United States General Accounting Office

GAO

Report to the Committee on Appropriations, House of Representatives

May 2003

# TRANSPORTATION RESEARCH

# Actions Needed to Improve Coordination and Evaluation of Research


GAO-03-500

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Highlights

Highlights of GAO-03-500, a report to the Committee on Appropriations, House of Representatives

## Why GAO Did This Study

The Research and Special Programs Administration (RSPA) within the Department of Transportation (DOT) is responsible for coordinating and ensuring the evaluation of DOT research programs to promote the efficient use of departmental research funds, which in fiscal year 2002 totaled over $1 billion. RSPA is also responsible for conducting multimodal research that cuts across different modes of transportation. The House Committee on Appropriations directed GAO to examine RSPA's coordination and evaluation of research within DOT and the status of its own multimodal research.

## What GAO Recommends

GAO is recommending that DOT and RSPA develop strategies to identify potential research duplication and ensure that the results of all DOT transportation research activities—including those conducted by RSPA—are evaluated. Further, GAO recommended that RSPA assess the effectiveness of its research coordination efforts by developing appropriate performance measures.

DOT reviewed a draft of this report and generally agreed with its contents but did not comment on the report's recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-03-500

To view the full report, including the scope and methodology, click on the link above. For more information, contact Kate Siggerud at (202) 512-2834 or siggerudk@gao.gov.

## What GAO Found

RSPA has met some, but not all, legislative and DOT requirements pertaining to the coordination of departmental research efforts. For example, while RSPA develops an annual plan and meets monthly with other DOT research officials, RSPA does not review the status of all DOT research activities. Thus, it cannot determine whether duplication of research efforts within DOT does or does not occur. Additionally, RSPA has not developed standards against which to measure its performance in coordinating research within DOT. Moreover, RSPA has not fully met all legislative and DOT requirements to measure research results and oversee research evaluations across DOT. RSPA officials cited a lack of ready information on DOT research activities budget constraints and a lack of authority over other DOT agencies as reasons why they served primarily an information-sharing role, rather than as an overseer and manager of the coordination and evaluation processes.

**Extent to Which RSPA Meets Coordination and Evaluation Requirements**

| Coordination requirements | Extent to which RSPA meets requirements | Evaluation requirements | Extent to which RSPA meets requirements |
|---|---|---|---|
| **Legislative requirements** | | **Legislative requirements** | |
| Develop an annual surface transportation research and technology development plan. | ● | Measure the results of federal transportation research activities and how they impact the performance of the surface transportation systems of the United States. | ○ |
| Coordinate surface transportation research and technology development activities to avoid duplication. | ◒ | | |
| **DOT requirement** | | **DOT requirement** | |
| Develop processes to routinely share research activities, problems, solutions, and information. | ● | Oversee the DOT research and technology development program and develop more efficient, effective, and participative ways to evaluate and measure program effectiveness and progress across all operating administrations and other selected projects. | ◒ |
| Review the status of all research projects across operating administrations and identify potential duplication. | ○ | | |

● Fully meets requirements
◒ Partially meets requirements
○ Does not meet requirements

Sources: TEA-21, DOT Order 1120.39, and GAO.

Since 1999, RSPA has budgeted $37 million to conduct four major research programs with applicability to more than one mode of transportation—for example, using technology to improve energy efficiency and reduce emissions and transportation dependence on petroleum. According to the Associate Administrator for Innovation, Research, and Education, RSPA's current multimodal research programs are scheduled for completion by the end of fiscal year 2004 and have had a variety of positive results. However, RSPA does not have an evaluation process to systematically evaluate the results of its multimodal research programs.

# Contents

## Abbreviations

| | |
|---|---|
| DOT | Department of Transportation |
| FAA | Federal Aviation Administration |
| FHWA | Federal Highway Administration |
| FMCSA | Federal Motor Carrier Safety Administration |
| FRA | Federal Railroad Administration |
| FTA | Federal Transit Administration |
| GPRA | Government Performance and Results Act of 1993 |
| MARAD | Maritime Administration |
| NASA | National Aeronautics and Space Administration |
| RSPA | Research and Special Programs Administration |
| TEA-21 | Transportation Equity Act for the 21st Century |
| TRB | Transportation Research Board |
| TSA | Transportation Security Administration |
| USCG | United States Coast Guard |

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**United States General Accounting Office**
**Washington, D.C. 20548**

May 1, 2003

The Honorable C.W. Bill Young
Chairman
The Honorable David R. Obey
Ranking Minority Member
Committee on Appropriations
House of Representatives

In fiscal year 2002, the Department of Transportation's (DOT) research and development budget totaled more than $1 billion. This sum supported the many individual projects undertaken by the Federal Highway Administration, the Federal Aviation Administration, and the other operating administrations that constitute DOT. This research is vital to meeting the department's key transportation priorities, such as increasing transportation safety, enhancing mobility for all Americans, supporting the nation's economic growth, and protecting the environment. The Congress has recognized the importance of coordinating and evaluating research throughout DOT and established requirements in the Transportation Equity Act for the 21st Century to ensure that those tasks are accomplished. In turn, the department has given responsibility to the Research and Special Programs Administration's Office of Innovation, Research, and Education (hereafter referred to as RSPA) for coordinating, and ensuring the evaluation of, DOT research programs to promote the efficient use of research funds. RSPA is additionally responsible for conducting multimodal research—research that applies to more than one mode of transportation—for the department that contributes to the safe, effective, and efficient transportation of people and goods.

In House Report 107-722, accompanying the DOT and Related Agencies Appropriations Bill for Fiscal Year 2003, the House Committee on Appropriations, directed us to examine RSPA's role in coordinating research activities and conducting multimodal research throughout the department. Specifically, in subsequent discussions with Committee staff, we agreed to address the following questions: (1) To what extent has RSPA fulfilled requirements for coordinating DOT research efforts? (2) To what extent has RSPA fulfilled requirements for evaluating research within DOT? and (3) What types of multimodal research has RSPA conducted since 1999, and what have been the results?

To address questions regarding RSPA's efforts to coordinate and evaluate the department's research efforts, we examined pertinent legislation, DOT

policy guidance, and DOT performance reports and plans as well as reports and documents provided by RSPA, including the department's Research, Development, and Technology Plan. Although we did not review the individual research programs and agendas of each DOT modal administration, we reviewed external assessments conducted by us and the National Research Council's Transportation Research Board regarding RSPA's role and efforts in coordinating DOT research.[1] Further, we interviewed RSPA officials, including RSPA's Associate Administrator for Innovation, Research, and Education (hereafter Associate Administrator); officials from the Volpe National Transportation Systems Center in Cambridge, Massachusetts; and all of the members of the department's Research and Technology Coordinating Council (hereafter Coordinating Council), to discuss research coordination efforts and identify potential improvements. At the time of our review, the council was made up of 15 members representing the department's Office of the Assistant Secretary for Transportation Policy, Office of Intelligence and Security, Office of the Assistant Secretary for Budget, Office of Intermodalism, United States Coast Guard, Federal Aviation Administration, Federal Highway Administration, Federal Railroad Administration, National Highway Traffic Safety Administration, Federal Transit Administration, Maritime Administration, RSPA, Bureau of Transportation Statistics, Federal Motor Carrier Safety Administration, and Transportation Security Administration.[2] In addition, to determine the types and status of multimodal research that RSPA conducted, we (1) reviewed and analyzed RSPA budget data from fiscal years 1999 through 2003 and (2) reviewed RSPA's multimodal project plans agreements and published project results for the same period. (One of RSPA's multimodal research programs—the Transportation Infrastructure Assurance Program—is also the subject of a separate GAO review.)[3]

[1]The Transportation Research Board is a unit of the National Research Council, a private, nonprofit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The board's mission is to promote innovation and progress in transportation by motivating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results.

[2]The U.S. Coast Guard and the Transportation Security Administration were transferred to the Department of Homeland Security in March 2003.

[3]U.S. General Accounting Office, *Transportation Security Research: Coordination Needed in Selecting and Implementing Infrastructure Vulnerability Assessments*, GAO-03-502 (Washington, D.C.: May 1, 2003).

We conducted our review from September 2002 through February 2003 in accordance with generally accepted government auditing standards.

## Results in Brief

RSPA has met some, but not all, legislative and DOT requirements for coordinating departmental research efforts. To meet the requirements of the Transportation Equity Act for the 21st Century, RSPA developed an annual surface transportation research and development plan and holds monthly meetings of the department's Research and Technology Coordinating Council to coordinate surface transportation research and technology development activities. The council also provides a venue for discussing research processes, procedures, and policies as well as a forum for networking among the department's researchers to meet DOT requirements for routinely sharing research information. However, RSPA has not met all of its legislative and DOT requirements for coordinating ongoing research efforts to avoid unnecessary duplication of effort because it does not review all DOT research projects. According to RSPA's Associate Administrator, RSPA has not reviewed all DOT research projects to identify unnecessary duplication because (1) RSPA does not have ready access to information on all research activities across the department because efforts to implement a DOT-wide computer-based research tracking system have stalled and (2) staff and resources dedicated to research coordination activities have declined. The Associate Administrator said that he did not believe that unnecessary duplication of research projects occurred, and that even if such duplication were identified, RSPA's limited authority within DOT would hinder efforts to eliminate that duplication.

RSPA has met some, but not all, legislative and DOT requirements for evaluating research within DOT. The Secretary of Transportation delegated responsibility to RSPA for measuring the results of federal surface transportation research—a legislative requirement—and overseeing and developing ways to improve research evaluations throughout the department, which is a DOT requirement. Of these requirements, RSPA partially meets one: it oversees research evaluation by discussing the issue at Coordinating Council meetings. According to RSPA officials, they do not measure the results of surface transportation research throughout DOT because the operating administrations perform their own evaluations and RSPA lacks the resources needed to review the individual research evaluation efforts of each of the operating administrations. Because RSPA does not oversee specific research evaluation efforts, it cannot ensure that evaluations are being conducted or assess the quality of DOT's operating administrations' evaluations. Neither RSPA nor DOT has developed a strategy to address the resource limitations cited by RSPA officials, and our previous work indicates that more specific oversight is warranted. For example, we have previously reported that the Federal Highway Administration does not have an agencywide systematic process to evaluate whether its research projects are achieving intended results and does not generally use a peer review approach,[4] consistent with federal research best practices.[5]

Since 1999, RSPA has conducted multimodal research in the following four areas: using technology to improve energy efficiency, reduce emissions, and reduce transportation dependence on petroleum; using satellite images to improve transportation safety and disaster planning; developing more effective means to reduce the fatigue of drivers and pilots; and assessing key transportation systems' vulnerabilities to damage from disasters or terrorist threats. RSPA budgeted about $37 million to conduct these four multimodal research programs from fiscal years 1999 through 2003. According to RSPA's Associate Administrator, all four programs have resulted or will result in significant contributions and improvements to the transportation industry. For example, he said that research aimed at advanced vehicle technologies has resulted in the testing and development

[4]Peer review is a process that includes an independent assessment of the technical and scientific merit or quality of research by peers with essential subject area expertise and perspective equal to that of the researchers.

[5]U.S. General Accounting Office, *Highway Research: Systematic Selection and Evaluation Processes Needed for Research Program*, GAO-02-573 (Washington, D.C.: May 24, 2002).

of components currently used in the production of commercially available hybrid electrical vehicles. RSPA officials said they use expert or peer review to assess their multimodal research process and status of their research programs, an approach that is widely recognized as a research evaluation best practice. However, we found that RSPA has not established a systematic approach for using peer or expert review to evaluate the results of all of its multimodal research programs. For example, RSPA has no plans to evaluate the results of its Transportation Infrastructure Assurance Program. As a result, RSPA is limited in its ability to determine the extent to which these programs are achieving their intended goals.

This report contains recommendations to the Secretary of Transportation and the Administrator of RSPA for actions to improve RSPA's ability to meet its legislative and DOT requirements pertaining to research coordination and evaluation. In commenting on this draft, DOT officials generally agreed with our findings and provided technical comments that we incorporated, as appropriate. They did not comment on the report's recommendations.

## Background

RSPA has both legislative and departmental responsibilities for coordinating and evaluating DOT's research and development programs, which, in fiscal year 2002, amounted to about $1 billion. The Transportation Equity Act for the 21st Century (TEA-21)[6] made DOT responsible for establishing a strategic plan for surface transportation research. The plan is to include a discussion of efforts to coordinate federal surface transportation research and technology development activities to avoid unnecessary duplication of effort. It also is to contain a description of program evaluations and a schedule for future evaluations of DOT research projects, among other things. DOT policy delegates the responsibility for meeting this and other legislative mandates related to research and development activities to RSPA's Associate Administrator as chair of the department's Coordinating Council. Moreover, DOT policy requires RSPA's Associate Administrator, through the Coordinating Council, to coordinate all research activities by developing processes for sharing information about research and technology and reviewing the status of all research and technology projects throughout DOT.

[6]Section 5108 codified at 23 U.S.C. § 508.

RSPA's Office of Innovation, Research, and Education had nine full-time employees and a budget of about $560,000 for fiscal year 2003. In addition to coordination and evaluation duties, RSPA manages and supports a variety of other programs for the department, including its Technology Transfer and Technology Sharing Programs, Small Business Innovation Research Program, and University Transportation Centers Program.[7] RSPA also conducts research on multimodal issues that affect the U.S. transportation system as a whole in contrast to the other operating administrations within DOT that focus on specific sectors of the U.S. transportation system.[8] In fiscal year 2003, RSPA conducted and managed four major multimodal research programs. Participants in RSPA's multimodal research programs include stakeholders from the departments' operating administrations; other federal departments and agencies; state departments of transportation; private and state universities; private-sector partners; and various consortia.[9] (See app. I for a listing of project stakeholders and researchers involved in RSPA's multimodal research programs.)

## RSPA Has Met Some, but Not All, Legislative or DOT Requirements for Coordinating DOT Research Efforts

Although RSPA has developed an annual plan and taken other steps to facilitate research coordination, it has not fully met legislative and DOT requirements for coordinating departmental research. Figure 1 summarizes these requirements and the extent to which RSPA has met them.

[7]Through the University Transportation Centers Program, DOT supports 33 university-based research centers to advance transportation research and education. In fiscal year 2003, RSPA received almost $30 million in reimbursable funds from the Federal Highway Administration and the Federal Transit Administration to manage the program.

[8]Operating administrations include the Federal Aviation Administration, Federal Highway Administration, Federal Motor Carrier Safety Administration, Federal Railroad Administration, Federal Transit Administration, Maritime Administration, and National Highway Traffic Safety Administration.

[9]A consortium focuses on research and development of products in a priority area and includes technical application and demonstration projects carried out in partnership with industries and service providers.

**Figure 1: Extent to Which RSPA Meets Selected Legislative and DOT Requirements for Coordinating DOT Research Efforts**

| Requirements | Extent to which RSPA meets requirements | Discussion |
|---|---|---|
| **Legislative requirements** | | |
| Develop an annual surface transportation research and technology development plan. | ● | The Research and Technology Coordinating Council issued the fourth edition of the department's Research Development and Technology Plan for fiscal year 2003. |
| Coordinate surface transportation research and technology development activities to avoid duplication. | ◒ | Monthly Research and Technology Coordinating Council meetings provide members with the opportunity to share information and develop the annual research plan. However, these efforts do not fully ensure that project duplication within DOT is avoided. |
| **DOT requirements** | | |
| Develop processes to routinely share research activities, problems, solutions, and information. | ● | Monthly Research and Technology Coordinating Council meetings provide members with the opportunity to share research activities, problems, solutions, and information. |
| Review the status of all research projects across operating administrations and identify potential duplication. | ○ | RSPA does not review all DOT research projects to identify potential duplication. |

● Fully meets requirement

◒ Partially meets requirement

○ Does not meet requirement

Sources: TEA-21, DOT Order 1120.39, and GAO.

## RSPA Facilitates Research Coordination by Developing an Annual Plan and Conducting Monthly Meetings

RSPA has met its legislative requirement under TEA-21 to develop an annual surface transportation research and technology development plan to coordinate and document research efforts. The plan covers not only surface transportation but also air and maritime. Now in its fourth edition, the plan discusses state and local transportation research activities; describes each operating administration's mission; and conveys priorities for the department's research activities, including identifying examples of research programs that are necessary to achieve the department's strategic goals. According to the Associate Administrator, the plan is an important resource for the department's budget and program deployment processes and helps to avoid unnecessary duplication of research among the operating administrations. In March 2000, the National Research Council, acting through the Transportation Research Board (TRB), assessed DOT's strategic planning process, including the first edition of its research plan, and generally commended RSPA's efforts in coordinating the department's

research activities.[10] In September 2001, we reported that the department's research plan achieved a number of important strategic functions, including supporting the department's budget and program development process, conveying priorities, linking research and development initiatives occurring throughout the department to specific strategic goals, and focusing on research and technology needs that concern the department as a whole.[11] However, upon reviewing the fiscal year 2003 research plan, we found that it does not summarize results of the previous year's surface transportation research programs. Such a summary is also absent from the department's overall performance plan and reports, where it is required by TEA-21.[12] Since the explicit intent of the research plan is to focus the department's research efforts, and the department is required to gather summary information on the previous years' research results, this information could provide continuity and context for observations about planned research for future years.

The research plan is the culmination of monthly Coordinating Council meetings in which the Associate Administrator meets with members from each of DOT's operating administrations as well as representatives from DOT's Office of Policy, Office of Budget, Office of Intelligence and Security, and Office of Intermodalism. These meetings also serve as a means to fulfill the legislative requirement to coordinate surface transportation research and technology development and the DOT requirement to coordinate research across all modes within DOT. Agendas and minutes from these meetings indicate that the Coordinating Council's discussions involve research processes, procedures, policy,[13] and presentations from council

[10]TRB study conducted by the Committee for Review of the National Transportation Science and Technology Strategy (Washington D.C.: Mar. 28, 2000) 3.

[11]U.S. General Accounting Office, *Combating Terrorism: Selected Challenges and Related Recommendations*, GAO-01-882 (Washington D.C.: Sept. 20, 2001) 85.

[12]According to the Government Performance and Results Act of 1993, each federal department is required to submit a performance plan to the Congress annually. The TEA-21 requirement to include results of the year's research in the department's annual performance plan is at 23 U.S.C. § 508 (c) (4) (A).

[13]For example, in October 2002, the Coordinating Council was delegated responsibility for coordination of all actions related to research misconduct, including providing guidance in research misconduct policy implementation. The federal policy on research misconduct was released in December 2000 by the Executive Office of the President's Office of Science and Technology Policy and directs all federal agencies that conduct or support research to implement this policy. In addition, the council is revising DOT Order 1700.18B dealing with acquisition, publication, and dissemination of DOT scientific and technical reports.

members and guest speakers. According to the Associate Administrator, these meetings further provide a forum for networking among DOT researchers, a venue for DOT operating administrations to learn about each other's research, and an opportunity for information sharing and technology transfer. In addition, in instances where research has multimodal applicability, the Associate Administrator said RSPA staff and representatives from the other operating administrations have been active in sharing information through working groups, such as the Human Factors Coordinating Committee, which shares information on research conducted by each of the operating administrations focusing on identifying ways to better manage human operator fatigue.

## RSPA Has Not Reviewed All DOT Research Projects to Identify Unnecessary Duplication

RSPA does not fully meet its legislative requirement to coordinate surface transportation and technology development activities because it does not review all surface transportation research projects to determine whether surface transportation researchers within DOT are unnecessarily duplicating research efforts. A similar DOT requirement broadens this responsibility to make RSPA responsible for reviewing the status of all research projects throughout DOT for the same purpose. In its March 2000 report, TRB reported the absence of information on the current status of all DOT research programs in the department's annual research plan.[14] We discovered that this information also remained absent from DOT's fiscal year 2003 research plan. The Associate Administrator said that RSPA lacked (1) readily accessible data on the research activities of other parts of DOT and (2) the staff and resources to review all research projects across the department to, at a minimum, identify and report on the extent of unnecessary duplication, if any, across the department. He also said that even if RSPA reviewed all of the department's research activities and identified any unnecessary duplication of effort, RSPA does not have the program and budget authority to direct changes in other operating administrations' research activities.

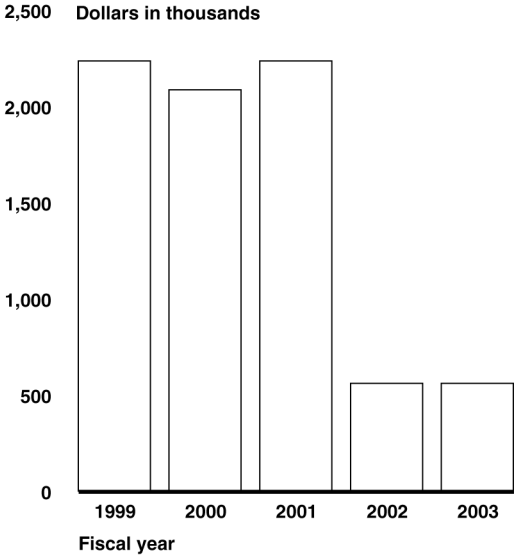
[14] TRB study, 13.

RSPA's Associate Administrator explained that RSPA does not have readily accessible data on the research activities of other parts of DOT because efforts to develop a computer-based tracking system to share DOT research program and budget information have stalled. RSPA's 1998 strategic plan discussed the need to create and deploy such a system to meet its strategic goal for coordinating research and technology. In fiscal year 1999, RSPA planned to allocate $200,000 annually for 4 years to develop and implement a system. According to the Associate Administrator, as of January 2003, RSPA had spent about $500,000 of its allocation and completed development of a prototype database. He said that implementing the centralized information system would (1) make basic project information (such as project methodologies, funding levels and sources, schedules, and planned products) across the department more accessible; (2) provide greater levels of organization and clarity on historical research; (3) facilitate strategic planning and coordination; and (4) improve the department's annual research plan by providing decision-makers with more complete, accurate, and timely information on all DOT research activities. According to the Associate Administrator and Coordinating Council members, some operating administrations do not support implementation of the system because they believe that the system would put additional demands on limited resources and would produce little in terms of tangible results. Coordinating Council members also said it would duplicate existing information systems already in place at some operating administrations and the new system would not be integrated into their other, modal-unique information systems (such as budget and accounting information systems). According to the RSPA official in charge of developing the database, each operating administration would require up to approximately 2 full-time employees for up to 1 year to input the historical research project data going back 5 years, and an additional ½ to 1 full-time employees per year to manage and update the database.

The Associate Administrator also said that RSPA did not review the status of all operating administrations' research projects to identify any unnecessary duplication because his office lacks sufficient staff and resources to do so. He noted, for example, that RSPA's total research and technology budget for fiscal year 1999 was about $3.7 million—of which $2.2 million was allocated for research and development planning and management activities[15]—and 13 full-time employees. However, in fiscal year 2003, this decreased to a total budget of about $2.9 million—of which $560,000 was allocated for research and development planning and management activities—and 9 full-time employees. The Associate Administrator said that the decline in RSPA's staff and resources—the only such staff and resources in the department for conducting long-term transportation research planning and coordinating research plans and programs—has also severely limited RSPA's efforts to coordinate with transportation research stakeholders outside of DOT, such as state, local, and other federal agencies. Figure 2 shows RSPA's funding levels for its research and development planning and management activities from fiscal years 1999 through 2003.

[15]According to RSPA, research and development planning and management includes funding for transportation research and development strategic planning, DOT research facilitation, coordination and partnerships, DOT technology transfer and technology sharing programs, National Science and Technology Council activities, Small Business Innovation Research Program support, and international research and development activities.

**Figure 2: RSPA Funding Dedicated to Research and Development Planning and Management Activities (Fiscal Years 1999-2003)**




Sources: GAO and RSPA (data).

RSPA's Associate Administrator said he believes that little or no duplication of research activities occurs. He said that, because the monthly Coordinating Council meetings provided a forum for discussing ongoing and planned research, unnecessary duplication of research efforts would be identified. Also, he said that most DOT operating administrations have discrete research programs and budgets that support their mode-specific regulatory and safety mandates. For example, the Federal Highway Administration research focuses on public roads and highways, and its primary users are state and local transportation departments that seek better ways to repair the public infrastructure and find improved materials for pavements. Similarly, the Federal Railroad Administration focuses on the rail industry's privately owned infrastructure and these owners—freight railroads, Amtrak, commuter railroads, and shippers—look to Federal Railroad Administration to conduct research that will reduce track failure, equipment failure, and human error.

According to members of the Coordinating Council, apparent duplication in research programs might reflect a number of conditions—for example, research that was intended to validate previous research results, expand research applications, and address different needs (such as pavement

research for airport runways and highways)—or an effort to explore alternative approaches before selecting one for further development. None of the council members, however, could provide us with specific examples of research projects that reflected these conditions.

Other Coordinating Council members with whom we spoke, however, said that the council should take further steps to more effectively coordinate DOT research. For example, one member said the Coordinating Council should review all of the current projects across the department to improve the level and quality of the department's research coordination efforts. Another member said that the primary functions of the Coordinating Council should be to universally review DOT research projects to eliminate unnecessary duplication of effort and to provide opportunities for joint research partnerships on similar work. Such opportunities might include research focusing on safety, environmental, training, and human factor issues. However, Coordinating Council members said that DOT support for the council and research coordination in general had declined in recent years (e.g., lower ranking members of the operating administrations attend the meetings, instead of the more senior personnel that had once attended, and meetings were shortened from 2 hours to 1 hour per month), and that greater departmental support for this effort was warranted.

The Associate Administrator said that RSPA did not have the program and budget authority over the department's operating administrations' research activities to direct changes in research programs, even if opportunities for greater joint efforts or elimination of unnecessary duplicative research were found. In a 1996 report examining the status of the department's coordination of surface transportation research, we identified RSPA's lack of internal clout within the department as an obstacle to its ability to function effectively as its research strategic planner because it had no direct program or budget authority over the department's operating administrations' research activities.[16] Although DOT proposed the creation of such an organization to have budgeting and program authority for DOT research in its fiscal year 1996 budget submission, the Congress did not approve the agency's proposal. According to the Associate Administrator, there are no current legislative or budget initiatives to pursue this proposal.

[16]U.S. General Accounting Office, *Surface Transportation: Research Funding, Federal Role, and Emerging Issues*, RCED-96-233 (Washington, D.C.: Sept. 6, 1996).

Although DOT's earlier effort to overcome RSPA's lack of internal authority was not implemented, neither the department nor RSPA has developed alternative approaches to overcome this obstacle as well as to address the information and resource limitations that continue to hinder RSPA's efforts to meet legislative and DOT requirements for coordinating departmental research. Developing a strategy that incorporates information about the costs involved in reviewing research projects throughout DOT to ensure that unnecessary duplication does not occur, and that determines whether finalizing the development and implementation of the DOT-wide research tracking system database could serve this purpose, is an important first step for RSPA to meet the legislative and DOT requirements entrusted to it. A strategy is also critical for communicating to the Congress and the Secretary of Transportation the challenges RSPA faces, and the specific actions it can take, in meeting the requirements with the resources it possesses.

## RSPA Has Not Developed Performance Standards Against Which to Measure Its Coordination Efforts

RSPA has not established performance measures to systematically document the results and benefits of coordinating DOT research activities.[17] In the absence of systematically gathered data on research activities across the department and associated performance measures, it is difficult to determine RSPA's overall success in coordinating DOT's billion-dollar research program. Demonstrated successes could garner greater departmental support for RSPA's research coordination efforts. In its fiscal year 2003 budget submission, RSPA cited the difficulty in defining and measuring the effectiveness of research coordination activities. According to RSPA, it is because of this difficulty that it relies upon external program assessments to provide independent evaluation of its research and coordination activities.[18]

[17]In RSPA's fiscal year 2003 budget submission to the Congress, it reported one quantifiable performance measure. This measure is aimed at gauging RSPA's progress in administrating the University Transportation Centers Program and focuses on the number of students graduating with advanced degrees from universities funded under the program. For fiscal year 2003, RSPA's performance goal is 1,228 students.

[18]TRB conducted such an assessment in March 2000.

Although we support the use of external assessments, we have reported that quantifiable measures are necessary to assess agency performance to meet the intent of the Government Performance and Results Act of 1993 (GPRA).[19] Among the stated purposes of GPRA is the improvement of federal program effectiveness and public accountability. For agencies to successfully become high-performing organizations, their leaders need to foster performance-based cultures, find ways to measure performance, and use performance information to make decisions. A fundamental element in an organization's efforts to manage for results is its ability to set meaningful goals for performance and, using performance information, measure performance against those goals. High-performing, results-oriented organizations establish a set of measures to gauge progress over various dimensions of performance.

In crafting GPRA, the Congress expressed its interest in American taxpayers' getting quality results from the programs they pay for as well as its concern about waste and inefficiency in federal programs. The fundamental reason for collecting information on a program's performance is to take action in managing the program on the basis of that information. By using performance information to assess the way a program is conducted, managers can consider alternative approaches and processes in areas where goals are not being met and enhance the use of program approaches and processes that are working well. Performance information also allows program managers to compare their programs' results with goals and thus determine where to target program resources to improve performance. When managers are forced to reduce their resources, the same analysis can help them target the reductions to minimize the impact on program results.

GPRA's emphasis on results implies that federal programs contributing to the same or similar outcomes should be closely coordinated to ensure that goals are consistent and complementary, and that program efforts are mutually reinforcing. Thus, measuring the effectiveness of RSPA's coordination of DOT research is a critical element of fulfilling its legislative and departmental coordination responsibilities—an element RSPA has not yet addressed.

[19]GPRA requires federal agencies to set strategic goals and establish performance measures for management.

## RSPA Has Met Some, but Not All, Legislative or DOT Requirements to Evaluate DOT Research

RSPA has not fully met all legislative and DOT requirements for evaluating research within the department. RSPA does not meet a legislative requirement for measuring the results of federal surface transportation research and partially meets a related DOT policy requirement to oversee and develop ways to improve research evaluations throughout the department. Figure 3 summarizes these requirements and the extent to which RSPA has met them.

**Figure 3: Extent to Which RSPA Meets Selected Legislative and DOT Responsibilities for Evaluating DOT Research Efforts**

| Requirements | Extent to which RSPA meets requirements | Discussion |
|---|---|---|
| **Legislative requirements** | | |
| Measure the results of federal transportation research activities and how they impact the performance of the surface transportation systems of the United States. | ○ | RSPA does not measure (or oversee the measurement of) the results of DOT transportation research activities. |
| **DOT requirements** | | |
| Oversee the DOT research and technology development program and develop more efficient, effective, and participative ways to evaluate and measure program effectiveness and progress across all operating administrations and other selected projects. | ◒ | RSPA initiates and provides discussions of evaluation at the monthly Research and Technology Coordinating Council meetings. However, no further oversight of research evaluation is provided. |

● Fully meets requirement

◒ Partially meets requirement

○ Does not meet requirement

Sources: TEA-21, DOT Order 1120.39, and GAO.

Although the department has delegated to RSPA the responsibility for meeting legislative and DOT requirements for evaluating research projects throughout the department, RSPA's oversight of DOT research evaluation is limited to facilitating exchange of information on evaluation approaches. As delegated by the Secretary of Transportation, RSPA is responsible for measuring the results of federal surface transportation research activities and how these results impact the performance of the surface transportation systems of the United States, as stated in TEA-21.[20] Also, TEA-21 calls for a strategic planning process[21] that includes information on research program evaluations conducted and a schedule of future evaluations.[22] RSPA has not taken steps to meet these legislative responsibilities for measuring the results of DOT surface transportation research, describing research program evaluations, and establishing a schedule for future evaluations.[23]

In terms of DOT policy, RSPA is responsible for overseeing and developing more efficient, effective, and participative ways to evaluate and measure research program effectiveness and progress across all operating administrations.[24] RSPA has taken steps to develop and communicate more effective means of evaluation by discussing this issue at monthly Coordinating Council meetings. For example, in October 2002, the council provided a forum for discussing four different agency approaches to research evaluation. In addition, according to RPSA officials, the council has discussed criteria established by the Office of Management and Budget for federal investment in research and how these criteria can have an impact on performance evaluation. RSPA, however, does not oversee operating administrations' research evaluation efforts and therefore cannot ensure that steps are being consistently taken to improve evaluation approaches.

[20]23 U.S.C. § 508 (a) (3) and (b) (3).

[21]As defined at 5 U.S.C. § 306.

[22]23 U.S.C. § 508 (a) (1).

[23]We noted that the department's performance plan for fiscal year 2003 contained an appendix detailing DOT program evaluation methods, results, and schedule for future evaluations for programs that represent significant DOT activities (other than research) that contribute to its strategic goals.

[24]DOT Order 1120.39.

The Associate Administrator said that RSPA does not measure the results of federal transportation research activities or provide oversight of the operating administrations' research program evaluation processes for the following two reasons: (1) the operating administrations have responsibility for performing and measuring their own research programs and (2) the resource constraints that have limited RSPA's ability to coordinate DOT-wide research also limit the agency's ability to oversee research program evaluations across the department.

Coordinating Council members said that increased oversight of DOT-wide research programs would be beneficial. Our previous work examining DOT's research activities also indicates that such oversight is warranted. For example, in reviewing the Federal Highway Administration's research program, which accounts for almost half of DOT's research budget, we found that the Federal Highway Administration lacked a systematic process for conducting research evaluations, and that the processes it used were not always consistent with federal research best practices because it generally did not use a peer review approach.[25] Thus, without oversight, RSPA and the department have no assurance that, at a minimum, operating administration research programs are routinely evaluated or that approaches to evaluations are consistent with established best practices.

DOT and RSPA also have not developed a strategy to meet the requirement to measure the results of federal transportation research activities and how they impact the performance of the surface transportation systems of the United States. Developing such a strategy that incorporates information about the costs involved in ensuring that evaluations are completed and performed according to best practices is an important first step for DOT and RSPA to meet the requirement. A strategy also is critical for communicating to the Congress and the Secretary of Transportation (1) the challenges that RSPA and the department face and (2) the specific actions that can be taken to meet this requirement given available resources. After we raised these issues to senior RSPA officials as a result of our review, they developed a proposed model for reorganizing the Coordinating Council to provide an opportunity for RSPA to meet legislative and departmental requirements to oversee DOT research evaluation. They said they were still considering the proposal when we completed our review.

[25]GAO-02-573.

## RSPA Has Conducted Multimodal Research in Four Areas but Does Not Have a Process to Systematically Evaluate Program Results

Since 1999, RSPA has conducted four multimodal research programs—advanced vehicle technologies, commercial remote sensing and spatial information, operator fatigue management, and transportation infrastructure assurance. According to RSPA's Associate Administrator, these four programs have resulted or will result in significant contributions and improvements to the transportation industry. For example, he said that research aimed at advanced vehicle technologies has resulted in the testing and development of components currently used in the production of commercially available hybrid electrical vehicles. Nonetheless, RSPA does not have a process to systematically evaluate the results of all its multimodal research programs. In the absence of such a process, RSPA manages its multimodal research programs by monitoring research contract agreements and using expert or peer review panels to assess the quality and relevance of ongoing research. By not systematically evaluating program results, however, RSPA is limited in its ability to determine the extent to which its multimodal research programs are achieving their intended goals.

### Status of RSPA's Multimodal Research Programs

Since 1999, RSPA has conducted four multimodal research programs, of which two were congressionally mandated. Specifically, TEA-21 required DOT to conduct research on using (1) technology to improve energy efficiency, and reduce emissions and transportation dependence on petroleum, and (2) satellite images to improve transportation safety and disaster planning. Transportation research experts within DOT developed a third RSPA research program to develop more effective means to increase the endurance and reduce fatigue of drivers and pilots. Finally, the catalyst for research in a fourth area that assesses key transportation system vulnerabilities to damage from disasters or terrorist threats came from the National Research Council's TRB.[26]

[26]TRB, *Improving Surface Transportation Security, A Research and Development Strategy* (1999).

According to the Associate Administrator, RSPA identified and selected individual projects for these multimodal research programs by obtaining input from experts within and outside DOT. For example, RSPA, in conjunction with other DOT operating administrations, published a plan in June 1999 to guide the selection of human fatique-related projects. In addition, in April 2000, RSPA issued a strategic multimodal research and development program plan to help focus advanced vehicle technology research. Also, in December 2000, RSPA and TRB held a conference on remote sensing and spatial information research to, among other things, discuss and define issues and possible research needs with representatives from academia, transportation agencies, remote sensing businesses, consulting firms, and other groups.[27] (See app. I for a list of project stakeholders and researchers involved in RSPA's multimodal research programs.) Table 1 provides summary data concerning the scope, funding, and status of RSPA's four multimodal research programs.

[27]See GAO-03-502 for a discussion of the coordination issues involved in developing and implementing RSPA's Transportation Infrastructure Assurance Program.

**Table 1: Information on and Status of Multimodal Research Programs Conducted by RSPA from Fiscal Years 1999 to 2003**

Dollars in thousands

| Multimodal research program | Reasons for initiating programs | Fiscal year | Direct and reimbursable funding | Number of projects initiated | Program status as of January 14, 2003 |
|---|---|---|---|---|---|
| Advanced Vehicle Technologies Program | TEA-21, section 5111 | 1999 | $9,908 | 21 | In process: 12 of 55 projects still ongoing—planned program completion, end of 2004. |
| | | 2000 | 5,000 | 15 | |
| | | 2001 | 0 | 11 | |
| | | 2002 | 0 | 8 | |
| | | 2003 | 0 | 0 | |
| | | **Total** | **$14,908** | **55** | |
| Commercial Remote Sensing and Spatial Information Technologies Program | TEA-21, section 5113 | 1999 | $4,000 | 0 | In process: 14 of 18 projects still ongoing—planned program completion, end of 2003. |
| | | 2000 | 6,000 | 9 | |
| | | 2001 | 8,000 | 6 | |
| | | 2002 | 0 | 3 | |
| | | 2003 | 0 | 0 | |
| | | **Total** | **$18,000** | **18** | |
| Human Centered Systems: Operator Fatigue Management Program | Generated by research experts within DOT | 1999 | $750 | 0 | In process: 2 of 4 projects still ongoing—planned program completion, end of 2004. |
| | | 2000 | 0 | 4 | |
| | | 2001 | 300 | 0 | |
| | | 2002 | 0 | 0 | |
| | | 2003 | 0 | 0 | |
| | | **Total** | **$1,050** | **4** | |
| Transportation Infrastructure Assurance Program | Identified in TRB's *Improving Surface Transportation Security, A Research and Development Strategy* (1999). | 1999 | 0 | 0 | In process: all 4 of the projects still ongoing—planned program completion, end of 2003. |
| | | 2000 | 0 | 0 | |
| | | 2001 | $1,000 | 2 | |
| | | 2002 | 1,000 | 2 | |
| | | 2003 | 1,000 | 0 | |
| | | **Total** | **$3,000** | **4** | |

Source: GAO presentation of RSPA data.

- *The Advanced Vehicle Technologies Program* was mandated in 1998 under section 5111 of TEA-21. This program combines transportation technologies and innovative program elements to produce new vehicles, components, and infrastructure for medium- and heavy-duty transportation needs. Since 1999, approximately $15 million has been allocated toward 55 separate research projects, 43 of which have been

completed, with the goal of improving energy efficiency and U.S. competitiveness while reducing emissions and transportation dependence on petroleum. According to the Associate Administrator, the program has resulted in (1) the testing of components that are being used in the development and production of commercially available hybrid electrical vehicles and (2) the development and implementation of electric vehicle recharging stations in Hawaii. A picture of an electric vehicle at a recharging station is shown in figure 4. RSPA plans to have all of the projects completed by the end of 2004.

**Figure 4: Electric Vehicle at a Recharging Station**


Sources: University of Florida and the National Renewable Energy Laboratory, U.S. Department of Energy.

- *The Commercial Remote Sensing and Spatial Information Technologies Program* was mandated in 1998 under section 5113 of TEA-21. The joint program between RSPA and the National Aeronautics and Space Administration (NASA) began in 1999. This research program focuses in part on using satellite images to assess transportation hazards and improve disaster recovery; provide opportunities to monitor and evaluate regional traffic flow, including the movement of freight; plan for improvements in the maintenance and security of transportation infrastructures; and aid in transportation corridor planning. Figure 5 shows an example of satellite-based photography of interstate highways. According to the Associate Administrator, RSPA has also supported transportation security technology project activities in the aftermath of the terrorist attacks of September 11, 2001. For instance, according to RSPA officials, the Remote Sensing Program reoriented two unmanned aerial vehicle projects toward monitoring for security as well as traditional transportation applications. RSPA has allocated $18 million to this research program since it began in 1999 and has disseminated program information; results to date have been disseminated through Web sites, publications,[28] workshops, and conferences. Eighteen separate research projects constitute the program; 4 have been completed, and RSPA plans to complete the remaining 14 projects by the end of 2003.

[28]In April 2002, DOT and NASA issued *Achievements of the DOT-NASA Joint Program on Remote Sensing and Spatial Information Technologies: Application to Multimodal Transportation*, which presented 3-year accomplishments from the program.

**Figure 5: Satellite-based Photographic Image of U.S. Interstates 25 and 40 in Albuquerque, New Mexico**

Source: Sandia National Laboratories, U.S. Department of Energy.

- *The Human Centered Systems: Operator Fatigue Management Program* was conceived by DOT researchers and experts with the primary goal to develop techniques that transportation operating companies can employ to ensure endurance and fatigue-free performance of their workforces. Since fiscal year 1999, approximately $1 million has been allocated to the Human Centered Systems: Operator Fatigue Management Program. According to the Associate Administrator, this program has resulted in significant benefit to the varied DOT transportation community stakeholders. For example, in January 2003, the program resulted in the production of the *Commercial*

*Transportation Operator Alertness Management Handbook*, which describes measures to better manage driver and pilot fatigue. According to RSPA's Associate Administrator, this handbook has been in high demand by the U.S. Coast Guard, the Maritime Administration, and the Federal Transit Administration. Two of the four projects being conducted are ongoing. RSPA plans to complete the program by the end of 2004. In figure 6, airline pilots participate in NASA research in this area.

**Figure 6: Airline Pilots Participating in Fatigue Research**

Source: National Aeronautics and Space Administration.

- *The Transportation Infrastructure Assurance Program*[29] consists of assessments on four separate transportation vulnerabilities. These include assessing the (1) relationship between the safety and security of the nation's transportation infrastructure and some of the nation's other critical infrastructures, such as energy, e-commerce, banking and finance, and telecommunications; (2) transportation and logistical requirements for emergency response teams in response to terrorist attacks using biochemical, nuclear, and explosive weapons of mass destruction; (3) costs, benefits, and practicality of alternative backup systems for the global positioning system; and (4) trade-offs between the different modes of transportation and security for hazardous materials. Since fiscal year 2001, the Congress has appropriated $3 million to conduct these assessments. In total, RSPA plans to publish 11 formal reports on the four vulnerabilities being assessed and develop a series of presentations and workshops to further disseminate the information. Figure 7 shows a picture of a global positioning satellite.

[29]GAO-03-502.

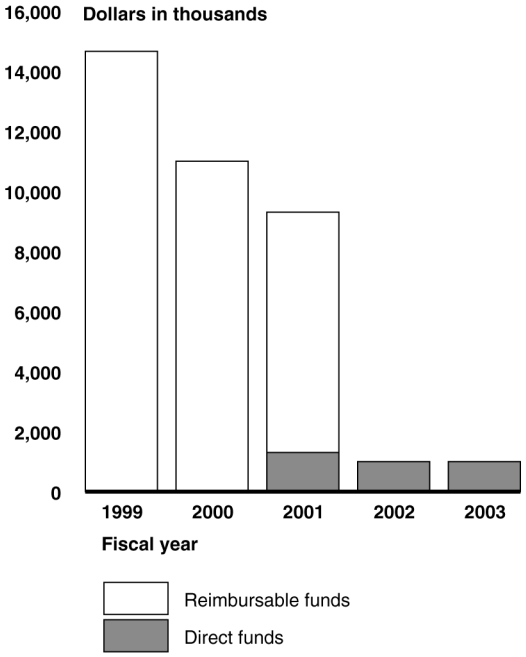
**Figure 7: Global Positioning Satellite**

Source: Lockheed Martin Missiles & Space.

From fiscal years 1999 through 2003, RSPA budgeted about $37 million to conduct these four major multimodal research programs. Of this $37 million, about 9 percent, or $3.3 million, came to RSPA from direct congressional appropriations. For example, in fiscal year 2001, the Congress appropriated $1 million for the Transportation Infrastructure Assurance Program and $300,000 for the Human Centered Systems: Operator Fatigue Management Program; in fiscal years 2002 and 2003, RSPA received an additional $1 million for the Transportation Infrastructure Assurance Program. The remaining $33.7 million for these programs was provided through reimbursable funding from other DOT administrations.[30] Figure 8 summarizes RSPA's annual budget for multimodal research from fiscal years 1999 to 2003.

[30]RSPA conducts and manages its multimodal research programs, excluding the Transportation Infrastructure Assurance Program, almost exclusively using reimbursable funds provided by the DOT administration sponsoring the research—that is, the Federal Highway Administration, Federal Railroad Administration, Federal Transit Administration, and National Highway Traffic Safety Administration.

**Figure 8: RSPA's Multimodal Research Funding (Fiscal Years 1999-2003)**




Sources: GAO and RSPA (data).

According to the Associate Administrator, RSPA's current multimodal research programs are scheduled for completion by the end of fiscal year 2004. He added that RSPA has made budgetary and legislative proposals to undertake future multimodal research to, among other things, further examine applications of unmanned aerial vehicles for commercial remote sensing or examine infrastructure safety issues in hydrogen energy systems. He noted, however, that there are no approved plans for future multimodal research, pending the President's budget proposal for the department and the reauthorization of TEA-21, which might affect RSPA's multimodal research roles and responsibilities.

## RSPA Oversees Research Contracts and Assesses the Status of Its Ongoing Research but Lacks a Systematic Process for Evaluating the Results of Its Multimodal Research

RSPA oversees its multimodal research programs by monitoring research contract agreements. Specifically, the Associate Administrator said that RSPA assesses project progress against contractual milestones to ensure that the research is being completed on time and within cost, while meeting research objectives. He added that researchers must meet or exceed contractual expectations, or corrective actions are taken. These actions may include project cancellation. RSPA provided a recent example of the impact of its monitoring efforts that dealt with a project being conducted under its Commercial Remote Sensing and Spatial Information Technologies Program. The evaluation focused on an unmanned aerial vehicle application to real-time traffic flow monitoring, a demonstration project with the Ohio Department of Transportation and several universities and industry partners. Due to a technical problem, the scheduled demonstration could not be conducted. The Remote Sensing Program Manager, working with the Federal Highway Administration Project Manager assigned to the project, pulled together a technical team to assess the state of the project. The technical team became convinced that the contractor could remedy the technical situation, allowed 3 additional months to make the milestone, and successfully encouraged the project partners to cover the costs of the delay. According to the Associate Administrator, these actions resulted in a demonstration to a state partner with no cost increase to RSPA.

In addition to providing this contractual oversight, RSPA uses the principles of expert or peer review through the use of multimodal and multiagency program oversight panels to assess the status, quality, and relevance of its ongoing multimodal research programs, according to the Associate Administrator. For example, in December 2000, TRB and RSPA held a conference on remote sensing and spatial information research with representatives from academia, transportation agencies, remote sensing businesses, consulting firms, and other groups. During the conference, participants met in breakout sessions to discuss and assess research progress and interim results. As we have reported, expert or peer review is

a particularly effective means to evaluate federally funded research.[31] The Committee on Science, Engineering, and Public Policy has also reported that expert review is widely used to evaluate the quality of current research as compared with other work being conducted in the field and with the relevance of research to the agency's goals and mission.[32] However, RSPA has not established a process or policies for systematically using peer or expert reviews to evaluate the results of all its multimodal research. For example, RSPA has no plans to evaluate the results of its Transportation Infrastructure Assurance Program.

We, among others, recognize that federal agencies that support research in science and engineering have been challenged to find the most useful and effective ways to evaluate the performance and results of the research programs. For example, since GPRA was passed in 1993, some questions have been raised about its applicability to the research activities of government agencies. Because the process required by GPRA is based on a 5-year strategic planning horizon, concerns exist that GPRA constrains, and perhaps prohibits, the long-term thinking and planning that characterize the federal role in research. This concern is particularly relevant for basic research, but even successes from highly applied research (the type sponsored by DOT) can require 5 to 10 years before achieving widespread recognition.[33] Nonetheless, as we noted in our report examining DOT highway research,[34] without systematic program evaluation, it is unclear as to whether research efforts are having the intended results. Such a systematic approach to evaluation, according to best practices used in other federal research programs, includes review of all ongoing and completed research on a regular basis and in accordance with GPRA principles.

[31]U.S. General Accounting Office, *Federal Research: Peer Review Practices at Federal Science Agencies Vary*, GAO/RCED-99-99 (Washington, D.C.: Mar. 17, 1999) 2.

[32]Committee on Science, Engineering, and Public Policy, *Evaluating Federal Research Programs: Research and the Government Performance and Results Act* (Washington, D.C.: February 1999) 39. The Committee on Science, Engineering, and Public Policy is a joint committee of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

[33]Applied research is original work undertaken to develop new knowledge with a specific, practical application in mind.

[34]GAO-02-573.

RSPA's Associate Administrator acknowledged that a documented process for systematically evaluating the results of its multimodal research programs would be beneficial, but that the process should be tailored to match the type of research and its objectives. He added that RSPA had not developed and implemented a process for systematically evaluating the results of its multimodal research because of a lack of funding and staffing resources. For example, he estimated that an external evaluation to assess the results of its multimodal programs could cost as much as $100,000 for each program. Nonetheless, without establishing and implementing a process for systematically evaluating the results of its research, RSPA cannot ensure that its multimodal research programs are achieving their intended goals.

## Conclusions

To its credit, RSPA has taken steps in recent years to meet its legislative and department responsibilities for coordinating and overseeing the evaluation of the department's transportation research activities. Nevertheless, ensuring that no unnecessary duplication of research programs occurs and that research programs—including the ones that RSPA conducts—are evaluated for results are critical responsibilities, given the importance of, and amount of money spent on, DOT research. Without a strategy to meet legislative and DOT requirements to coordinate and oversee evaluation of departmental research, RSPA may not be able to meet these responsibilities, particularly given its lack of authority within the department and resource limitations. In addition, a lack of performance standards against which to measure coordination efforts limits RSPA's ability to identify areas where coordination is working effectively and areas that could be improved upon. With a strategy and performance measures in place, however, RSPA and DOT should be in a better position to assure the Congress that the department is making the most of its significant research dollars through effective coordination and evaluation of its research programs.

## Recommendations for Executive Action

To better meet legislative and DOT requirements for coordinating and evaluating transportation research within the department, we recommend the Secretary, in conjunction with RSPA's Administrator, work with DOT operating administrations to:

- Develop a strategy for reviewing all DOT research projects to identify areas of unnecessary research duplication, overlap, and opportunities for joint efforts. The strategy should address time frames for implementing this review as well as discuss the extent to which finalizing the development and implementation of a DOT-wide research tracking system database could serve to facilitate this process. Once this strategy has been developed and implemented, the results of this effort should be incorporated in the department's annual research plan and reported to the Congress on an annual basis.

- Develop and apply quantifiable performance measures to assess the effectiveness of research coordination efforts (once a strategy for review has been developed and implemented), and document the results of these efforts in the department's annual research plan. These measures could include the number of research projects identified as possible candidates for joint effort or elimination and/or the associated reduction in the department's research spending.

- Develop a strategy to ensure that the results of all DOT's transportation research activities are evaluated according to established best practices. This strategy should include estimates of the costs for ensuring that evaluations are completed. Once the strategy has been developed and implemented, the results of these efforts should be incorporated in the department's annual research plan and reported to the Congress on an annual basis.

- Include in the department's annual research plan a summary of all research program evaluations conducted and a schedule of future evaluations.

In addition, we recommend that the Secretary direct RSPA's Administrator to document RSPA's process for systematically evaluating the results of its own multimodal research programs, and apply this process to any future multimodal research programs that RSPA conducts.

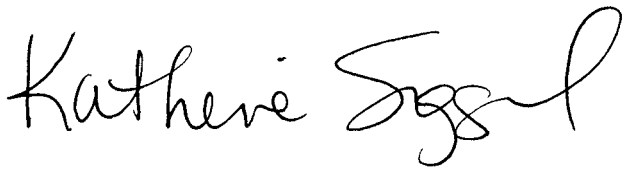
## Agency Comments and Our Evaluation

We obtained oral comments on a draft of this report from RSPA officials, including the Associate Administrator for Innovation, Research, and Education. These officials generally agreed with the contents of the draft report but did not comment specifically on the report's recommendations. They also provided technical comments that we incorporated as appropriate.

Regarding RSPA's evaluation of its own multimodal research, the officials said that RSPA had conducted evaluation activities—peer and expert reviews of the progress of three of its four multimodal research programs and had no plans to evaluate the fourth. We acknowledge that RSPA has used peer and expert review to evaluate the status of at least one of its ongoing multimodal research programs—commercial remote sensing and spatial information technology—and we describe this example in this report. Nevertheless, we continue to believe that our recommendation for documenting and applying a process for systematically evaluating the results of any future multimodal research programs conducted by RSPA is warranted to ensure that such evaluations are consistently conducted in accordance with established best practices.

We are sending copies of this report to congressional committees and subcommittees with responsibilities for transportation, the Secretary of Transportation, the Research and Special Programs Administration Administrator, and the Director of the Office of Management and Budget. We will make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you have questions about this report, please contact me at (202) 512-2834 or siggerudk@gao.gov. Other key contributors were Colin Fallon, Christopher Keisling, Bert Japikse, Steve Morris, and Jason Schwartz.



Katherine Siggerud
Acting Director, Physical Infrastructure Issues

# Stakeholders and Researchers Involved in the Four Multimodal Programs Conducted by RSPA

**Table 2: Advanced Vehicle Technologies Program**

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Model Park | Northeast Advanced Vehicle Consortium/Boston Edison | FTA |
| Hybrid School Bus | Northeast Advanced Vehicle Consortium/Solectria | FTA |
| Extended Hybrid Electric Heavy Duty Vehicle Emission Test Certification | Northeast Advanced Vehicle Consortium/MJ Bradley | FTA |
| Jet Vapor Deposition for Catalyzing Fuel Cell Membranes | Northeast Advanced Vehicle Consortium/Jet Process Corporation | FTA |
| AV 900 Cycler for a 600-900 Volt System for Heavy Duty Hybrid Electric Vehicles | Electricore/Allison Transmission Division of General Motors Corporation | FTA |
| Installation of Capstone Microturbines into AVS Passenger Trams | Electricore/Advanced Vehicle Systems, Inc. | FTA |
| Novel Silicon Carbide JFET-Gated Thyristor | Electricore/Rutgers University | FTA |
| Electric Vehicle Ready State | Hawaii Electric Vehicle Demonstration Project | FTA |
| Zero Emission 100-Passenger Electric Tram for Airports | Hawaii Electric Vehicle Demonstration Project/U.S. Electricar | FTA, FAA |
| Battery Life Cycle Prediction | Hawaii Electric Vehicle Demonstration Project/Hawaii Natural Energy Institute/University of Hawaii/SOEST | FTA |
| Extension of the Hybrid Electric HMMWV Power Train Development Program | Southern Coalition for Advanced Transportation/PEI Electronics | FTA |
| Optimization of Hybrid Electric Vehicles Compression Ignition Auxiliary Unit Control Strategy for Emissions Reduction and Improved Fuel Economy | Mid Atlantic Regional Consortium for Advanced Vehicles/Navistar International Transportation Corporation | FTA |
| Integrated Simulation and Testing System for Electric Vehicle Batteries | Mid Atlantic Regional Consortium for Advanced Vehicles/Pennsylvania Transportation Institute | FTA |
| Smaller Better Inverters with Polymer Multi-Layer Capacitors | Mid Atlantic Regional Consortium for Advanced Vehicles/Sigma Technologies International, Inc. | FTA |
| NiMH Battery System Development for an Electric Vehicle Bus | Sacramento Municipal Utility District/Ovonic Battery | FTA |
| Advanced PLI Hybrid Electric Vehicle Battery | Sacramento Municipal Utility District/Compact Power | FTA |
| Reliable Electric Propulsion System for Medium and Heavy Duty Vehicles | CALSTART/Santa Barbara Electric Bus Works | FTA |
| All-Purpose Electric Tractor | CALSTART/ISE Research Corporation | FTA, FAA |
| Development of Advanced Electrochemical Capacitors Using Carbon and Lead-Oxide Electrodes for Hybrid Vehicle Applications | CALSTART/University of California, Davis | FTA |
| Hybrid Transit Bus with Flywheel | CALSTART/Trinity Flywheel Power | FTA |
| Auxiliary Power Unit Project Using Fuel Cell Technology | CALSTART/Freightliner Corporation | FTA |

*(Continued From Previous Page)*

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Caterpillar Heavy Duty Powertrain Applicable to Heavy Duty Machines | Northeast Advanced Vehicle Consortium | FTA |
| Design/Integrate/Test Auxiliary Power Units/Hybrid Electric Vehicles for Deployment in Commercial Delivery Fleet | Northeast Advanced Vehicle Consortium | FTA |
| Low Cost, Modular, Highly Reliable, Universal Propulsion Inverter for Heavy-Duty Commercial and Military Hybrid Vehicles | Electricore | FTA |
| Design and Fabrication of 4H-SiC Hybrid JBS Diode for High Temperature and High Efficiency Inverters for Medium and Heavy Duty Applications | Electricore/Rutgers University | FTA |
| Electric Vehicle Ready State (Phase II) | Hawaii Electric Vehicle Demonstration Project | FTA |
| Hybrid Drive System for Heavy Duty Transit Buses and Trucks (Phase I) | Hawaii Electric Vehicle Demonstration Project/Hawaii Technology Development Corporation | FTA |
| Georgia 1 - Design, Manufacture and Test a Low Speed Industrial Motor System in Heavy-Duty Vehicles | Southern Coalition for Advanced Transportation | FTA |
| Texas 1 - Enhanced Safety and Risk Reduction for University of Texas Demonstration Program | Southern Coalition for Advanced Transportation | FTA |
| Simulation and Field Test Hybrid Ultra-Capacitor Battery Energy Storage System for Electric Transit Vehicles | Mid Atlantic Regional Consortium for Advanced Vehicles/Pennsylvania Transportation Institute | FTA |
| Development of Scalable Direct-Methanol Fuel Cell Stacks | Mid Atlantic Regional Consortium for Advanced Vehicles/GATE Center for Advanced Energy Storage | FTA |
| Zebra Battery Demonstration in an Electric School Bus | Sacramento Municipal Utility District/Santa Barbara Electric Bus Works | FTA |
| Fuel Cell Auxiliary Power Unit Demonstration in a Heavy-Duty Truck | Sacramento Municipal Utility District/ISE Research Corporation | FTA |
| DOT Center for Climate Change and Environmental Forecasting Conference Support | CALSTART/WestStart Corporation | All modes |
| Hybrid Electric Prototype Truck, Phase II Program | CALSTART/ISE Research Corporation | FTA |
| 150 kW Traction Drive/Hybrid Auxiliary Power Unit System for Large Electric or Hybrid Electric Vehicle Applications | CALSTART/Unique Mobility, Inc. | FTA |
| Hickam Air Force Base Project Development | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |
| Rapid Chargers | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |
| Electric Bus Conversion | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |
| *U.S.S. Arizona* Memorial Tour Boat Study | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Navy, National Park Service |

(Continued From Previous Page)

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Advanced Vehicles for Great Smoky Mountains National Park | Mid Atlantic Regional Consortium for Advanced Vehicles/Electric Power Research Institute | FTA, National Park Service |
| Plug-In Hybrid Vehicles Energy Control System | Mid Atlantic Regional Consortium for Advanced Vehicles | FTA |
| Phase I Fast Track Fuel Cell Bus Project | Sacramento Municipal Utility District/Sacramento Electric Transportation Consortium/CALSTART/WestStart | FTA |
| Development of NiMH Battery System for Application in Heavy Duty Hybrid Electric Vehicles | Sacramento Municipal Utility District/Sacramento Electric Transportation Consortium | FTA |
| Lightweight Hybrid Electric Transit Bus Program | CALSTART/NOVA Bus Incorporated | FTA |
| Airport Clean Fuel Vehicle Outreach -- Targeted Project Development | CALSTART/WestStart Corporation | FTA, FAA |
| Phase I, Fast Track Fuel Cell Bus Project | CALSTART/WestStart/Sacramento Electric Transportation Consortium | FTA |
| National Conference on Climate Change | Northeast Advanced Vehicle Consortium | All modes |
| Development and Fabrication of a PEM Fuel Cell Power Plant for Heavy Duty Vehicle Applications | Northeast Advanced Vehicle Consortium/University Transportation Centers Fuel Cells | FTA |
| Drive Line Development Team and Industry Work Group | Northeast Advanced Vehicle Consortium | FTA |
| Route-Ready Fuel Cell Component Testing | Northeast Advanced Vehicle Consortium/Concurrent Technologies Corporation | FTA |
| Hybrid Electric Bus (Phase II) | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |
| Multi-Vehicle Charging System | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |
| Data Acquisition Systems | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |
| Aircraft Loader | Hawaii Electric Vehicle Demonstration Project | FTA, Department of the Air Force |

Source: RSPA.

Legend

FAA Federal Aviation Administration
FTA Federal Transit Administration

Note: This program is performed in partnership with seven major consortia consisting of (1) Sacramento Electric Transportation Consortium; (2) Northeast Advanced Vehicle Consortium; (3) CALSTART-WESTSTART; (4) Electricore, Inc.; (5) Mid-Atlantic Regional Consortium for Advanced Vehicles; (6) Hawaii Electric Vehicle Demonstration Project; and (7) Southern Coalition for Advanced Transportation.

**Table 3: Commercial Remote Sensing and Spatial Information Technologies Program**

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Airborne Sensor Fusion: A Fast-Track Approach to National Environmental Policy Act Streamlining and Environmental Assessment | NCRST-E/Earthdata Int'l of NC | FHWA |
| Remote Sensing of Environmental Parameters for Use in National Environmental Policy Act Documentation in Support of Highway Corridor Studies | NCRST-E/ICF Consulting | FHWA |
| Remote Sensing Applications in Transit | NCRST-F/Bridgewater State College | FHWA, FTA |
| Airborne Ground-Penetrating Radar to Support Monitoring of Pipeline Safety and Performance | NCRST-H/Aeris Inc. | RSPA/Office of Pipeline Safety |
| Environmental Impact and Risk Modeling of Petroleum and Gas Transmission Lines Using Interferometry and High Resolution Imagery from Satellite and Airborne-based Remote Sensing Systems | NCRST-H/EarthWatch, Inc. | RSPA/Office of Pipeline Safety |
| Facilitating the Operation Efficiency and Growth of Intermodal Freight Traffic: Application of Remote Sensing Technology to the Alameda Corridor, Los Angeles, CA | NCRST-I/ASL Consulting Engineers (Tetra Tech Corp.) | Office of the Secretary of Transportation/ Office of Intermodalism |
| Remote Sensing Applications Supporting Regional Database for Transportation Planning | NCRST-F/Veridian System Division (formerly Veridian ERIM) | FHWA, FTA |
| Road Network Planning Tool | NCRST-F/Technology Service Corp. | FHWA |
| Impact of Instant Imagery Access on a Regional Database for Transportation Planning | NCRST-I/Orbimage | FHWA |
| Development of Regional Databases for Transportation Planning | NCRST-E/Veridian Systems Division | FHWA, FTA |
| Remote Sensing for Airport Development and Transportation Planning | NCRST-F/Grafton Technologies, Inc. | FAA, FHWA |
| Remote Sensing of Invasive Aquatic Plant Obstruction in Navigable Waterways | NCRST-F/TerraMetrics, Inc. | MARAD |
| Using an Unmanned Airborne Data Acquisition System (ADAS) for Traffic Surveillance, Monitoring, and Management | NCRST-F/GeoData Systems, Inc. | FHWA |
| The Application of Remote Sensing Technologies in Post-Disaster Damage Assessment | NCRST-H/ImageCat, Inc. | All modes |
| Long-Term Monitoring of Changes in Transportation and Land Use Associated with the Central Artery/Third Harbor Tunnel in Boston, MA. | NCRST-I/University of Massachusetts | FHWA |

(Continued From Previous Page)

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Implementing Remote Sensing Applications to Develop and Environmental Impact Statement and Decision Options to Relocate the Current CSX Railroad from Mississippi Gulf Coast townships to the I-10 Right of Way | NCRST-E/FHWA/Mississippi Department of Transportation | FHWA, FRA |
| Remote Sensing Applications for Environmental Analysis in Transportation Planning | NCRST-E/Washington State Department of Transportation | FHWA |
| Highway Features and Characteristics Database Development Using Commercial Remote Sensing Technology, Combined with Mobile Mapping, GIS and GPS. | NCRST-I/Florida Department of Transportation | FHWA |

Source: RSPA.

Legend

FAA Federal Aviation Administration
FHWA Federal Highway Administration
FRA Federal Railroad Administration
FTA Federal Transit Administration
MARAD Maritime Administration
RSPA Research and Special Programs Administration

Note: This program is performed in partnership with four major consortia consisting of (1) the National Consortia for Remote Sensing in Transportation - Environmental Assessment/Application (NCRST-E); (2) the National Consortia for Remote Sensing in Transportation - Traffic Flow (NCRST-F); (3) the National Consortia for Remote Sensing in Transportation - Safety, Hazards, and Disasters (NCRST-H); and (4) the National Consortia for Remote Sensing in Transportation - Infrastructure Management (NCRST-I).

**Table 4: Human-Centered Systems: Operator Fatigue Management Program**

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Framework for Multimodal Synthesis and Cost Benefit Analyses | ORC Macro | All DOT modes through the Human Factors Coordinating Committee |
| Work Schedule Representation Analysis Software | XIMES GmbH | All DOT modes through the Human Factors Coordinating Committee |
| Development of a Fatigue Management Reference Handbook | Battelle Memorial Institute, Columbus Operations | All DOT modes through the Human Factors Coordinating Committee |
| Fatigue Analysis Systems for Transportation Operations: Railroad Applications | Science Applications International Corporation | All DOT modes through the Human Factors Coordinating Committee |

Source: RSPA.

Legend

DOT Department of Transportation

**Table 5: Transportation Infrastructure Assurance Program**

| Project title | Project performer(s) | Project stakeholders |
|---|---|---|
| Interdependency of the Transportation System with Other Critical Infrastructures | Volpe National Transportation Systems Center | Office of Intelligence and Security, TSA, FAA, Louisiana Offshore Oil Port, TRB. |
| Transportation and Logistical Requirements for Emergency Response Teams in Dealing with Weapons of Mass Destruction | Volpe National Transportation Systems Center | DOT Maritime Academy, FAA, Federal Emergency Management Adminstration, FHWA, MARAD, RSPA's Office of Emergency Transportation. |
| Feasibility of Alternative Backup Systems for the Global Positioning System | Volpe National Transportation Systems Center | Booz-Allen Hamilton, DOT Office of the Secretary, FAA, FRA, Northrop-Grumman, USCG. |
| Options to Transition Hazardous Materials Transportation Security Guidelines to Security Requirements | Volpe National Transportation Systems Center | TSA, American Association of Railroads, American Chemistry Council, Bureau of Transportation Statistics, DOT Office of the Secretary, FMCSA, FRA, GAO, TRB, RSPA's Office of Hazardous Materials Safety, RSPA's Office of Pipeline Safety, and USCG, American Institute of Chemical Engineers, the National Transportation Safety Board, the Inland Rivers, Ports and Waterways Association, the Bureau of the Census, the U.S. Army Corps of Engineers, and Vanderbilt University. |

Source: RSPA.

Legend

DOT Department of Transportation
FAA Federal Aviation Administration
FHWA Federal Highway Administration
FMCSA Federal Motor Carrier Safety Administration
FRA Federal Railroad Administration
MARAD Maritime Administration
RSPA Research and Special Programs Administration
TRB Transportation Research Board
TSA Transportation Security Administration
USCG United States Coast Guard

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