPHandbook10-20-05.pdf>

Other FTA 2006 Publications

Federal Transit Administration's Project Management Guidelines for Research Projects, FTA O 6200.1, August 14, 2006

Multi-Year Research Program Plan (FY 2007 – FY 2011), FTA, October 2006

Strategic Research Plan, FTA, September 2005

Appendix C: FTA 2006 Patents

- Vehicle Emissions Remote Sensing System (VERSS) for the on-road measurement of fuel-based particulate matter (PM) emissions, Desert Research Institute (DRI), U.S. Patent Number 6,542,831

This patent was developed as part of the Southern Nevada Air Quality Study (SNAQS) that created cross-plume and in-plume measurement systems to quantify emissions distributions and source profiles from transportation emissions, specifically gasoline and diesel powered vehicles. The cross-plume system measures back-scattered ultraviolet radiation to estimate particulate emissions and infrared and ultraviolet absorption to measure gas concentrations in exhaust plumes. The in-plume system draws a portion of air from the plume and directs it to continuous monitors and filter samples that are analyzed in the laboratory. Both systems were applied to on-road measurements in Las Vegas, Nevada.

Results from both methods found that most of the particulate and gas pollutant emissions came from a small fraction of the vehicles. High carbon monoxide emitters were not always high particulate matter and oxide of nitrogen emitters, implying that smog checks must measure all of these pollutants to be effective. Receptor models were applied to ambient particulate samples taken in Las Vegas using source profiles obtained with the in-plume system. Gasoline engine exhaust was the largest contributor to the carbon component at all sites, and diesel exhaust was only a large contributor at commercial sites near major highways. Residential wood combustion was also an important contributor in residential areas, but not in the commercial areas.

