



U.S. Department of  
Transportation  
**Federal Railroad  
Administration**

## 2003 Highway-Rail Grade Crossing Safety Research Needs Workshop

### Volume I – Summary of Results

Office of Research  
and Development  
Washington, DC 20590



NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the objective of this report.

<b>1. REPORT DOCUMENTATION PAGE</b>			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE April 2009		3. REPORT TYPE AND DATES COVERED Final Report April 2009
4. TITLE AND SUBTITLE 2003 Highway-Rail Grade Crossing Safety Research Needs Workshop Volume I-Summary of Results			5. FUNDING NUMBERS 1.1.1 1.1.1.1 RR97/DB063	
6. AUTHOR(S) - Anya A. Carroll, Marsha J. Haines*				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Research and Innovative Technology Administration John A. Volpe National Transportation Systems Center 55 Broadway Cambridge, MA 02142-1093			8. PERFORMING ORGANIZATION REPORT NUMBER DOT-VNTSC-FRA-07-07	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Federal Railroad Administration Office of Research and Development 1200 New Jersey Avenue, SE, RDV-33 Washington, DC 20590			10. SPONSORING/MONITORING AGENCY REPORT NUMBER DOT/FRA/ORD-09/09	
11. SUPPLEMENTARY NOTES *EG&G Technical Services, Inc. 55 Broadway Cambridge, MA 02142-1093				
12a. DISTRIBUTION/AVAILABILITY STATEMENT This document is available to the public through the National Technical Information Service, Springfield, VA 22161.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) The purposes of the workshop were to provide up-to-date information and research reports from selected organizations, analyze a number of safety research topics by a selected group of delegates from all areas of technology and government organizations associated with the rail industry, and define a new practical list of research needs for the Highway-Rail at Grade Crossing Safety Program of the Federal Railroad Administration's Office of Research and Development and Office of Safety in coordination with other organizations having similar needs.				
14. SUBJECT TERMS Highway-rail grade crossing, rail industry, safety, security, fatalities, research needs, countermeasures.			15. NUMBER OF PAGES 108	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT 1.2 Unlimited	

## ACKNOWLEDGMENTS

The U.S. Department of Transportation and the Federal Railroad Administration's (FRA) Office of Research and Development sponsored the 2003 Highway-Rail Grade Crossing Safety Research Needs Workshop and this report. The authors wish to thank all who contributed to the direction, helpful guidance, and input on the conduct of the workshop.

The authors also wish to extend special thanks to all of the 2003 Steering Committee members for their contributions to the successful planning and conduct of this workshop. The Steering Committee members included the following:

Jo Strang	FRA
Tom Raslear	FRA
Ron Ries	FRA
Jim Smailes	FRA
Debra Chappell	Federal Highway Administration & Joint Program Office
Rhonda Crawley	Federal Transit Administration (FTA)
Terrell Williams	FTA
Ron Engle	National Highway Traffic Safety Administration
Amy Houser	Federal Motor Carrier Safety Administration (FMCSA)
James Keenan	FMCSA
Miriam Kloeppel	National Transportation Safety Board
Brian Bowman	Transportation Research Board
Gerri Hall	Operation Lifesaver, Inc.
Bill Browder	Association of American Railroads
Tom Simpson	Railway Supply Institute
Phil Caruso	Institute of Transportation Engineers (ITE)
Ed Stolloff	ITE
James Cheeks	ITE
George Newman	Brotherhood of Locomotive Engineers
Tim DePaepe	Brotherhood of Railroad Signalmen
Paul Lemay	Transport Canada/Transportation Development Center
Sesto Vespa	Transport Canada/Transportation Development Center

Anya A. Carroll, Project Leader for the John A. Volpe National Transportation Systems Center (Volpe Center) Highway-Rail Grade Crossing Safety Research Program, was the report team leader and provided overall direction for the workshop.

Lorraine G. Brewer, formerly of Planners Collaborative, Inc., provided planning and logistical support.

The authors wish to thank and acknowledge the contributions of the speakers and presenters, as well as the professional support provided by the following facilitators for their part in the successful development of the formal research needs: Elaine Lyte and Marilyn Mullane of the

Volpe Center; Jane Saks, Jonathan Mozenter, and Jon Anderson formerly of EG&G Technical Services, Inc.; and Linda Sharpe of Cambridge Systematics.

## Table of Contents

List of Tables .....	vii
List of Figures .....	viii
Executive Summary .....	1
1 Introduction .....	5
1.1 Purpose .....	5
1.2 Background .....	6
1.3 Workshop-Related Documents .....	9
1.4 Report Organization .....	12
2 Research Needs .....	13
2.1 Identified Needs .....	13
2.2 Top 10 Research Needs .....	14
2.3 High-Urgency Research Needs .....	17
2.4 Summary of Ballot Results .....	74
2.5 Summary of High-Urgency Research Needs .....	76
3 Discussion and Analysis of Identified Needs .....	77
3.1 Priority Research Needs Statement Data Sorts .....	77
3.2 Comparison of 1995 and 2003 Research Needs .....	85
4 Summary of Findings .....	95
4.1 R&D Trends and New Directions .....	95
Abbreviations and Acronyms .....	99



## List of Tables

Table 1. Distribution of Workshop Delegates by Organizational Type .....	1
Table 2. 2003 High-Urgency Research Needs by Ballot Priority Rank .....	2
Table 3. Distribution of High-Urgency Research Needs by Topic Area .....	3
Table 4. Steering Committee Members .....	6
Table 5. Topic Area Team Leaders.....	7
Table 6. Speakers for Topic Areas.....	8
Table 7. Distribution of Workshop Delegates by Organizational Type .....	8
Table 8. Distribution of Delegates by Topic Area .....	9
Table 9. Top 10 High-Urgency Research Needs Listed by Cost .....	14
Table 10. High-Urgency Research Needs Listed by Ease of Implementation .....	15
Table 11. Top 10 High-Urgency Research Needs Listed by Research Objectives .....	15
Table 12. Top 10 High-Urgency Research Needs Listed by Relation to Current Research.....	16
Table 13. Top 10 High-Urgency Research Needs Listed by Potential Research Organization .....	16
Table 14. Top 10 High-Urgency Research Needs Listed by Applicability to High-Speed Rail ....	16
Table 15. Distribution of All Research Needs Identified .....	17
Table 16. CIP Delegates .....	18
Table 17. High-Urgency CIP Research Needs .....	19
Table 18. HF Delegates.....	36
Table 19. High-Urgency HF Research Needs.....	36
Table 20. STP Delegates.....	51
Table 21. High-Urgency STP Research Needs.....	51
Table 22. DGS Delegates.....	61
Table 23. High-Urgency DGS Research Needs.....	61
Table 24. DPE Delegates .....	65
Table 25. High-Urgency DPE Research Needs .....	65
Table 26. ITS/PTC Delegates .....	69
Table 27. High-Urgency ITS/PTC Research Needs .....	69
Table 28. Distribution of High-Urgency Research Needs by Topic Area.....	74
Table 29. 2003 High-Urgency Research Needs Listed by Ballot Priority Rank .....	75
Table 30. High-Urgency Research Needs Listed by Cost .....	78
Table 31. High-Urgency Research Needs Listed by Ease of Implementation .....	79
Table 32. High-Urgency Research Needs Listed by Research Objectives .....	80
Table 33. High-Urgency Research Needs Listed by Relationship to Current Research .....	81
Table 34. High-Urgency Research Needs Listed by Organization Performing Current Research.....	82
Table 35. High-Urgency Research Needs Listed by Potential Research Organization.....	83
Table 36. High-Urgency Research Needs Listed by Applicability to High-Speed Rail.....	84



## List of Figures

Figure 1. All Research Needs by Topic Area and Urgency .....	3
Figure 2. FRA Project Timeline.....	10
Figure 3. All Research Needs by Topic Area .....	13
Figure 4. All Research Needs by Topic Area and Urgency .....	13
Figure 5. Cost Distribution of Top 10 High-Urgency Research Needs .....	14
Figure 6. Comparison of 1995 and 2003 CIP Needs .....	86
Figure 7. Comparison of 1995 and 2003 HF Needs .....	88
Figure 8. Comparison of 1995 and 2003 STP Needs.....	90
Figure 9. Comparison of 1995 and 2003 DGS Needs .....	91
Figure 10. Comparison of 1995 and 2003 DPE Needs.....	92
Figure 11. Comparison of 1995 and 2003 ITS/PTC Needs .....	93

## Executive Summary

The United States Department of Transportation (U.S. DOT) Federal Railroad Administration (FRA), in partnership with other Federal agencies, Congress, individual States, industry, academia, Operation Lifesaver, Incorporated (OLI), and others, has achieved a significant reduction in the number of highway-rail grade crossing accidents over the past 20 years. To ensure continuation of these successes, FRA developed the U.S. DOT's Action Plan for Highway-Rail Grade Crossing Safety. The Action Plan is an intermodal document that was released by the Secretary of Transportation, Federico Pena, on June 13, 1994, to further enhance safety at highway-rail grade crossings nationwide. The objective of the plan was to achieve at least a 50-percent reduction in accidents and fatalities at grade crossings over the next 10 years. To accomplish this, the Action Plan identified six major initiatives encompassing 55 individual activities. One of these activities identified the need for a workshop to develop intermodal consensus on projected research needs to support continued improvement in highway-rail grade crossing safety. The U.S. DOT Research and Innovative Technology Administration (RITA), John A. Volpe National Transportation Systems Center (Volpe Center), as part of its support program to FRA, hosted and conducted the first Highway-Rail Grade Crossing Safety Research Needs Workshop from April 10–13, 1995.

A second research needs workshop was held on June 3–5, 2003, to address the many issues and questions generated since the previous workshop, as well as to discuss progress on specific highway-rail grade crossing research projects and develop an updated set of research needs. FRA nominated a multi-organizational Steering Committee to achieve the objective of developing an intermodal consensus of highway-rail grade crossing research needs. The Steering Committee in turn nominated approximately 120 individuals to speak at and/or attend the workshop. As a result of this activity, 87 delegates participated in the workshop. Table 1 provides a distribution of workshop participants by type of organization.

**Table 1. Distribution of Workshop Delegates by Organizational Type**

<b>Organizational Type</b>	<b>Number of Delegates</b>
Federal Government	30
State/Local Officials	8
Railroad/Transit	8
Industry	9
Consultants	18
University/Academia	7
Unions	4
Canadian Organizations	3
<b>Total</b>	<b>87</b>

These 87 workshop delegates synthesized 113 formal research needs within six topic areas: Crossing Improvement and Closure (CIP), Human Factors (HF), Security and Trespass Prevention (STP), Data and Geographical Information Systems (DGS), Driver/Public Education and Enforcement (DPE), and Intelligent Transportation Systems and Positive Train Control (ITS/PTC). Of the 113 established research needs, the workshop delegates identified 49 to be of

high urgency for the enhancement of grade crossing safety and security. The workshop delegates established a priority ranking of the 49 high-urgency research needs (see Table 2). This ranking was established through a balloting process, with a 60-percent survey return rate by workshop delegates.

**Table 2. 2003 High-Urgency Research Needs by Ballot Priority Rank**

Priority No.	Topic No.	Research Need Title
1	CIP-02	Establish Standards for States Regarding Elimination/Consolidation of At-Grade Crossings
2	CIP-09	Pre-Signal Design Criteria and Warrants
3	HF-10	Driver Decisionmaking at Grade Crossings
4	CIP-22	Replacement Criteria for Older Grade Crossing Warning Devices
5	HF-02	Enhancing Driver Risk Perception at Grade Crossings: Evaluating and Standardizing
6	CIP-27	Innovative Low-Cost Grade Separation (Vehicle and Pedestrian)
7	DGS-01	Crossing Inventory
8	CIP-04	Wheelchair Crossing Flangeway Gaps at Grade Crossings
9	CIP-08	Pedestrian Treatments at Highway-Rail Crossings/Undercrossings*
10	CIP-01	Develop Limited Access Rail Lines
11	CIP-18	Effectiveness of Incentives for Closures, Including Cost Analysis
12	HF-07	Determining Driver Decisionmaking at Grade Crossings: A Survey of Accident Survivors*
13	HF-06	Development of Near-Miss Data Through Compilation of Elements from Various Sources
14	CIP-07	Provision of Warning to Motorists at Highway-Rail Grade Crossings Where Remote Control Train Operations Are in Effect
15	HF-03	Develop Leading Indicators That Contribute to Accidents
16	CIP-16	Common Corridor Usage (Light Rail Transit (LRT)/Freight) and How It Relates to Grade Crossings
17	DPE-04	Educational Programs and Outreach Assessment
18	ITS/PTC-05	Identify the Functional and Safety Requirements for Highway-Rail Grade Crossing ITS Applications
19	ITS/PTC-03	Identify Data Needs and Requirements for Information Flows Between Railroad Centers, Highway Centers, Railroad Users, and Highway Users
20	STP-03a	Pedestrian Decision Tree-Review Available Technology Applications
21	STP-06a	Obstacle/Intrusion Detection-Technology Survey*
22	HF-08	Development of New Form for Reporting Trespassing Fatalities/Incidents
23	CIP-24	Highway Median Barriers
24	HF-04	Needs Assessment for Emergency Response Teams*
25	HF-13	Collection of Data to Assess Likely Conditions for Rail Suicide/Trespassing
26	CIP-14	Standards for Signals for LRT Street Running Systems
27	HF-05	Comprehensive Model of Driver Behavior/Countermeasures Assessment
28	CIP-21	Vehicle Queuing at Grade Crossings Adjacent to Stop Sign-Controlled Intersections
29	ITS/PTC-06	Interface with Intelligent Vehicle Initiative (IVI)
30	CIP-13	Effectiveness and Application of Simultaneous versus Advanced Preemption
31	CIP-05	Performance Criteria for Use of Light Emitting Diodes (LEDs) in Flashing Light Devices at Highway-Rail Grade Crossings
32	HF-11	Evaluation Strategies for Improving the Implementation, Utilization, Effectiveness, and Impact of Grade Crossing Research in the U.S. Rail Industry
33	DPE-03	Innovative Training for Law Enforcement
34	HF-12	Development and Implementation of a Highway-Rail Intersection (HRI) HF Research Results Database
35	HF-14	Assess Trauma of Railroad Employees
36	HF-09	Best Research Practices to Conduct HF Research in Highway-Rail Research
37	DGS-03	Using the Web to Advance Safety Initiatives
38	CIP-10	Modify Design of Existing Railroad Crossing Warning Devices
39	ITS/PTC-02	Improve Risk Assessment Models

**Table 2. 2003 High-Urgency Research Needs by Ballot Priority Rank (continued)**

40	HF-01	Context Evaluation: Developing a Consensus-Based Approach for Establishing Grade Crossing Research Guidelines and Standards in the U.S. Rail Industry
41	DGS-05	Synthesis of Current Grade Crossing Analyses
42	STP-05a	Securing Multimodal Rail Infrastructure*
43	STP-22a	Define Safe Hazmat Transport Issues at Grade Crossings*
44	DPE-02	Information Dissemination to Transportation Professionals
45	STP-17	Department of Homeland Security/Transportation Security Administration/Federal Emergency Management Agency (DHS/TSA/FEMA) Emergency Preparedness Coordination with FRA
46	STP-20a	Detect Chemical, Biological, Nuclear, and Explosive Materials*
47	STP-14	Develop Performance Measures to Improve Security and Decrease Risk
48	STP-18a	Cell Phone and Communication Availability—ID Technologies/Emergency Protocols*
49	STP-19	Credentialing of Transportation Employees

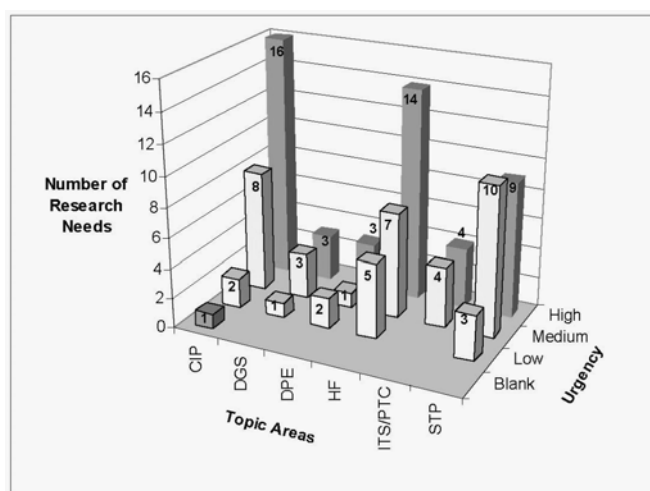
\*Research topics with associated research programs.

Table 3 presents the distribution of high-urgency research needs by topic area. As shown, the CIP topic area accounts for 16 of the 49 high-urgency research needs identified.

**Table 3. Distribution of High-Urgency Research Needs by Topic Area**

Topic Area	Number/Percent of High-Urgency Research Needs
CIP	16 (33%)
HF	14 (29%)
STP	9 (18%)
DGS	3 (6%)
DPE	3 (6%)
ITS/PTC	4 (8%)
<b>TOTAL</b>	<b>49</b>

Figure 1 summarizes all research needs by topic area and urgency.



Note: Some needs were consolidated.

**Figure 1. All Research Needs by Topic Area and Urgency**

The 2003 Research Needs Workshop focused on innovative research to improve FRA's research objectives in the areas of Safety, Security, Mobility, Global Connectivity (GC), and Environmental Stewardship. The workshop results contain statements of research needs that expand earlier research on highway-rail grade crossings. The purpose of such research statements is to bring critical existing and emerging grade crossing issues of interest before policy makers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions. Transportation agencies at all levels of government are concerned about the safety and security of the Nation's grade crossings and the adequacy of privately and publicly owned infrastructure and facilities. Many of these research needs statements address concerns of public agencies in relation to their investments in grade crossing facilities. Workshop delegates identified areas where the collective knowledge of grade crossings can be expanded through future research efforts. Identified research needs support the continued development of a meaningful grade crossing research agenda and will allow FRA to make informed research and development (R&D) decisions that are consistent with industry needs. Identified needs will also support the selection of research projects that will have the greatest utility for the grade crossing community.

The 2003 workshop delegates defined research that cut across topic boundaries, more so than at the workshop held in 1995. Work groups were encouraged to communicate freely with each other. This communication resulted in research needs statements that were of interest to several groups. In particular, two specific research need types were trespass and data issues. The consensus among delegates was that the workshop was a worthwhile step in developing an intermodal approach to improving highway-rail grade crossing safety, and the process should continue.

## 2. Introduction

This report documents the purpose, process, analyses, and results of the 2003 Highway-Rail Grade Crossing Safety Research Needs Workshop sponsored by the Federal Railroad Administration (FRA) Office of Research and Development and held at the John A. Volpe National Transportation Center.

The workshop length was 2½ days, starting on Tuesday, June 3, 2003, and ending midday on Thursday, June 5, 2003. The first full day of the workshop included 19 presentations from representatives of various multimodal organizations on grade crossing issues covering 6 topic areas: Crossing Improvement and Closure (CIP), Human Factors (HF), Security and Trespass Prevention (STP), Data and Geographical Information Systems (DGS), Driver Public Education and Enforcement (DPE), and Intelligent Transportation Systems and Positive Train Control (ITS/PTC). Participants spent the first day reviewing the current status of research with three to four presentations on each topic area. Groups of delegates assigned to the six topic areas dedicated the second day of the workshop solely to the identification of intermodal highway-rail grade crossing research needs. The second day was used to identify the research needs previously established by the Steering Committee and to generate additional research needs. The third day encompassed a plenary session, at which the team leader(s) of each group presented a review of the research needs identified by the respective topic area groups. A priority ranking of the designated high-urgency needs was completed by ballot and mailed to each of the workshop delegates after the workshop. Appendix B of Volume II includes additional information on the workshop agenda, correspondence, and forms.

Following the adjournment of the workshop on June 5, 2003, attendees were given a tour of the Central Artery/Tunnel Project in South Boston, the most complex and expensive highway project ever undertaken in the United States. The Central Artery project is an 18-year, multibillion dollar project consisting of 2 major components: the depression of Boston's Central Artery and the extension of I-90 (the Massachusetts Turnpike) from its current end point south of downtown Boston, through the Ted Williams Tunnel to Logan Airport.

The Highway-Rail Grade Crossing Safety Research Needs Workshop provided FRA and other U.S. Department of Transportation (U.S. DOT) modal agencies with the current status of research in the area of highway-rail grade crossings. Based on a review of FRA's Five-Year Strategic Plan and Transport Canada's (TC) Research Program (D2006), and through intermodal and stakeholder consensus, workshop participants formulated and prioritized an updated set of research needs related to technology, methodology, and hardware to continue the downward trend of crossing collisions and fatalities. These research needs were formally documented for use in revisiting the 1994 U.S. DOT Action Plan for Highway-Rail Grade Crossing Safety and aided in the future planning of scarce resources for research funding in the highway-rail grade crossing safety arena.

### 2.1 Purpose

The purposes of the workshop were to provide up-to-date information and research reports from selected organizations, analyze a number of safety research topics by a selected group of delegates from all areas of technology and government organizations associated with the rail industry, and define a new practical list of research needs for the Highway-Rail at Grade

Crossing Safety Program of the FRA Office of Research and Development and Office of Safety in coordination with other organizations having similar needs.

## 2.2 Background

The FRA Office of Research and Development held a similar workshop on April 10–13, 1995, and considered it appropriate to convene a new workshop to gather and exchange this subsequent information with experts, academics, and organizations dealing with safety issues at highway rail at grade crossings. To achieve the objectives of the workshop, a multi-organizational steering committee was nominated by FRA and coordinated through the Volpe Center. The function of the steering committee was to develop the workshop format and nominate delegates, speakers, presenters, and team leaders. Table 4 provides a list of the Steering Committee members and their respective organizations.

**Table 4. Steering Committee Members**

<b>Committee Member</b>	<b>Organization</b>
Amy Houser	Federal Motor Carrier Safety Administration
Bill Browder	Association of American Railroads
Brian Bowman	Transportation Research Board
Debra Chappell	Federal Highway Administration (FHWA) & Joint Program Office
Ed Stoloff	Institute of Transportation Engineers
George Newman	Brotherhood of Locomotive Engineers (BLE)
Gerri Hall	Operation Lifesaver, Inc. (OLI)
James Cheeks	Institute of Transportation Engineers (ITE)
James Keenan	Federal Motor Carrier Safety Administration
Jim Smailes	FRA
Jo Strang	FRA
Miriam Kloeppel	National Transportation Safety Board
Paul Lemay	Transport Canada/Transportation Development Center
Phil Caruso	ITE
Rhonda Crawley	Federal Transit Administration (FTA)
Ron Engle	National Highway Traffic Safety Administration
Ron Ries	FRA
Sesto Vespa	Transport Canada/Transportation Development Center
Terrell Williams	FTA
Tim DePaepe	Brotherhood of Railroad Signalmen
Tom Raslear	FRA
Tom Simpson	Railway Supply Institute

The 2003 workshop was planned to bring together a wide range of views of Federal researchers, representatives of highway safety, law enforcement, rail and transit industry, management and labor, academia, and consultants. To ensure positive participation and feedback, the committee limited attendance at the workshop to nominated delegates.

The steering committee agreed that it was necessary to inform invitees and participants of historical perspectives of research, current research activities, and research that may impact the development of high-speed rail in the United States. The committee identified the six topic areas that would be addressed in the workshop:

### 1. CIP

2. HF
3. STP
4. DGS
5. DPE
6. ITS/PTC

The committee designated six team leaders (listed in Table 5) to direct delegates in the analysis and discussion of the research needs provided for each working group.

**Table 5. Topic Area Team Leaders**

<b>Topic Area</b>	<b>Team Leader</b>	<b>Organization</b>
CIP	Debra Chappell	FHWA
HF	Tom Raslear	FRA
STP	Rhonda Crawley/Anyia Carroll	FTA/Volpe Center
DGS	Brian Bowman	Auburn University
DPE	Gerri Hall	OLI
ITS/PTC	Jim Smailes	FRA

The steering committee nominated 19 speakers and presenters to provide up-to-date research information and research progress in the six topic areas for the workshop (see Table 6). From the nominees, the Volpe Center was able to confirm all speakers.



**Table 6. Speakers for Topic Areas**

Topic	Speaker Name	Organization
CIP	Kurt Anderson	Railroad Controls, Ltd.
	Brian Gilleran	FRA
	Jeff Schultz	Washington State DOT
HF	Jordan Multer	Volpe Center
	Eddy Llaneras	Westat, Inc.
	Patrick Sherry	University of Denver
STP	Rhonda Crawley	FTA
	Marco daSilva	Volpe Center
	William Fleming	MBTA Police
	Linda Meadow	Linda J. Meadow & Associates
DGS	Steve Laffey	Illinois Commerce Commission
	Raphael Kedar	FRA
	Pamela Caldwell-Foggin	FRA
DPE	Jim Bedell	Naperville, IL Police Department
	Steve Laffey	Illinois Commerce Commission
	Gary Drouin	TC
ITS/PTC	Steve Ditmeyer	FRA
	Terrell Williams	FTA
	James Cheeks	ITE

Eighty-seven workshop delegates met in designated working groups and joined in an analytical process to define research needs for highway-rail crossing safety issues. Each team was responsible for determining the characteristics of the identified research needs for each concentration area and setting their priority. Table 7 shows the distribution of workshop delegates by the type of organization they represented.

**Table 7. Distribution of Workshop Delegates by Organizational Type**

Organizational Type	Number of Delegates
Federal Government	30
State/Local Officials	8
Railroad/Transit	8
Industry	9
Consultants	18
University/Academia	7
Unions	4
Canadian Organizations	3
<b>Total</b>	<b>87</b>

Table 8 shows the number of delegates assigned to each of the workshop working groups.

**Table 8. Distribution of Delegates by Topic Area**

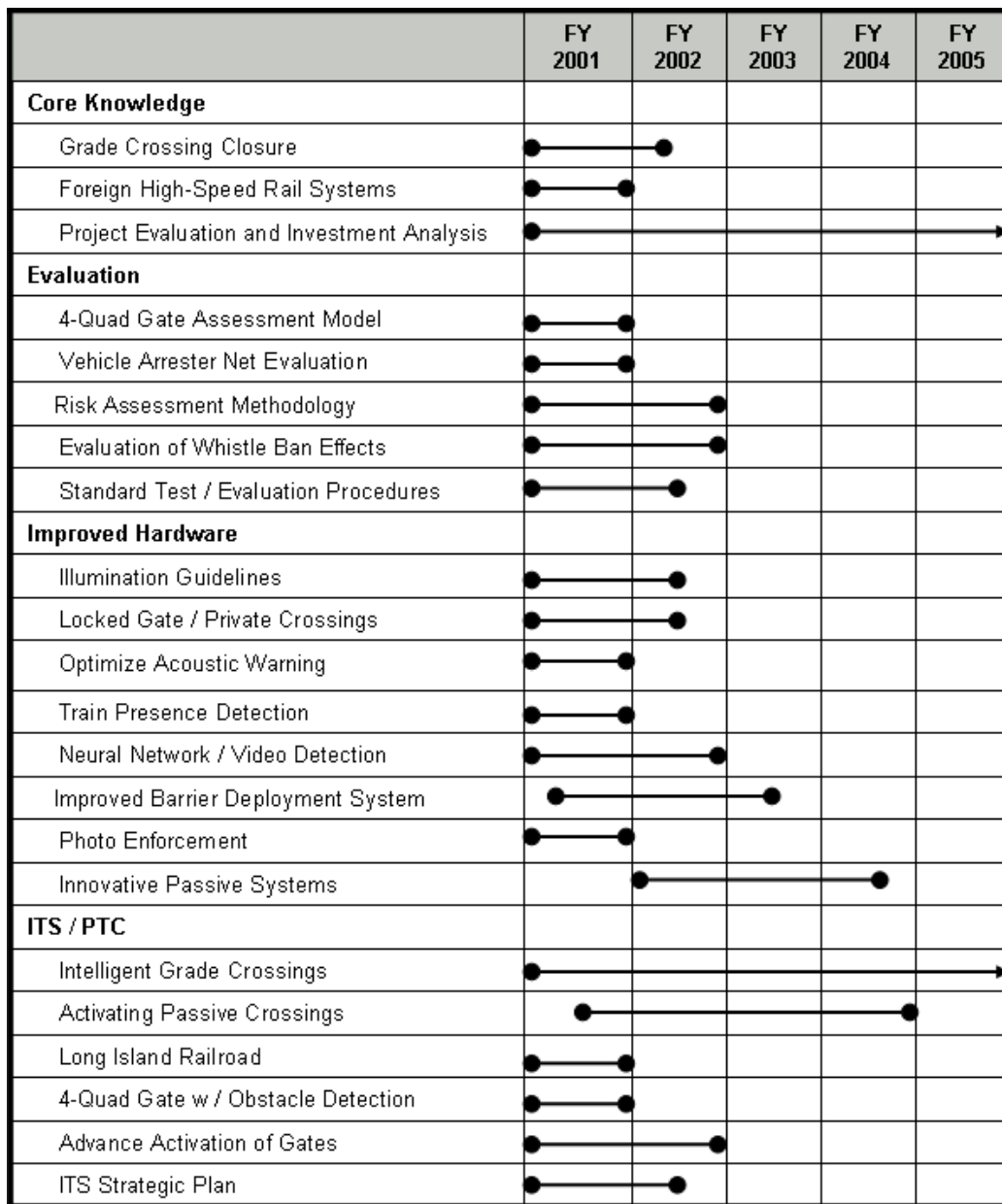
<b>Topic Area</b>	<b>Number of Delegates</b>
CIP	18
HF	14
STP	14
DGS	14
DPE	13
ITS/PTC	14
<b>Total</b>	<b>87</b>

### 2.3 Workshop-Related Documents

To fully inform the delegates of current and past efforts, the Volpe Center provided them with FRA, TC, and other documents of interest on highway-rail grade crossing safety and security research. The Web site for the 2003 Highway-Rail Grade Crossing Safety Research Needs Workshop provided the delegates with documents related to the different issues to be discussed in order to prepare them. Appendix D in Volume II provides this information.

### **FRA**

- *FRA's Highway-Rail Grade Crossing Projects.* These projects contain valuable information on the research and development (R&D), policy, and Next Generation Program on grade crossings available within FRA. Workshop delegates were provided with the timeline summary of projects from 2002 through 2005, as shown in Figure 2.



**Figure 2. FRA Project Timeline**

- *Five-Year Strategic Plan for Railroad Research, Development, and Demonstrations (Five-Year Plan for RD&D).* FRA, at the request of the Senate Appropriations Committee, prepared the Five-Year Plan for RD&D in March 2002. The Five-Year Plan for RD&D includes projects funded under three programs: the Railroad Research and Development Program, the Next Generation Technology Demonstration Program, and the Magnetic Levitation Technology Deployment Program.
- *FRA's Highway-Rail Crossing Safety and Trespasser Prevention Program.* This FRA program is committed to reducing the number of collisions at highway-rail grade crossings and along railroad rights-of-way (ROW), where approximately 900 deaths occur every year. Using the enforcement, education, and engineering approach (three E

approach), the crossing team has helped to reduce the number of fatalities at highway-rail crossings by 43 percent since 1994.

## TC

- *TC's Highway-Rail Grade Crossing Projects.*
- *TC, Direction 2006.* Every year in Canada approximately 370 collisions and trespassing incidents occur at highway-rail crossings and along railway tracks, resulting in the death or serious injury of nearly 170 people. Direction 2006 is a partnership between all levels of government, railway companies, public safety organizations, police, unions, and community groups. Its objective was to reduce grade crossing collisions and trespassing incidents by 50 percent by the year 2006.
- News Release. *\$1.6 Million to Improve Safety at Railway Crossings Across Canada.*

## Other Documents and Resources

- *Safety of Highway-Railroad Grade Crossings Research Needs Workshop, Volume I, and Safety of Highway-Railroad Grade Crossings Research Needs Workshop, Volume II-Appendices.* In 1995, the Volpe Center hosted and conducted a Highway-Railroad Grade Crossing Safety Research Needs Workshop. Delegates participated in the workshop, which identified 92 grade crossing research needs, 42 of which were highly urgent. This document contains the results of analyses of the 1995 research needs. The results suggest that cost-effective research can be conducted without a large expenditure of public funds. The results also indicate that a majority of research needs apply to high-speed rail and that the CIP and HF areas should receive increased emphasis in the future. Finally, the results address relationships among the identified research needs, the Action Plan, and current research being conducted.
- *Federal Transit Administration (FTA), Rail Safety, State Safety Oversight Program.* In response to Congressional concern regarding the potential for accidents and incidents on rail transit systems, the Intermodal Surface Transportation Efficiency Act of 1991 added Section 28 to the Federal Transit Act (codified at Title 49 U.S. Code Section 5330). This section requires FTA to issue a regulation creating the first State-managed oversight program for rail transit safety.
- *Federal Highway Administration's (FHWA) Office of Safety, Highway-Rail Grade Crossing Program.* Although the number of railroad grade crossing fatalities, injuries, and crashes are small in comparison with other events, these incidents have the potential for catastrophic consequences. This page includes grade crossing definitions, as well as links to a number of related Web sites.
- *U.S. DOT-ITS Joint Programs Office (JPO).* The national ITS program, which aims to use advanced technology to improve the efficiency and safety of the Nation's surface transportation system, addresses both information- and infrastructure-based approaches to achieving its goals. The program also has an intermodal nature, incorporating highways, transit, and rail—thus requiring unprecedented cooperation among diverse groups of public and private stakeholders. The objectives of the ITS JPO are to provide strategic leadership for ITS research; development, testing, and deployment; guide policy coordination; and ensure resource accountability.

- *Association of American Railroads (AAR)*. The following three documents were provided:
  - Highway-Rail Grade Crossing Safety
  - Grade Crossing Warning Device Selection
  - Whistle Bans at Grade Crossings
- Operation Lifesaver Web site

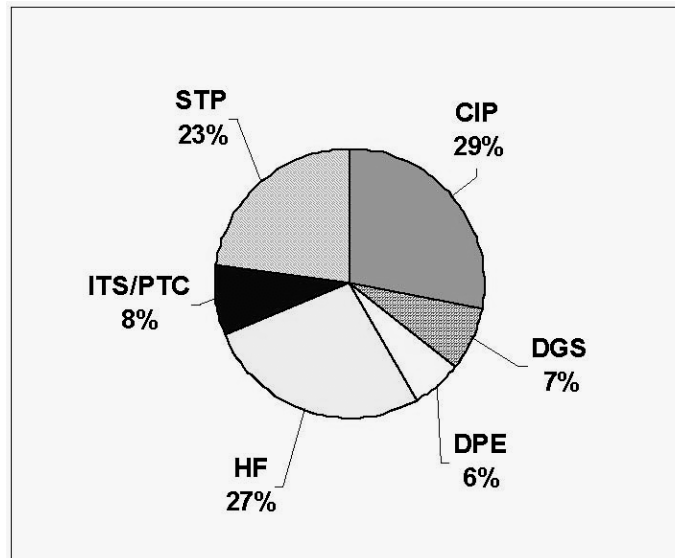
#### 2.4 Report Organization

Volume I of this report presents the identified needs of the 2003 Highway-Rail Grade Crossing Safety Research Needs Workshop. Volume II provides supporting materials and presentations that were distributed to workshop participants. Appendix A includes a complete list of workshop attendees. Appendix B provides the workshop agenda, working group assignments, sample research need form, high-urgency research-need ballot, and evaluation form. Appendix C provides presentations that were given by representatives of various multimodal organizations on grade crossing issues. Appendix D lists the additional reference material distributed to workshop delegates to prepare for attendance at the 2003 workshop. Appendix E provides a transcript from the final day of the workshop, as well as discussions and closing remarks. Appendix F contains all of the one-page research need statements for the identified high-urgency research needs.

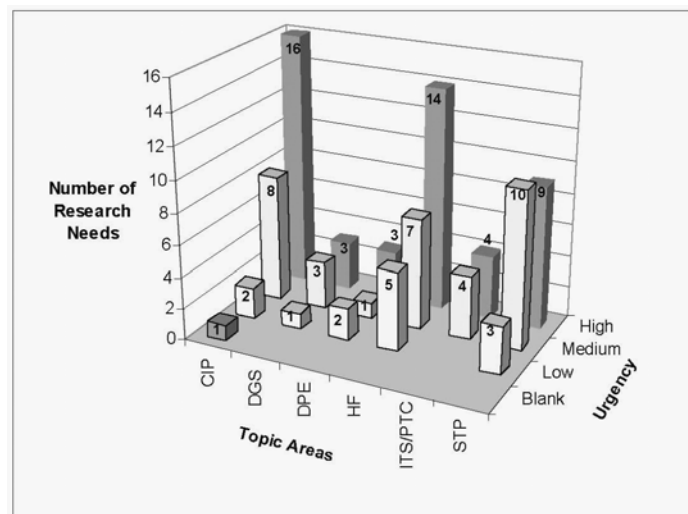
### 3. Research Needs

#### 3.1 Identified Needs

The workshop resulted in the identification of 113 research needs across six topic areas. Figure 3 shows the percentages of all research needs by topic area. After consolidating a few research areas, the balloting process resulted in the identification of 49 high-urgency needs. Figure 4 illustrates all of the research needs by topic area and urgency.



**Figure 3. All Research Needs by Topic Area**



Note: Some needs were consolidated.

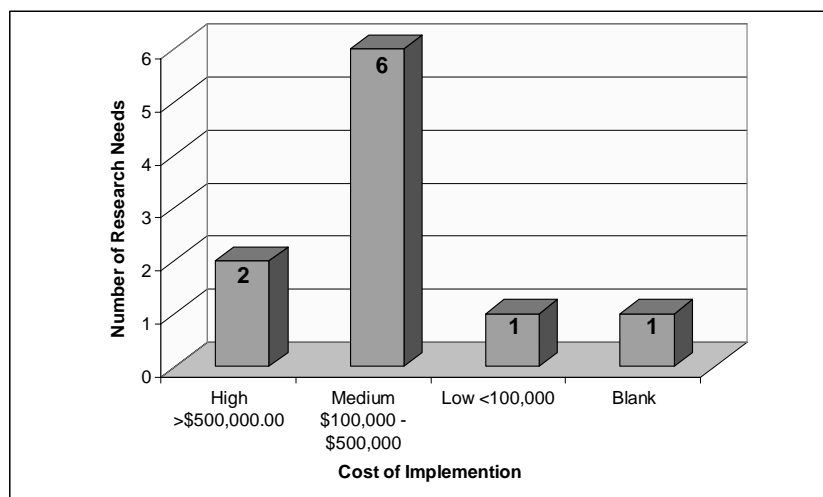
**Figure 4. All Research Needs by Topic Area and Urgency**

### 3.2 Top 10 Research Needs

Research needs were put into high-, medium-, or low-cost categories. The high-cost range is defined as more than \$500,000; the medium-cost range is more than \$100,000 but less than \$500,000; and the low-cost range is less than \$100,000. Table 9 shows the cost categories for the top 10 rated research needs. Figure 5 shows the cost distribution for the top 10 needs. Six of the top 10 research needs are medium cost, and only two are high cost. This shows overall moderate funding requirements for the group, balanced by one low-cost and one unknown cost requirement. This distribution has the top priority need at low cost. The next five research needs are medium cost whereas the following two are high cost. This indicates that required funding will be moderate, with low demand for high-cost research needs.

**Table 9. Top 10 High-Urgency Research Needs Listed by Cost**

Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives
7	DGS-01		Medium	Safety/Mobility/GC/Security
8	CIP-04		Medium	Safety/Mobility
2	CIP-09		Easy	Safety
3	HF-10		Difficult	Safety
4	CIP-22		Difficult	Safety
5	HF-02		Medium	Safety
6	CIP-27		Medium	Safety
10	CIP-01		Medium	Safety
1	CIP-02		Difficult	Safety
9	CIP-08		-	Safety



**Figure 5. Cost Distribution of Top 10 High-Urgency Research Needs**

Table 10 shows the top 10 ranking high-urgency research needs by ease of implementation: difficult, medium difficulty, and easy. Here, only one was easy, one was unspecified, and the rest fell between difficult (3) and medium (5). This ease of implementation distribution indicates that more consideration must be given to alternative implementation methodologies and that mutual collaboration with other institutions involved will be required to smooth the expected complexity and hard work for implementation. Without correlation of the factors, since each is independent of the other, research cost to ease of implementation is noticeable. The research cost for the top

priority item is low; however, implementation is difficult. For the #2 priority need, the cost is medium, and implementation will be easy. The majority of research needs will fall into the medium ease of implementation category. This balancing act between cost and ease of implementation will appeal to organizations that may be willing to participate and collaborate on different stages of development for each research need.

**Table 10. High-Urgency Research Needs Listed by Ease of Implementation**

Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives
1	CIP-02	Low		Safety
3	HF-10	Medium		Safety
4	CIP-22	Medium		Safety
5	HF-02	Medium		Safety
6	CIP-27	Medium		Safety
7	DGS-01	High		Safety/Mobility/GC/Security
8	CIP-04	High		Safety/Mobility
10	CIP-01	Medium		Safety
2	CIP-09	Medium		Safety
9	CIP-08 [STP-01a-d]	-		Safety

Table 11 shows the distribution of research objectives for the top 10 research needs. The first eight items are safety-related only, and the last two have combined objectives. The most prevalent factor, which is safety, defines the effects on different characteristics of the rail transportation industry and the required consideration of safety in the development of countermeasures and actions. The last item includes four of the five U.S. DOT objectives, except for ES.

**Table 11. Top 10 High-Urgency Research Needs Listed by Research Objectives**

Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives
1	CIP-02	Low	Difficult	
2	CIP-09	Medium	Easy	
3	HF-10	Medium	Difficult	
4	CIP-22	Medium	Difficult	
5	HF-02	Medium	Medium	
6	CIP-27	Medium	Medium	
9	CIP-08 [STP-01a-d]	-	-	
10	CIP-01	Medium	Medium	
8	CIP-04	High	Medium	
7	DGS-01	High	Medium	

Table 12 shows the top 10 research needs that are considered to be new research topics and those that are supplemental (complementary to existing research). Seven new and three supplemental research needs provide a good measure of fresh analysis since the last workshop. The predominantly new items show more analytical and resourceful contributions by looking at past problems from different angles and finding new components to arrive at practical and effective solutions.



**Table 12. Top 10 High-Urgency Research Needs Listed by Relation to Current Research**

Priority No.	Topic No.	Relationship to Current Research	Organization of Current Research and/or Title	Potential Research Organization	Applicability to High-Speed Rail
1	CIP-02		-	-	Yes
2	CIP-09		-	FHWA/FRA	Yes
3	HF-10		-	FRA	Yes
4	CIP-22		-	Railroad (RR) /FHWA/FRA	Yes
8	CIP-04		-	-	Yes
9	CIP-08 [STP-01a-d]		-	FHWA	Yes
10	CIP-01		-	-	Yes
5	HF-02		-	FRA	-
6	CIP-27		-	FRA/TC	Yes
7	DGS-01		Old '95 D-3	FRA/FHWA	Yes

Table 13 lists the top 10 research needs by potential research organization that could be responsible for the activity. The top seven research needs listed identify the organization(s) that have a direct relation to the issues considered. An organization could not be identified to conduct the research on three of the needs.

**Table 13. Top 10 High-Urgency Research Needs Listed by Potential Research Organization**

Priority No.	Topic No.	Relationship to Current Research	Organization of Current Research and/or Title	Potential Research Organization
9	CIP-08 [STP-01a-d]	New	-	
2	CIP-09	New	-	
3	HF-10	New	-	
5	HF-02	Supplemental	-	
7	DGS-01	Supplemental	Old '95 D-3	
6	CIP-27	Supplemental	-	
4	CIP-22	New	-	
1	CIP-02	New	-	
8	CIP-04	New	-	
10	CIP-01	New	-	

Table 14 shows the distribution of the top 10 high-urgency research needs sorted by their applicability to high-speed rail transportation. Nine of the needs are applicable to high-speed rail transportation; no applicability information was provided for the last need listed. High applicability to high-speed rail indicates a common direction for development and requirements planning.

**Table 14. Top 10 High-Urgency Research Needs Listed by Applicability to High-Speed Rail**

Priority No.	Topic No.	Relationship to Current Research	Organization of Current Research and/or Title	Potential Research Organization	Applicability to High-Speed Rail
1	CIP-02	New	-	-	
2	CIP-09	New	-	FHWA/FRA	
3	HF-10	New	-	FRA	
4	CIP-22	New	-	RR/FHWA /FRA	
6	CIP-27	Supplemental	-	FRA/TC	
7	DGS-01	Supplemental	Old '95 D-3	FRA/FHWA	
8	CIP-04	New	-	-	
9	CIP-08 [STP-01a-d]	New	-	FHWA	
10	CIP-01	New	-	-	
5	HF-02	Supplemental	-	FRA	

### 3.3 High-Urgency Research Needs

The identification of research needs was initiated on the first day, with three presentations given to the workshop delegation in each topic area. On the second day of the workshop, delegates met in topic-area breakout groups after the “rules of engagement” were reviewed in a general session. Table 15 shows the team assignments for each topic area.

**Table 15. Distribution of All Research Needs Identified**

Work Group #	Topic Area
1. Red Team	CIP
2. Blue Team	HF
3. Violet Team	STP
4. Green Team	DGS
5. Yellow Team	DPE
6. Silver Team	ITS/PTC

The following sections discuss the results from each of these research need topic areas. Each section includes a list of the working group’s composition team leader, delegates, and the group facilitator, as well as his/her organization, a list of high-urgency needs for each topic area, and a detailed description for each high-urgency need.

Information listed on the research need statement form includes the following:

1. Topic area/number
2. Title
3. Problem statement
4. Research objectives
5. Relationship to current research
6. Potential benefits of identified research need
7. Research need urgency
8. Cost of research
9. Potential organization to conduct research
10. Ease of implementation
11. Applicability to high-speed rail service
12. Other comments

### 3.3.1 CIP

Table 16 identifies the delegates responsible for identifying high-urgency research needs in the CIP topic area.

**Table 16. CIP Delegates**

Name	Organization
Debra Chappell (Team Leader)	FHWA
Adrian Hellman	Volpe Center
Ahmer Nizam	Washington Utilities & Transportation Commission
Brian Gilleran	FRA, Office of Safety
Charles Gullakson	CSX
Danny Gilbert	Norfolk Southern (NS) Corporation
Forest Ballinger	GE Transportation Systems, Global Signaling
Jeff Schultz	Washington State DOT
John Sharkey	Safetran Systems Corp.
Kurt Anderson	Railroad Controls, Ltd.
Lorraine Pacocha	Massachusetts Bay Transportation Authority (MBTA)
Luis Miranda-Moreno	University of Waterloo/Canada
Michael Shumsky	North Carolina DOT Rail Division
Phil Poichuk	TC
Ron Mathieu	Southern California Regional Rail Authority
Scott Windley	U.S. Access Board
Varoujan Jinbachian	California Public Utilities Commission
Elaine Lyte (Facilitator)	Volpe Center

Table 17 includes a list of the 16 high-urgency research needs identified, analyzed, and evaluated by the CIP working group. A one-page research need statement for each of these CIP items follows.

**Table 17. High-Urgency CIP Research Needs**

<b>Priority No.</b>	<b>Topic No.</b>	<b>Research Need Title</b>
<b>10</b>		Develop Limited Access Rail Lines
<b>1</b>		Establish Standards for States Regarding Elimination of/Consolidation At-Grade Crossings
<b>8</b>		Wheelchair Crossing Flangeway Gaps at Grade Crossings
<b>31</b>		Performance Criteria for Use of LEDs in Flashing Light Devices at Highway-Rail Grade Crossings
<b>14</b>		Provision of Warning to Motorists at Highway-Rail Grade Crossings Where Remote Control Operations Are in Effect
<b>9</b>		Pedestrian Treatments at Highway-Rail Grade Crossings/Undercrossings [Pedestrian Grade Crossing Treatments]
<b>2</b>		Pre-Signal Design Criteria and Warrants
<b>38</b>		Modify Design of Existing Railroad Crossing Warning Devices
<b>30</b>		Effectiveness and Application of Simultaneous versus Advance Preemption
<b>26</b>		Standards for Signals for LRT Street Running Systems
<b>16</b>		Common Corridor Usage (LRT/Freight) and How It Relates to Grade Crossings
<b>11</b>		Effectiveness of Incentives for Closures, Including Cost Analysis
<b>28</b>		Vehicle Queuing at Grade Crossings Adjacent to Stop Sign-Controlled Intersections
<b>4</b>		Replacement Criteria for Older Grade Crossing Warning Devices
<b>23</b>		Highway Median Barriers
<b>6</b>		Innovative Low-Cost Grade Separation (Vehicular and Pedestrian)

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-01**
2. Title: Develop Limited Access Rail Lines
3. Problem Statement: Counties and local communities continue to request new at-grade crossings in areas that have large numbers of train movements and in areas that interfere with train operations. Because railroads and at times DOTs oppose the new at-grade crossings because of safety and operational issues, lawsuits are filed in order to ensure the new at-grade crossing is installed.
4. Research Objectives: Develop federal guidelines for limiting new crossings and develop criteria to have high rail volume rail lines designed as “limited access rail lines.”
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ X\_ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Increase safety and in turn reduce the potential for collisions, injuries, and fatalities.
7. Research Need Urgency: ☒ X\_ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ X\_ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ X\_ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ X\_ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–CIP

1. Topic Area/Number: **CIP-02**
2. Title: Establish Standards for States Regarding Elimination/Consolidation of At-Grade Crossings
3. Problem Statement: Because of local sentiments regarding the elimination/consolidation of grade crossings, the decisions that are made not to close crossings are based on convenience, not safety.
4. Research Objectives:
  - Safety X Research State laws regarding crossing closures and what processes are required to eliminate crossings. Develop minimum standards on crossing closures that each State would be required to enact. If States do not enact the standards, Federal dollars will be withheld until the standards are enacted.
  - Mobility Meet Federal guidelines for grade crossing closures.
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Insure redundant crossings are closed/consolidated, which in turn will reduce potential of collisions. This would take the political pressure away from elected officials.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☐ Medium ☒ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-04**
2. Title: Wheelchair Crossing Flangeway Gaps at Grade Crossings
3. Problem Statement: Flangeway gaps at light rail and freight crossings are an impediment to pedestrians who use wheelchairs and scooters. Numerous reports detail the dangers, including some with deaths resulting. Rail lines that carry freight need a 3-inch minimum flangeway width when the crossing is newly constructed; realistic allowances for rail wear would be about 1 inch. Light rail lines where freight equipment is not operated can achieve 2½-inches maximum width when a crossing is newly constructed. ADA Accessibility Guidelines generally permit no more than a ½-inch gap in the surface of the accessible route.
4. Research Objectives: Research and develop treatment for rails or rail crossings so that pedestrians using wheelchairs may cross tracks on at-grade pedestrian crossings without risk of entrapment.
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ X\_ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Persons with disabilities being able to cross railroad tracks safely
7. Research Need Urgency: ☒ X\_ High ☐ Medium ☐ Low
8. Cost of Research: ☒ X\_ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ X\_ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ X\_ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–CIP

1. Topic Area/Number:	<b>CIP-05</b>
2. Title:	Performance Criteria for Use of LEDs in Flashing Light Devices at Highway-Rail Grade Crossings
3. Problem Statement:	Light-emitting diodes (LED) are gaining acceptance in traffic control devices. Industry recommended practices currently do not specify a minimum light output. Research is needed to determine the minimum light intensity during bright ambient conditions, maximum intensity during night conditions and evaluate their performance (compared to incandescent lights) in adverse weather (i.e., fog, snow, rain).
4. Research Objectives:	<p>Safety <input checked="" type="checkbox"/> X</p> <p>Mobility</p> <p>Global Connectivity</p> <p>Environmental Stewardship</p> <p>Security</p>
5. Relationship to Current Research:	<p><input type="checkbox"/> New <input checked="" type="checkbox"/> X Supplemental (list organization &amp; title of current research)</p> <p>Transport Canada – “LED Technology for Improved Conspicuity of Signal Lights at Highway/Railroad Grade Crossings”</p>
6. Potential Benefits of Identified Research Need:	Potential benefits include improved conspicuity, extended life cycle between lamp outages, and long-term savings from reduced energy consumption.
7. Research Need Urgency:	<input checked="" type="checkbox"/> X High <input type="checkbox"/> Medium <input type="checkbox"/> Low
8. Cost of Research:	<input type="checkbox"/> High > \$500,000 <input type="checkbox"/> Medium = \$100,000 to \$500,000 <input checked="" type="checkbox"/> X Low < \$100,000
9. Potential Organization to Conduct Research:	
10. Ease of Implementation:	<input checked="" type="checkbox"/> X Easy <input type="checkbox"/> Medium <input type="checkbox"/> Difficult
11. Applicability to High-Speed Rail Service:	<input checked="" type="checkbox"/> X Yes <input type="checkbox"/> No
12. Other Comments:	Research should also investigate the effects of fast rise and fall time (time taken to reach full intensity from off and vice versa) on conspicuity and perceived brightness.



## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

- |  |  |
|--|--|
| 1. Topic Area/Number:                              | <b>CIP-07</b>  |
| 2. Title:  | Provision of Warning to Motorists at Highway-Rail Grade Crossings Where Remote Control Operations Are in Effect  |
| 3. Problem Statement:                              | Operation of locomotives using a remote control operation (RCO) system operated by an employee not at the control stand can create issues when the RCO locomotive is to shove or lead a cut of cars through a public grade crossing. |
| 4. Research Objectives:                            | Investigate the wide range of potential safety issues that may be created when RCO may be run across a public grade crossing.  |
| Safety X   |  |
| Mobility   | Attempt to identify railroad operating strategies and crossing improvements that may mitigate the identified issues.   |
| Global Connectivity                                |  |
| Environmental Stewardship                          |  |
| Security   |  |
| 5. Relationship to Current Research:               | <input checked="" type="checkbox"/> New <input type="checkbox"/> Supplemental (list organization & title of current research)  |
| 6. Potential Benefits of Identified Research Need: | Enhanced safety at grade crossings.<br>Enhanced safety for railroad employees (not just the RCO employee).   |
| 7. Research Need Urgency:                          | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low  |
| 8. Cost of Research:                               | <input type="checkbox"/> High > \$500,000 <input checked="" type="checkbox"/> Medium = \$100,000 to \$500,000 <input type="checkbox"/> Low < \$100,000   |
| 9. Potential Organization to Conduct Research:     | Consortium – RR, Highway Agency, FRA   |
| 10. Ease of Implementation:                        | <input type="checkbox"/> Easy <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Difficult  |
| 11. Applicability to High-Speed Rail Service:      | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  |
| 12. Other Comments:                                |  |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–CIP

- |  |   |
|--|---|
| 1. Topic Area/Number:                              | <b>CIP-08</b>   |
| 2. Title   | Pedestrian Treatments at Highway-Rail Grade Crossings/Undercrossings  |
| 3. Problem Statement:                              | Current edition of the Manual on Uniform Traffic Control Devices (MUTCD) has no guidance/standards for pedestrian/bike (non-motorized) paths on sidewalks at railroad/highway intersections. Many streets have adjacent sidewalks. To improve safety for pedestrians/bikes, standards for pedestrian treatments should be developed to ensure safety and consistency. |
| 4. Research Objectives:                            | Develop standards and/or design criteria for pedestrian treatments (gates, channelization, etc.) for crossings with moderate to high levels of traffic.   |
| Safety X   | Objectives: Determine best practices, examine treatments for vision/hearing/mobility impaired, walkway design, etc. Develop standards for MUTCD (chapter 8).  |
| Mobility   |   |
| Global Connectivity                                |   |
| Environmental Stewardship                          |   |
| Security   |   |
| 5. Relationship to Current Research:               | <input checked="" type="checkbox"/> New <input type="checkbox"/> Supplemental (list organization & title of current research)   |
| 6. Potential Benefits of Identified Research Need: | Reduce pedestrian deaths/injuries. Develop consistent standards for nation.   |
| 7. Research Need Urgency:                          | <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low  |
| 8. Cost of Research:                               | <input type="checkbox"/> High > \$500,000 <input type="checkbox"/> Medium = \$100,000 to \$500,000 <input type="checkbox"/> Low < \$100,000   |
| 9. Potential Organization to Conduct Research:     | FHWA  |
| 10. Ease of Implementation:                        | <input type="checkbox"/> Easy <input type="checkbox"/> Medium <input type="checkbox"/> Difficult  |
| 11. Applicability to High-Speed Rail Service:      | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No   |
| 12. Other Comments:                                |   |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-09**
2. Title: Pre-Signal Design Criteria and Warrants
3. Problem Statement: Currently no guidelines exist to determine when preemption does not adequately clear traffic queues at grade crossings and when pre-signals should be recommended. Once a pre-signal is deemed necessary, design criteria, such as rear-side vs. far-side placement, pavement markings, etc., need to be determined.
4. Research Objectives:
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental
  - Stewardship
  - Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: The need for pre-signals and design criteria will be developed.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FHWA/FRA
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-10**
2. Title: **Modify Design of Existing Railroad Crossing Warning Devices**
3. Problem Statement: **Proposals have been made to modify existing grade crossing warning devices. Installing pre-signals on cantilevers housing flashing light signals or extending height of flashing light signal mast and installing another set of lights at top of mast are examples. Such modifications need to be identified and studied for their effectiveness.**
4. Research Objectives:
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: **Provide more options to rail crossing safety professionals to better alert motorists of approaching trains.**
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–CIP

1. Topic Area/Number: **CIP-13**
2. Title: Effectiveness and Application of Simultaneous Versus Advance Preemption
3. Problem Statement: At least one State prefers to use simultaneous preemption at locations requiring extremely long warning times. The effectiveness of simultaneous preemption in this type of application, instead of advance preemption, needs to be evaluated. If simultaneous preemption is used and warning times are extended, should additional treatments, such as median barriers, be considered?
4. Research Objectives:
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Specific guidance for the use of simultaneous and advance preemption.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-14**
2. Title: Standards for Signals for LRT Street Running Systems
3. Problem Statement: Street running light rail transit (LRT) uses its own traffic signals, which might be attached to regular street traffic signals. Motorists might confuse some of the LRT traffic signals with vehicular traffic signals. Standards need to be established for type and positioning of LRT traffic signals.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental
  - Stewardship
  - Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Prevent train-vehicle and vehicle-vehicle accidents resulting from confusing traffic signals.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☒ No
12. Other Comments: Some LRT agencies use bar indicators as train traffic signals, where vertical bar indicates stop, horizontal bar indicates go, and a slanted bar is the same as an orange signal. These signals may be attached to the end of the traffic signal mast arm. Motorists may confuse the horizontal bar (which indicates go for trains) with a left turn green arrow, resulting in collisions with trains. Some LRT agencies have moved the bar indicators to the top of the traffic signal masts and placed an active “train” sign at the end of the traffic signal mast arm, which is in the front of motorists field of vision and replacing them with active “train” signs. Collisions with vehicles making a left turn in front of oncoming trains have been reduced.

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-16**
2. Title: Common Corridor Usage (LRT/Freight) and How It Relates to Grade Crossings
3. Problem Statement: Grade crossings that include different types of rail service (freight, light rail, trolley, etc.) have unique problems. Research needs to be conducted on the special treatment of such crossings. Guidelines need to be developed for the types of warning devices, including both active and passive signs and signals, and other considerations.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Preventing train-vehicle accidents that may result in injury or death to passengers on trains, motorists, and train crews.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☒ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-18**
2. Title: Effectiveness of Incentives for Closures, Including Cost Analysis
3. Problem Statement: Crossing closures have been proposed and implemented as a convenience countermeasure to improve safety in the railroad network. But until now, it is not clear how to assess the potential closure of a crossing (costs and benefits).
4. Research Objectives: Establish the criteria or conditions that a crossing should have to be classed, such as:
 

Safety X	Characteristics of the crossing (e.g., warning device)
Mobility X	Traffic conditions
Global Connectivity X	Community features (e.g., population density)
Environmental Stewardship	Impact to the community's accessibility
Security	
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need:
 

Improving safety or decreasing risk

Reduction of cost (maintenance)

Improving of rail operation
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☐ No
12. Other Comments:



## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-21**
2. Title: Vehicle Queuing at Grade Crossings Adjacent to Stop Sign-Controlled Intersections
3. Problem Statement: Many crossing locations are where traffic queues cross the tracks near stop sign-controlled intersections. Consideration should be given to including these conditions in traffic signal warrants. Consideration should also be given to other means of clearing the queue, on a priority basis, such as emergency preemption.
4. Research Objectives:
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ X\_ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Development of potential solutions to a significant grade crossing safety issue that is currently not being addressed.
7. Research Need Urgency: ☒ X\_ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ X\_ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ X\_ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ X\_ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–CIP

1. Topic Area/Number: **CIP–22**
2. Title: Replacement Criteria for Older Grade Crossing Warning Devices
3. Problem Statement: Grade crossing active warning devices that were upgraded at the beginning of the program are aging. For certain older systems, parts are no longer available and adequate maintenance may be difficult. No set of analysis criteria exists to allow a highway agency to collectively assess the age, condition, performance, and maintainability of aging, active warning devices that are in place system-wide.
4. Research Objectives: Improve overall condition, performance, and reliability of active warning devices system-wide.
- Safety ☒ X
- Mobility
- Global Connectivity
- Environmental Stewardship
- Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Raise the overall level of active warning device technology, while reducing the cost and complexity of device maintenance. Enhanced safety and reliability.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: RR, Highway Agency, and FRA Signal and Train Control personnel
10. Ease of Implementation: ☐ Easy ☐ Medium ☒ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-24**
2. Title: Highway Median Barriers
3. Problem Statement: Median barriers have been found to be effective in reducing driving around gates. However, no standards or best practices exist at the Federal level for guidance in MUTCD. Evaluation of all-weather/maintenance costs with capital costs must be done.
4. Research Objectives: Study permanent and removable median separations.
  - Safety ☒ Develop standards for minimum length/width, reflective visibility. Develop recommended practices for using removable vs. permanent medians.
  - Mobility
  - Global Connectivity
  - Environmental
  - Stewardship
  - Security
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Provide clear guidance for use of median separators in various situations.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FHWA
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–CIP

1. Topic Area/Number: **CIP-27**
2. Title: Innovative Low-Cost Grade Separation (Vehicular and Pedestrian)
3. Problem Statement: Grade separation is the only completely effective protection for grade crossings. The cost of grade separation must be decreased before it can be fully implemented. However, institutional barriers (e.g., aesthetics, marriage to traditional practices) have blocked progress to date.
4. Research Objectives: Demonstrate low-cost design using existing low-cost construction options.
- Safety ☒ X
- Mobility
- Global Connectivity
- Environmental
- Stewardship
- Security
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: A permanent solution of comparable cost to high-end signal installation
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA or TC
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments: The CIP #17 (1995) has had minimal response. It is suggested that this response is in part due to insufficient attention paid to the incremental cost of a low-cost grade separation over the cost of a high-end signal installation. Possible prospects might be an installation on a high-speed line/lower volume road, where closing at the crossing might be virtually impossible.

### 3.3.2 HF

Table 18 lists the delegates responsible for identifying high-urgency research needs in the HF topic area.

**Table 18. HF Delegates**

Name	Organization
Tom Raslear (Team Leader)	FRA
Eddy Llaneras	Westat, Inc.
Fred Coleman	University of Illinois
George Newman	BLE
Jordan Multer	Volpe Center
Karen Philbrick	University of Denver
Michael Coplen	FRA
Monica Gil	Volpe Center
Patrick Sherry	University of Denver
Roger Hannan	Farm Resource Center
Sesto Vespa	TC
Steven Fritter	United Transportation Union
Vijay Kohli	Fulcrum Corporation
Jonathan Mozenter (Facilitator)	EG&G Technical Services, Inc.

Table 19 lists the 14 high-urgency research needs identified, analyzed, and evaluated by the HF working group. A one-page research need statement for each of these HF items follows.

**Table 19. High-Urgency HF Research Needs**

Priority No.	Topic No.	Research Need Title
40	HF-01	Context Evaluation: Developing a Consensus-Based Approach for Establishing Grade Crossing Research Guidelines and Standards in the U.S. Rail Industry
5		Enhancing Driver Risk Perception at Grade Crossings: Evaluating and Standardizing Advisory and Warning Signs
15		Develop Leading Indicators That Contribute to Accidents
24		Needs Assessment for Emergency Response Teams
27		Comprehensive Model of Driver Behavior/Countermeasures Assessment
13		Development of Near-Miss Data through Compilations of Elements from Various Sources
12		Determining Driver Decisionmaking at Grade Crossings: A Survey of Accident Survivors
22		Development of New Form for Reporting Trespassing Fatalities/Incidents
36		Best Research Practices to Conduct HF Research in Highway-Rail Research
3		Driver Decisionmaking at Grade Crossings
32		Evaluation Strategies for Improving the Implementation, Utilization, Effectiveness, and Impact of Grade Crossing Research in U.S. Rail Industry
34		Development and Implementation of a HRI HF Research Results Database
25		Collection of Data to Assess Likely Conditions for Rail Suicide/Trespassing
35		Assess Trauma of Railroad Employees

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

- |   |   |
|---|---|
| 1. Topic Area/Number:   | <b>HF-01</b>  |
| 2. Title:   | Context Evaluation: Developing a Consensus-Based Approach for Establishing Grade Crossing Research Guidelines and Standards in the U.S. Rail Industry   |
| 3. Problem Statement:   | Numerous pilot grade crossing research projects are being implemented in the railroad industry. Broad stakeholder acceptance and consensus is needed to fully implement broad industry-wide applications. |
| 4. Research Objectives:   | Develop strategies for user buy-in and acceptance.  |
| Safety <input checked="" type="checkbox"/> X<br>Mobility<br>Global Connectivity<br>Environmental<br>Stewardship<br>Security | Develop consensus-building strategies.  |
| 5. Relationship to Current Research:  | <input checked="" type="checkbox"/> New <input type="checkbox"/> Supplemental (list organization & title of current research)   |
| 6. Potential Benefits of Identified Research Need:  | Improves effectiveness, impact, and utilization<br>Increases likelihood of broad implementation   |
| 7. Research Need Urgency:   | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low   |
| 8. Cost of Research:  | <input type="checkbox"/> High > \$500,000 <input type="checkbox"/> Medium = \$100,000 to \$500,000 <input checked="" type="checkbox"/> Low <\$100,000   |
| 9. Potential Organization to Conduct Research:  | FRA   |
| 10. Ease of Implementation:   | <input type="checkbox"/> Easy <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Difficult   |
| 11. Applicability to High-Speed Rail Service:   | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No   |
| 12. Other Comments:   |   |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

1. Topic Area/Number:	<b>HF-02</b>						
2. Title:	Enhancing Driver Risk Perception at Grade Crossings: Evaluating and Standardizing Advisory and Warning Signs						
3. Problem Statement:	<p>Drivers generally do not understand the behavioral implications of existing advisory and warning messages presented at highway-rail grade crossings, a problem that is particularly evident at passive crossings where warning messages may not be clearly communicated or are simply ignored by drivers (particularly by familiar drivers). Perceived risk may underlie inappropriate driver behaviors.</p> <p>A variety of low-cost and innovative grade crossing treatments have been proposed and researched over the past decade (e.g., enhanced crossbuck signs, pavement markings, etc.) with some promising results. Large-scale or definitive system evaluations that provide clear system behavioral benefits are lacking.</p>						
4. Research Objectives:	<p>This work is intended to improve driver behavior and compliance at highway-rail grade crossings by:</p> <table border="0" style="margin-left: 40px;"> <tr> <td style="vertical-align: top;">Safety XX</td> <td rowspan="5">Assessing driver information needs and effectively communicating necessary and relevant information to guide driver behavior.</td> </tr> <tr> <td style="vertical-align: top;">Mobility</td> </tr> <tr> <td style="vertical-align: top;">Global Connectivity</td> </tr> <tr> <td style="vertical-align: top;">Environmental Stewardship</td> </tr> <tr> <td style="vertical-align: top;">Security</td> </tr> </table>	Safety XX	Assessing driver information needs and effectively communicating necessary and relevant information to guide driver behavior.	Mobility	Global Connectivity	Environmental Stewardship	Security
Safety XX	Assessing driver information needs and effectively communicating necessary and relevant information to guide driver behavior.						
Mobility							
Global Connectivity							
Environmental Stewardship							
Security							
5. Relationship to Current Research:	<p><input type="checkbox"/> New <input checked="" type="checkbox"/> Supplemental (list organization &amp; title of current research)</p> <p>Continue and expand line of work conducted by the National Committee on Highway Research Program (NCHRP), which overviewed innovative and low-cost signing treatments. Implementations and evaluations of promising approaches.</p>						
6. Potential Benefits of Identified Research Need:	<p>Improved safety by achieving better compliance</p> <p>Increased standardization and relevance of messages</p>						
7. Research Need Urgency:	<input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low						
8. Cost of Research:	<input type="checkbox"/> High > \$500,000 <input checked="" type="checkbox"/> Medium = \$100,000 to \$500,000 <input type="checkbox"/> Low < \$100,000						
9. Potential Organization to Conduct Research:	FRA						
10. Ease of Implementation:	<input type="checkbox"/> Easy <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Difficult						
11. Applicability to High-Speed Rail Service:	<input type="checkbox"/> Yes <input type="checkbox"/> No						
12. Other Comments:							

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

1. Topic Area/Number: **HF-03**
2. Title: Develop Leading Indicators that Contribute to Accidents
3. Problem Statement: As grade crossing incidents decline, they become less useful in predicting what type of incident may occur next. Leading indicators provide an opportunity to proactively prevent incidents before they occur. Leading indicators can also help to identify the causal factors that contribute to grade crossing incidents.
4. Research Objectives: Identify, develop, and collect leading indicators and show their relationship to incidents. Examine “near” miss data such as 1-800 information, video data, event recorder data, to learn what measures may be predictive of grade crossing information and can be used as a source of information to better understand why incidents occur.
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ X\_ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Development of leading indicators will provide railroads, federal, state, and local staffs with information to estimate the risk at grade crossings before accidents occur, as well as understanding the factors that contribute to accidents.
7. Research Need Urgency: ☒ X\_ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA
10. Ease of Implementation: ☐ Easy ☒ X\_ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ X\_ Yes ☐ No
12. Other Comments:



## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–HF

1. Topic Area/Number: **HF-04**
2. Title: Needs Assessment for Emergency Response Teams
3. Problem Statement: What are the training, information, train operations understanding, rail equipment familiarization, etc., needs for effective emergency response to grade crossing and other rail incidents and emergencies?
4. Research Objectives: Conduct a needs assessment for emergency responders and rail operators to determine various requirements for effective responses to rail incidents and emergencies. Stakeholder groups other than rail operators and emergency responders also need to be included to assure the proper scope of needs.
- Safety ☒ X
- Mobility
- Global Connectivity
- Environmental Stewardship
- Security
5. Relationship to Current Research: ☒ X New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Improved emergency response and readiness for emergencies and incidents.
7. Research Need Urgency: ☒ X High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ X Medium = \$100,000 to \$500,000 ☐ Low <\$100,000
9. Potential Organization to Conduct Research: FRA, FHWA, FTA
10. Ease of Implementation: ☐ Easy ☒ X Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ X Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

1. Topic Area/Number: **HF-05**
2. Title: Comprehensive Model of Driver Behavior/Countermeasures Assessment
3. Problem Statement: Drivers suffer from a variety of problems affecting decisionmaking performance including alcohol and drugs, fatigue, medical conditions, and environmental/peer pressures, all of which can lead to unsafe response time. Many of these unsafe responses have traditionally been attributed to risky behavior, when in fact this aspect may be a small proportion of the overall problem. Unfortunately, attributing these factors to risky behavior tends to give these other factors the semblance of inevitability and irresponsible behavior, which may not be the case and for which more than the educational response may be warranted.
4. Research Objectives:
- |                           |  |
|---------------------------|--|
| Safety X                  | Yes—Attacking more fundamental safety issues associated with hardcore/difficult problem areas. |
| Mobility                  |  |
| Global Connectivity       |  |
| Environmental Stewardship |  |
| Security X                | Yes  |
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FRA/FHWA
6. Potential Benefits of Identified Research Need: Solution of fundamental human performance issues, which may be at the heart of the remaining safety issues at grade crossings, because these elements are the hardest to identify and implement countermeasures.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☒ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low <\$100,000
9. Potential Organization to Conduct Research: FRA lead agency
10. Ease of Implementation: ☐ Easy ☐ Medium ☒ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–HF

1. Topic Area/Number: **HF-06**
2. Title: Development of Near-Miss Data through Compilation of Elements from Various Sources
3. Problem Statement: Currently no database exists of near-miss data publicly available for analysis and countermeasure purposes. There is also no systematic method for collecting this data; it rather depends upon gathering information from disparate public and private data that is often not even publishable.
4. Research Objectives:
 

Safety X	Yes—As preventive measures, ahead of the incident curve.
Mobility	
Global Connectivity	
Environmental Stewardship	
Security X	Yes
5. Relationship to Current Research: X\_\_ New \_\_ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Identify potential problems that may result in preventable incidents.
7. Research Need Urgency: X\_\_ High \_\_ Medium \_\_ Low
8. Cost of Research: X\_\_ High > \$500,000 \_\_ Medium = \$100,000 to \$500,000 \_\_ Low <\$100,000
9. Potential Organization to Conduct Research: FRA
10. Ease of Implementation: \_\_ Easy \_\_ Medium X \_\_ Difficult
11. Applicability to High-Speed Rail Service: X\_\_ Yes \_\_ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

1. Topic Area / Number: **HF-07**
2. Title: Determining Driver Decisionmaking at Grade Crossings:  
A Survey of Accident Survivors
3. Problem Statement: Due to the high frequency of grade crossing accidents, a compelling need exists to gain a more complete understanding of the decisionmaking process through which drivers decide whether or not to attempt driving over a grade crossing, even if danger is imminent.  
  
To date, preventive efforts have met with considerable success but have not completely eliminated grade crossing incidents, as evidenced by the number of incidents that continue to occur. In-depth interviews of incident survivors and a comprehensive literature review of decisionmaking models as well as rational versus irrational decisions will be conducted.
4. Research Objectives:
 

Safety XXX	Develop an organizational framework for characterizing driver decisionmaking styles.
Mobility	
Global Connectivity	Allocate more effective education and information to reduce the number of grade crossing accidents by aiding compliance with grade crossing traffic control devices (TCD).
Environmental Stewardship	Conduct in-depth interviews with persons surviving accidents.
Security	
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: This research has the potential to reduce the number of grade crossing incidents that occur each year by identifying the process through which decisions are made and by highlighting more effective educational methods. Furthermore, this research will help to identify shared personality/individual characteristics among grade crossing incident survivors, thus allowing for more resource concentration and focused interventions.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FHWA/FRA
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

1. Topic Area/Number: **HF-08**
2. Title: Development of New Form for Reporting Trespassing Fatalities/Incidents
3. Problem Statement: The current FRA incident form does not address trespassing elements. There is a requirement for the development of creating new data fields on the current form or developing a new form. This is very important because trespassing incidents are increasing proportionally each year.
4. Research Objectives:
 

Safety	X	Safety will be improved by better analysis and countermeasure developments.
Mobility	X	It will improve mobility by providing safety.
Global Connectivity		No
Environmental Stewardship		No
Security	X	Yes, it allows weak points to improve the vulnerability of the system.
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Help to reduce accidents on the railroad crossing and save lives.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low <\$100,000
9. Potential Organization to Conduct Research: FRA
10. Ease of Implementation: ☐ Easy ☐ Medium ☒ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

1. Topic Area/Number: **HF-09**
2. Title: Best Research Practices to Conduct HF Research in Highway-Rail Research
3. Problem Statement: A variety of research methods have been used to conduct research projects in the HRI arena. In the railroad-highway arena, at least two research methods guidebooks have been developed to aid highway researchers in effectively conducting valid research studies. This same type of guidebook or other guidance needs to be produced and compiled in the HRI arena because of its complexity and often-difficult research issues.
4. Research Objectives: Objectives include but are not limited to: (1) overall improved research design; (2) improved valid research studies; and (3) wider knowledge of techniques to apply and where to apply them.
- Safety (1)
- Mobility
- Global Connectivity
- Environmental Stewardship
- Security
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: See Research Objectives above. Also, the knowledge in this field would be more readily accepted. This would also encourage application of gaps in ways to conduct research and encourage methodologists to develop or adapt new research methods to improve the quality of potential research findings.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FHWA, FRA
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

- |  |  |
|--|--|
| 1. Topic Area/Number:                              | <b>HF–10</b>   |
| 2. Title:  | Driver Decisionmaking at Grade Crossings   |
| 3. Problem Statement:                              | What decision strategies do motorists use at different types of grade crossings? Do these strategies change with conditions of stress, fatigue, familiarity with the crossing, etc.? Naturalistic decisionmaking studies suggest that the context of the decision is extremely important for understanding how the decision is made. |
| 4. Research Objectives:                            | Determine decision strategies for various types of grade crossings.  |
| Safety X   | Determine conditions that influence changes in strategies.   |
| Mobility   | Obtain information on decisions at grade crossings from motorists making poor decisions at crossings.  |
| Global Connectivity                                | Determine countermeasures that can be implemented on basis of research.  |
| Environmental Stewardship                          |  |
| Security   |  |
| 5. Relationship to Current Research:               | X__ New __ Supplemental (list organization & title of current research)  |
| 6. Potential Benefits of Identified Research Need: | New countermeasures and educational tools can be created to reduce accidents and improve the safety of grade crossings.  |
| 7. Research Need Urgency:                          | _X_ High __ Medium __ Low  |
| 8. Cost of Research:                               | __ High > \$500,000 _X_ Medium = \$100,000 to \$500,000 __ Low < \$100,000   |
| 9. Potential Organization to Conduct Research:     | FRA  |
| 10. Ease of Implementation:                        | __ Easy __ Medium _X_ Difficult  |
| 11. Applicability to High-Speed Rail Service:      | _X_ Yes __ No  |
| 12. Other Comments:                                |  |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

- |   |  |
|---|--|
| 1. Topic Area/Number:                             | <b>HF–11</b>   |
| 2. Title:   | Evaluation Strategies for Improving the Implementation, Utilization, Effectiveness, and Impact of Grade Crossing Research in the U.S. Rail Industry  |
| 3. Problem Statement:                             | Numerous pilot grade crossing research projects are being implemented in the railroad industry, with little or no evaluation to help improve broad industry-wide utilization, effectiveness, and positive impact. Critical success factors must be identified for each stakeholder group and systematically addressed to improve broad level impact and effectiveness. |
| 4. Research Objectives:                           | Clearly identify different stakeholder user groups for each specific project implementation, and assess their needs for that project.  |
| Safety X  | Define current, intended, and potential uses of that project for each stakeholder group.   |
| Mobility  | Identify both intended and unintended consequences of possible broad level implementation for that project.  |
| Global Connectivity                               | Clearly identify data requirements, information sources, and resources needed to support these activities and broad level implementation, utilization, effectiveness, and impact.  |
| Environmental Stewardship                         | Develop and define intended outcomes (short term and intermediate) that directly link project activities and outputs to long-term goals of impact and effectiveness.   |
| Security  | Develop outcome measures and indicators for each outcome defined.<br>Criteria to include specificity, relevance, and measurability.<br>Confirm current and proposed activities support intended short term and intermediate outcomes.<br>Develop utilization strategies.   |
| 5. Relationship to Current Research               | <input checked="" type="checkbox"/> New <input type="checkbox"/> Supplemental (list organization & title of current research)  |
| 6. Potential Benefits of Identified Research Need | Increased likelihood project activities and outputs will lead to intended outcomes.<br>Increased utilization of resources.<br>Broader impact and effectiveness.  |
| 7. Research Need Urgency                          | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low  |
| 8. Cost of Research                               | <input type="checkbox"/> High > \$500,000 <input type="checkbox"/> Medium = \$100,000 to \$500,000 <input checked="" type="checkbox"/> Low < \$100,000   |
| 9. Potential Organization to Conduct Research     | RAND Corporation, the Performance Institute  |
| 10. Ease of Implementation                        | <input type="checkbox"/> Easy <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Difficult  |
| 11. Applicability to High-Speed Rail Service      | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  |
| 12. Other Comments                                | Contractor must have experience and expertise in the field of program evaluation.  |



## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

- |  |  |
|--|--|
| 1. Topic Area/Number:                              | <b>HF-12</b>   |
| 2. Title:  | Development and Implementation of a Highway-Rail Intersection<br>HF Research Results Database  |
| 3. Problem Statement:                              | The need was identified to develop and implement a searchable database of past and current research on human factors at highway-rail intersections. This database would include all relevant areas of research that have been conducted where driver behavior and human factors exist or have been discussed. The variety of issues and areas under human factors within HRI safety is quite broad. It includes areas such as driver behavior, driver risk and performance, conspicuity of traffic control devices, etc. |
| 4. Research Objectives:                            | Objectives of this research include: (1) make accessible and reduce learning time to researchers and practitioners in HRI research; (2) identify a single location to minimize search time for this broad body of knowledge while focusing resources; and (3) enhance overall safety through broader consistent learning by users without duplicating projects where this knowledge is known and by building on the knowledge database.  |
| Safety (1)   |  |
| Mobility   |  |
| Global Connectivity                                |  |
| Environmental<br>Stewardship                       |  |
| Security   |  |
| 5. Relationship to Current Research:               | <input checked="" type="checkbox"/> New <input type="checkbox"/> Supplemental (list organization & title of current research)  |
| 6. Potential Benefits of Identified Research Need: | See research objectives. Also, (1) lack of duplication in research; (2) quicker dissemination of knowledge; (3) ability to identify new, better approaches.  |
| 7. Research Need Urgency:                          | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low  |
| 8. Cost of Research:                               | <input type="checkbox"/> High > \$500,000 <input type="checkbox"/> Medium = \$100,000 to \$500,000 <input checked="" type="checkbox"/> Low < \$100,000   |
| 9. Potential Organization to Conduct Research:     | FRA, FHWA  |
| 10. Ease of Implementation:                        | <input checked="" type="checkbox"/> Easy <input type="checkbox"/> Medium <input type="checkbox"/> Difficult  |
| 11. Applicability to High-Speed Rail Service:      | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  |
| 12. Other Comments:                                | TRB A3A05 Web site has an annotated bibliography that could be used as a basis for starting design of this database.   |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–HF

- |  |   |
|--|---|
| 1. Topic Area/Number:                              | <b>HF–13</b>  |
| 2. Title:  | Collection of Data to Assess Likely Conditions for Rail Suicide/Trespassing   |
| 3. Problem Statement:                              | The increase of trespasser fatalities and suicides on rail lines compel the collection of data (place, time of day, and orientation of area to the larger community) to identify location and conditions and therefore prevent future occurrences.  |
| 4. Research Objectives:                            | Collect information on locations, time of day, and relationship of problem area to the larger surrounding community.  |
| Safety X   |   |
| Mobility   | Develop prevention programs to use with community groups and local law enforcement agencies to implement.   |
| Global Connectivity                                | Gather demographic information to develop profiles of high-risk groups of trespassers.  |
| Environmental Stewardship                          |   |
| Security X   | Coordinate data gathered with security prevention programs.   |
| 5. Relationship to Current Research:               | __ New __XX_ Supplemental (list organization & title of current research)<br><br>Transport Canada/D2006   |
| 6. Potential Benefits of Identified Research Need: | Decrease the occurrence of trespasser fatalities.<br><br>Decrease the incidence of critical incidents for train crews and other railroad employees.<br><br>Improve the overall safety of railroad operations vis-à-vis the local community.   |
| 7. Research Need Urgency:                          | __XX_ High __ Medium __ Low   |
| 8. Cost of Research:                               | __ High > \$500,000 __XX_ Medium = \$100,000 to \$500,000 __ Low < \$100,000  |
| 9. Potential Organization to Conduct Research:     | FRA   |
| 10. Ease of Implementation:                        | __XX_ Easy __ Medium __ Difficult   |
| 11. Applicability to High-Speed Rail Service:      | __XX_ Yes __ No   |
| 12. Other Comments:                                | Trespasser fatalities are one of the fastest growing categories of incidents in the rail industry. Moreover, these incidents have indirect and negative impacts on train crews and other railroad employees. Train crews and other personnel may also be harmed psychologically by being involved in, witnessing, and/or responding to these incidents. |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–HF

1. Topic Area/Number: **HF-14**
2. Title: Assess Trauma of Railroad Employees
3. Problem Statement: Train and engine crews as well as other railroad employees, such as signalmen and maintenance-of-way workers, constitute the “second victim” when grade crossing and trespassing fatalities take place. These employees may be at risk for post-traumatic stress syndrome. Currently, no procedures or policies exist for addressing the potential health needs of these employees.
4. Research Objectives:
 

Determine the frequency and severity of health-related problems among railroad employees who have experienced critical incidents in the performance of their duties.

Safety X

Mobility Develop a method/procedure for connecting people needing service with providers.

Global Connectivity

Environmental Identify a standard procedure for responding to employees who have been involved in these incidents.

Stewardship

Security
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FRA
6. Potential Benefits of Identified Research Need: The goal is to ensure that safety-critical employees do not operate equipment when they are not fit for duty because of possible impairment as a result of experiencing a traumatic incident.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

### 3.3.3 STP

Table 20 identifies the delegates responsible for identifying high-urgency research needs in the STP topic area.

**Table 20. STP Delegates**

Name	Organization
Rhonda Crawley (Co-Team Leader)	FTA
Anya Carroll (Co-Team Leader)	Volpe Center
Alvin Richardson	Amtrak
Bill Fleming	MBTA
Brent Ogden	Korve Engineering
David Skinner	Volpe Center
Judith Gertler	Foster-Miller, Inc.
Len Allen	FRA
Linda Meadow	Linda J. Meadow & Associates
Marco daSilva	Volpe Center
R. Andrew Davis	Quixote
Robert Dorer	Volpe Center
Jon Anderson (Facilitator)	EG&G Technical Services, Inc.

Table 21 lists the nine high-urgency research needs identified, analyzed, and evaluated by the STP working group. A one-page research need statement for each of these STP items follows.

**Table 21. High-Urgency STP Research Needs**

Priority No.	Topic No.	Research Need Title
20	STP-3a	Pedestrian Decision Tree—Review Available Technology Applications
42		Securing Multimodal Rail Infrastructure
21		Obstacle/Intrusion Detection—Technology Survey
47		Develop Performance Measures to Improve Security and Decrease Risk
45		DHS/TSA/FEMA Emergency Preparedness Coordination with FRA
48		Cell Phone and Communication Availability—ID Technology/Emergency Protocols
49		Credentialing of Transportation Employees
46		Detect Chemical, Biological, Nuclear, and Explosive Materials
43		Define Safe Hazmat Transport Issues at Grade Crossings

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area / Number: **STP-03a**
2. Title: Pedestrian Decision Tree–Review Available Technology Applications
3. Problem Statement: Review all available pedestrian technology application decision trees. Include a review of the draft pedestrian decision tree developed by Korve engineers. Develop a synthesis of information report.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
TCRP 69
6. Potential Benefits of Identified Research Need: Reduction of injuries and fatalities to pedestrians. Increased cost effectiveness of grade crossing deployments of treatments.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low < \$100,000
9. Potential Organization to Conduct Research: FTA/FRA/FHWA
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP-05a**
2. Title: **Securing Multimodal Rail Infrastructure**
3. Problem Statement: **Conduct comprehensive threat and vulnerability assessment. Review literature of seaport and freight port perimeter and container security. Monitor Congressional activity of DOT reauthorization of Safe, Accountable, Flexible and Efficient Transportation Equity Act (SAFETEA) for port-specific, multimodal funding for new research, development, and deployment.**
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity ☒ X
  - Environmental Stewardship ☒ X
  - Security ☒ X
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: **Protection of infrastructure assets. Enhancing safety and mobility within the transportation network. Protection of the affected communities.**
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☒ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: **TSA/FTA/FRA/FHWA**
10. Ease of Implementation: ☐ Easy ☐ Medium ☒ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP-06a**
2. Title: Obstacle/Intrusion Detection–Technology Survey
3. Problem Statement: Perform a technology survey to identify currently available technology for intrusion detection, including sensors and computer-image processing. On the basis of previous studies conducted by the FRA and the FTA, revisit the technology available to detect intruders on the rail network. Develop a synthesis of information report. Begin a move toward treatment of railroad track like an airport runway. Review new MBTA Silver Line detection equipment as a supplemental case study.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security ☒ X
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FRA/Volpe/FTA
6. Potential Benefits of Identified Research Need: Reduction of intrusion on rail ROW. Reduce collateral damage to systems, facilities, and communities.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low < \$100,000
9. Potential Organization to Conduct Research: FRA
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–STP

1. Topic Area/Number: **STP-14**
2. Title: Develop Performance Measures to Improve Security and Decrease Risk
3. Problem Statement: Conduct a security measure review of literature, methodology, and processes in use at the Department of Homeland Security (DHS), the Transportation Security Administration (TSA), and all DOT modes since September 11, 2001. Develop performance measures to improve security and decrease risk. Include cost-effectiveness measures of technology applications to determine if the expense is worth the investment. Estimate number of lives saved by technologies and their value.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☒ X New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Improved security and reduced risk. Maintain continuity of service. Protection of critical assets.
7. Research Need Urgency: ☒ X High ☐ Medium ☐ Low
8. Cost of Research: ☒ X High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: DHS/TSA/FTA/FRA/FHWA
10. Ease of Implementation: ☐ Easy ☒ X Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ X Yes ☐ No
12. Other Comments:



## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP–17**
2. Title: DHS/TSA/FEMA Emergency Preparedness Coordination with FRA
3. Problem Statement: Establish a process for coordination of security emergency preparedness drills. Ensure that FRA is included in any emergency drill planning and execution. Also, include FRA in any policy, rulemaking, or guidance related to emergency preparedness and execution.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FTA
6. Potential Benefits of Identified Research Need: Enhanced emergency response and minimized damage and speed recovery after security breach events on the rail network.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA/FTA
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP–18a**
2. Title:  
Protocols Cell Phone and Communication Availability–ID Technology/Emergency
3. Problem Statement: Review current state-of-the-art technologies for cell phones and telecommunication devices and their use in emergency situations. Identify technologies and protocols to provide continuity and interoperability of cell phone communication before and during an incident from all locations. Examine the introduction of redundant hardware or equipment to ensure continuous telecommunication functioning during a calamity or terrorist strike.
4. Research Objectives:
- Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity ☒ X
  - Environmental Stewardship
  - Security ☒ X
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Reduce injuries, fatalities, and collateral damage. Restore system operations more effectively.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☒ Low < \$100,000
9. Potential Organization to Conduct Research: FTA/FRA
10. Ease of Implementation: ☒ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP–19**
2. Title: Credentialing of Transportation Employees
3. Problem Statement: Develop standard practices and protocols for credentialing and authenticating bona fide Federal, State, and local transportation employees. Special care will be taken to ensure conspicuity of badges.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FTA
6. Potential Benefits of Identified Research Need: Reduce trespassing and intrusion on railroad right of way (ROW). Reduce collateral damage to systems, facilities, and communities.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☒ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: TSA/FTA/FR/FHWA
10. Ease of Implementation: ☐ Easy ☐ Medium ☒ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP–20a**
2. Title: Detect Chemical, Biological, Nuclear, and Explosive Materials
3. Problem Statement: Assess available technologies to detect chemical, biological, nuclear, and explosive materials. Explore the use of technology transfer from military projects. Assess Hazmat threat of incidents and exposure at grade crossings based on the major DOT/Research and Innovative Technology Administration (RITA) placarded chemical and explosive material.
4. Research Objectives:
  - Safety
  - Mobility X
  - Global Connectivity X
  - Environmental Stewardship X
  - Security X
5. Relationship to Current Research: \_\_\_ New \_\_\_X\_ Supplemental (list organization & title of current research)  
DOD/DOE/DHS/TSA/FTA
6. Potential Benefits of Identified Research Need: Minimize damage and speed recovery. Save lives.
7. Research Need Urgency: \_\_\_X\_ High \_\_\_ Medium \_\_\_ Low
8. Cost of Research: \_\_\_ High > \$500,000 \_\_\_X\_ Medium = \$100,000 to \$500,000 \_\_\_ Low < \$100,000
9. Potential Organization to Conduct Research: FTS/FRA
10. Ease of Implementation: \_\_\_ Easy \_\_\_X\_ Medium \_\_\_ Difficult
11. Applicability to High-Speed Rail Service: \_\_\_X\_ Yes \_\_\_ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–STP

1. Topic Area/Number: **STP–22a**
2. Title: Define Safe Hazmat Transport Issues at Grade Crossings
3. Problem Statement: Define issues related to transportation of spent nuclear fuel and other hazardous materials (hazmat) through grade crossings on the rail network. The opening of Yucca Mountain for disposal of spent nuclear fuel requires FRA assessment. A study is required to obtain information about the project. Review Yucca Mountain Environmental Impact Statement to determine what grade crossing research has already been conducted and what further safety measures can be implemented. Assess Hazmat threat of incidents and exposure at grade crossings based on the major DOT/RITA placarded chemical and explosive material. Ensure the secure shipment of spent nuclear fuel along the rail network nationwide, including grade crossing safety and security issues.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity ☒ X
  - Environmental Stewardship ☒ X
  - Security ☒ X
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Enhanced emergency response. Minimize damage and speed recovery. Prevent or reduce loss of life and property damage.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA/FTA
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☐ No
12. Other Comments:

### 3.3.4 DGS

Table 22 lists the delegates responsible for identifying high-urgency research needs in the DGS topic area.

**Table 22. DGS Delegates**

Brian Bowman (Team Leader)	Auburn University
Daniel Brod	Decision Tek
Frank Saccomanno	University of Waterloo, Canada
Gary Baker	Volpe Center
Jerry Powers	Volpe Center
Marsha Haines	EG&G Technical Services, Inc.
Pamela Caldwell-Foggin	FRA, Office of Safety
Raphael Kedar	FRA, Office of Safety
Robert Gnadt	Lambda Tech International
Ron Mathieu	Southern California Regional Rail Authority
Steve Berki	Union Pacific Railroad
Steve Laffey	Illinois Commerce Commission
Susan Kirkland	Ohio Rail Development Commission
Suzanne Sposato	Volpe Center
Marilyn Mullane (Facilitator)	Volpe Center

Table 23 lists the three high-urgency research needs identified, analyzed, and evaluated by the DGS working group. A one-page research need statement for each of these DGS items follows.

**Table 23. High-Urgency DGS Research Needs**

<b>7</b>		Crossing Inventory
<b>37</b>		Using the Web to Advance Safety Initiatives
<b>41</b>		Synthesis of Current Grade Crossing Analyses

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–DGS

1. Topic Area/Number: **DGS-01**
2. Title: Crossing Inventory
3. Problem Statement: Consistency is lacking among states and railroads in updating the FRA Grade Crossing Inventory where new technologies have the potential for increased spatial accuracy and data utility. This research need improves accuracy and utility of the inventory by resolving:
- a) Crossing inventory database accuracy: 1) ascertain accuracy of the FRA database; 2) establish corrective update strategy; and 3) determine feasibility of performing a dump update of the entire database.
  - b) Frequency of data update: How often or what trigger should exist to update equipment, volume, profile, approach photos, etc., at grade crossings.
  - c) Data needs: Ascertain total data needs to be collected: 1) identify collective end product users; 2) build structure of elements to be collected and perimeters of level of accuracy; and 3) break elements into levels-collecting agency can choose funding available.
  - d) Web-based FRA inventory update: Feasibility of performing real-time electronic updates to the crossing inventory.
4. Research Objectives:
- Safety X Will provide a tool to better allocate funding, identify countermeasures.
  - Mobility X A tool to improve highway and rail mobility.
  - Global Connectivity X Will enable nationwide mapping capabilities through geographic information systems (GIS) elements.
  - Security X Will provide accurate grade crossing information pertinent to establishing emergency evacuation routes.
5. Relationship to Current Research: \_\_\_ New ☒ Supplemental (list organization & title of current research) (Old 1995 D-3)
6. Potential Benefits of Identified Research Need: Save lives, reduce costs, and provide accurate working platform.
7. Research Need Urgency: ☒ High \_\_\_ Medium \_\_\_ Low
8. Cost of Research: ☒ High > \$500,000 \_\_\_ Medium = \$100,000 to \$500,000 \_\_\_ Low < \$100,000
9. Potential Organization to Conduct Research: Federal – FRA/FHWA (Volpe)
10. Ease of Implementation: \_\_\_ Easy ☒ Medium \_\_\_ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes \_\_\_ No
12. Other Comments: This research effort should be combined with the data and GIS research need “Linking of Diverse Data Elements (Priority #2)”.

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–DGS

1. Topic Area/Number: **DGS-03**
2. Title: Using the Web to Advance Safety Initiatives
3. Problem Statement: The Web provides a medium for obtaining data and furthering education in the grade crossing safety arena. Ideas include, but are not limited to: 1) reports of active device damage from the public (similar to 800 numbers); 2) notice of crossing closure due to repair to the public; 3) gathering or correcting data fields in grade crossing database; and 4) exploring the use of the Web to facilitate public outreach. This research project would determine the cost/benefit of Web site applications.
4. Research Objectives:
- Safety ☒ Will provide the traveling public the opportunity to give quick notice of improperly operating active warning devices and the notice of crossings that are experiencing greater crash potential.
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security
5. Relationship to Current Research: ☐ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Improved data  
Increased public awareness  
Build partnerships  
Disseminate information  
Connect with young adults and children
7. Research Need Urgency: ☐ High ☐ Medium ☐ Low
8. Cost of Research: ☒ High > \$500,000 ☐ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: Federal, state, and local, NGO
10. Ease of Implementation: ☐ Easy ☐ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☒ No
12. Other Comments: The goal of the effort is for the researcher to explore the Web and assess its potential for increasing grade crossing safety and information dissemination. Inspiration came from Canada's program.



## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–DGS

1. Topic Area/Number: **DGS-05**
2. Title: Synthesis of Current Grade Crossing Analyses
3. Problem Statement: This research need is intended to identify what States, Federal agencies, metropolitan planning organizations, and railroads have developed with respect to grade crossing analyses. For example, to identify the studies published and internally conducted in the areas of grade crossing safety, homeland security, and environmental impacts (noise and emissions, etc.). These studies will be evaluated and aggregated to allow other agencies to benefit from the research results.
4. Research Objectives:
  - Safety ☒ X
  - Mobility ☒ X
  - Global Connectivity ☒ X
  - Environmental Stewardship ☒ X
  - Security ☐
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: Collect and review previous efforts to evaluate grade crossings in the document to demonstrate/illustrate the successes other states/agencies/locals have had. Focus on States/locals and railroads.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: University research centers
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments: This will be a more intensive effort than that typically funded from NCHRP's Synthesis Program since states, local governments, and private companies will need to be contacted.

### 3.3.5 DPE

Table 24 lists the delegates responsible for identifying high-urgency research needs in the DPE topic area.

**Table 24. DPE Delegates**

Gerri Hall (Team Leader)	OLI
Dominick Bua	TranSystems Corporation
Fred Fraini	FRA–Region I
Gary Drouin	TC
Jim Bendell	Naperville Police Department
Kate Chang	EG&G Technical Services, Inc.
Lois Keck	Keck & Associates
Louis-Paul Tardif	L-P Tardif & Associates, Canada
Patrick Bien-Aime	Volpe Center
Steve Popkin	Volpe Center
Tim DePaepe	Brotherhood of Railroad Signalmen
Linda Sharpe (Facilitator)	Cambridge Systematics

Table 25 lists the three high-urgency research needs identified, analyzed, and evaluated by the DPE working group. A one-page research need statement for each of these DPE items follows.

**Table 25. High-Urgency DPE Research Needs**

<b>17</b>		Information Dissemination to Transportation Professionals: 1. Advanced Technology; 2. North American Traffic Laws
<b>33</b>		Innovative Training for Law Enforcement
<b>44</b>		Educational Programs and Outreach Assessment

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–DPE

1. Topic Area/Number: **DPE-02**
2. Title: Information Dissemination to Transportation Professionals:  
1. Advanced Technology; 2. North American Traffic Laws
3. Problem Statement:
1. The first goal is to promote awareness of new technologies, practices, and findings to transportation engineering, design, and operations personnel. Existing mechanisms do not ensure that transportation engineers receive current design standards. What needs to be added to their education? What barriers exist to the cross flow of information between traffic/transportation engineers and ITS/technology communities?
  2. The second goal is to ensure that information on international practices and variations in North American laws and regulations is disseminated to appropriate transportation professionals.
4. Research Objectives:
- Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security ☒ X
5. Relationship to Current Research: ☒ New ☐ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need:
- More effective application of engineering and technological advances for design and upgrades of grade crossing/trespass control.
  - More application of advanced technology for law enforcement.
  - Better compliance with traffic laws.
  - Ultimately, better laws that are more uniform across North America.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA, FTA, FHWA, Federal Motor Carrier Safety Administration (FMCSA)
10. Ease of Implementation: ☒ (1) Easy ☐ Medium ☒ (2) Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–DPE

1. Topic Area/Number: **DPE-03**
2. Title: Innovative Training for Law Enforcement
3. Problem Statement: This is an ongoing need since 1995. Activities under this research need include:  
  
Assess effectiveness of current efforts.  
  
Survey of practices and innovative methods (e.g., use of the Internet) or increasing law enforcement awareness, including judges and prosecutors.  
  
Develop strategies for including new and existing grade crossing training into academy curricula for new recruits and in continuing education.
4. Research Objectives
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security ☒ X
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FRA/OLI/International Association of Chiefs of Police (IACP)
6. Potential Benefits of Identified Research Need: More effective law enforcement for grade crossing/trespass control.  
  
Greater awareness of community safety implications of grade crossing and trespassing violations/security issues.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA, FTA
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–DPE

1. Topic Area/Number: **DPE-04**
2. Title: Educational Programs and Outreach Assessment
3. Problem Statement: This is an ongoing need since 1995. Activities under this research need include:  
  
Survey all related programs.  
  
Assess impact and effectiveness of current programs, materials, and outreach methods related to grade crossings, including short- and long-term impacts.  
  
Determine what media, message style, methods, formats, locations, etc., are most appropriate for age groups and other demographic and attitudinal characteristics.  
  
Identify and test nontraditional outreach activities.  
  
Use the Internet as a tool for measurement of program impact.
4. Research Objectives:
  - Safety ☒ X
  - Mobility
  - Global Connectivity
  - Environmental Stewardship
  - Security ☒ X
5. Relationship to Current Research: ☐ New ☒ Supplemental (list organization & title of current research)  
FRA/OLI
6. Potential Benefits of Identified Research Need: More effective educational programs to reduce risk-taking behavior and adverse effects
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research:
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☐ Yes ☐ No
12. Other Comments:

### 3.3.6 ITS/PTC

Table 26 lists the delegates responsible for identifying high-urgency research needs in the ITS/PTC topic area.

**Table 26. ITS/PTC Delegates**

Jim Smailes (Team Leader)	FRA
Andy Palanisamy	Jet Propulsion Laboratories
Bill Moore Ede	CANAC, Inc.
George Casey	United Transportation Union
Gopal Samavedam	Foster-Miller, Inc.
James Cheeks	Institute of Transportation Engineers
Jo Strang	FRA
Lee Fu	University of Waterloo/Canada
Steve Ditmeyer	FRA, Office of Research and Development
Steven Peck	Volpe Center
Terrell Williams	FTA
Uwe Rutenberg	Rutenberg Design Inc., Canada
Jane Saks (Facilitator)	EG&G Technical Services, Inc.

Table 27 lists the four high-urgency research needs identified, analyzed, and evaluated by the ITS/PTC working group. A one-page research need statement for each of these ITS/PTC items follows.

**Table 27. High-Urgency ITS/PTC Research Needs**

<b>18</b>		Improve Risk Assessment Models
<b>19</b>		Identify Data Needs and Requirements for Information Flows Between Railroad Centers, Highway Centers, Railroad Users, and Highway Users
<b>29</b>		Identify the Functional and Safety Requirements for Highway-Rail Grade Crossing ITS Applications
<b>39</b>		IVI

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–ITS/PTC

1. Topic Area/Number: **ITS/PTC-02**
2. Title: Improve Risk Assessment Models
3. Problem Statement:
 

Improve current risk assessment models to reflect ITS systems installed at crossings.

Improve current risk assessment models to reflect heavy commercial vehicles.

Improve current risk assessment models to reflect hazmat/nuclear materials being carried by the train or highway vehicle.

Improve current risk assessment models to reflect “humped” crossings.
4. Research Objectives:
 

Evaluate existing statistical data to determine extent of problem.

Safety Identify high-risk areas, specific high-risk crossings, and highway traffic and railroad characteristics.

Security
5. Relationship to Current Research ☐ New ☒ Supplemental (list organization & title of current research)
6. Potential Benefits of Identified Research Need: (Relate to Strategic Plan) Improved allocation of resources for investment based on estimated hazards.
7. Research Need Urgency: ☒ High ☐ Medium ☐ Low
8. Cost of Research: ☐ High > \$500,000 ☒ Medium = \$100,000 to \$500,000 ☐ Low < \$100,000
9. Potential Organization to Conduct Research: FRA, Volpe
10. Ease of Implementation: ☐ Easy ☒ Medium ☐ Difficult
11. Applicability to High-Speed Rail Service: ☒ Yes ☐ No
12. Other Comments:

## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–ITS/PTC

- |   |  |
|---|--|
| 1. Topic Area / Number:   | <b>ITS/PTC-03</b>  |
| 2. Title:   | Identify Data Needs and Requirements for Information Flows Between Railroad Centers, Highway Centers, Railroad Users, and Highway Users  |
| 3. Problem Statement:   | <p>Railroads have a need for highway information and vice versa.</p> <p>Required as a prerequisite to developing a concept of operations.</p> <p>Required as a component of the ITS Strategic Plan's development and implementation.</p> |
| 4. Research Objectives:   | Identify the railroad information needed for highway activities and vice versa.  |
| Safety  | Identify possible sources of the aforementioned information.   |
| Mobility  | Identify existing examples of information exchange.  |
| Multiple Systems Connectivity   | Investigate information gaps.  |
| Security  | Goals: To achieve seamless information flow, identify possible low-cost demonstration projects/opportunities.  |
| 5. Relationship to Current Research:  | <input type="checkbox"/> New <input checked="" type="checkbox"/> Supplemental (list organization & title of current research)  |
| 6. Potential Benefits of Identified Research Need: (Relate to Strategic Plan) | <p>Seamless exchange of information between rail and highway agencies.</p> <p>Potential reduction in accidents.</p> <p>Potential reduction in motorist delay and reduced emissions.</p>  |
| 7. Research Need Urgency:   | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low  |
| 8. Cost of Research:  | <input type="checkbox"/> High > \$500,000 <input checked="" type="checkbox"/> Medium = \$100,000 to \$500,000 <input type="checkbox"/> Low < \$100,000   |
| 9. Potential Organization to Conduct Research:                                | American Association of State Highway and Transportation Officials (AASHTO)/ITE, FRA, AAR/American Public Transportation Association (APTA), FHWA JPO  |
| 10. Ease of Implementation:   | <input type="checkbox"/> Easy <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Difficult  |
| 11. Applicability to High-Speed Rail Service:                                 | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  |
| 12. Other Comments:   |  |



## 2003 Highway-Rail Grade Crossing Research Needs Workshop

### Research Needs–ITS/PTC

- |  |  |
|--|--|
| 1. Topic Area/Number:  | <b>ITS/PTC–05</b>  |
| 2. Title:  | Identify the Functional and Safety Requirements for Highway-Rail Grade Crossing ITS Applications   |
| 3. Problem Statement:  | <p>Many potential applications exist for ITS at highway-rail grade crossings, but they have not yet been quantified from a functional standpoint or the requirements examined to meet public safety.</p> <p>Such new systems must be cost effective.</p> <p>Safety-related requirements would require fail-safe design, failure mode analysis, and specific response to/and reporting of failures/problems.</p> <p>A structure is required to deal with liability and implementation agreement issues.</p> |
| 4. Research Objectives:  | Provide a framework for all future test and demonstration projects.  |
| Safety   | Develop a consistent methodology to evaluate new and different technologies.   |
| Mobility   |  |
| Multiple Systems Connectivity  |  |
| Security   |  |
| 5. Relationship to Current Research:   | <input checked="" type="checkbox"/> New <input type="checkbox"/> Supplemental (list organization & title of current research)  |
| 6. Potential Benefits of Identified Research Need: (Relate to Strategic Plan): | Essential foundation for future ITS applications in the railroad industry involving highway-rail grade crossings.  |
| 7. Research Need Urgency:  | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low  |
| 8. Cost of Research:   | <input type="checkbox"/> High > \$500,000 <input checked="" type="checkbox"/> Medium = \$100,000 to \$500,000 <input type="checkbox"/> Low < \$100,000   |
| 9. Potential Organization to Conduct Research:                                 | ITS and railroad communities   |
| 10. Ease of Implementation:  | <input type="checkbox"/> Easy <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Difficult  |
| 11. Applicability to High-Speed Rail Service:                                  | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  |
| 12. Other Comments:  |  |

## 2003 Highway-Rail Grade Crossing Research Needs Workshop Research Needs–ITS/PTC

- |  |   |
|--|---|
| 1. Topic Area/Number:  | <b>ITS/PTC-06</b>   |
| 2. Title:  | Interface with IVI  |
| 3. Problem Statement:  | <p>Research is needed to show the potential advantages of using IVI technologies at highway-rail grade crossings.</p> <p>Develop inventory of ITS equipment on commercial vehicles.</p> <p>Involve FMCSA/NHTSA.</p> |
| 4. Research Objectives:  | <p>Research is needed to show the potential advantages of using IVI technologies at highway-rail grade crossings.</p> <p>Safety</p> <p>Mobility</p> <p>Multiple Systems<br/>Connectivity</p> <p>Security</p>        |
| 5. Relationship to Current Research:   | <input type="checkbox"/> New <input checked="" type="checkbox"/> Supplemental (list organization & title of current research)   |
| 6. Potential Benefits of Identified Research Need:<br>(Relate to Strategic Plan) | <p>Integrate systems that are currently available or under development under the IVI.</p> <p>Eliminates the need for redundant communications links.</p>  |
| 7. Research Need Urgency:  | <input checked="" type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low   |
| 8. Cost of Research:   | <input type="checkbox"/> High > \$500,000 <input checked="" type="checkbox"/> Medium = \$100,000 to \$500,000 <input type="checkbox"/> Low < \$100,000  |
| 9. Potential Organization to Conduct Research:                                   | FRA, Consultants, FHWA, FMCSA, NHTSA  |
| 10. Ease of Implementation:  | <input type="checkbox"/> Easy <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Difficult   |
| 11. Applicability to High-Speed Rail Service:                                    | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No   |
| 12. Other Comments:  |   |

### 3.4 Summary of Ballot Results

The workshop working groups provided a final set of 49 main research needs across the six concentration areas. The 49 topics were included in a voting ballot, which was provided to each of the attendees after the workshop. Nine topics had additional associated research items from different topic areas of concentration, creating an additional 17 separate research items to consider. An example of an additional item is CIP-08, Pedestrian Treatments at Highway-Rail Crossings and Undercrossings, in the ninth priority position. This item is associated with STP, resulting in four added items listed as STP-01a, b, c, and d (see Appendix F in Volume II).

Table 28 shows the distribution of the 49 high-urgency research needs categorized by topic area. The distribution shows the largest amount of research needs (16 identified needs or 33 percent) in the CIP topic area, followed by the HF area (14 identified needs or 29 percent), the STP area (9 identified needs or 18 percent), and the DGS and DPE areas (3 identified needs or 6 percent each). Finally, ITS/PTC received 4 identified needs (8 percent).

**Table 28. Distribution of High-Urgency Research Needs by Topic Area**

CIP	16 (33%)
HF	14 (29%)
STP	9 (18%)
DGS	3 (6%)
DPE	3 (6%)
ITS/PTC	4 (8%)
<b>TOTAL</b>	<b>49</b>

The balloting process resulted in a prioritized list of high-urgency research needs across all topic areas. Table 29 lists the ranked high-urgency research needs for the 2003 workshop.

**Table 29. 2003 High-Urgency Research Needs Listed by Ballot Priority Rank**

1	CIP-02	Establish Standards for States Regarding Elimination/Consolidation of At-Grade Crossings
2	CIP-09	Pre-Signal Design Criteria and Warrants
3	HF-10	Driver Decisionmaking at Grade Crossings
4	CIP-22	Replacement Criteria for Older Grade Crossing Warning Devices
5	HF-02	Enhancing Driver Risk Perception at Grade Crossings: Evaluating and Standardizing
6	CIP-27	Innovative Low-Cost Grade Separation (Vehicle and Pedestrian)
7	DGS-01	Crossing Inventory
8	CIP-04	Wheelchair Crossing Flangeway Gaps at Grade Crossings
9	CIP-08	Pedestrian Treatments at Highway-Rail Crossings/Undercrossings*
10	CIP-01	Develop Limited Access Rail Lines
11	CIP-18	Effectiveness of Incentives for Closures, Including Cost Analysis
12	HF-07	Determining Driver Decisionmaking at Grade Crossings: A Survey of Accident Survivors*
13	HF-06	Development of Near-Miss Data through Compilation of Elements from Various Sources
14	CIP-07	Provision of Warning to Motorists at Highway-Rail Grade Crossings Where Remote Control Train Operations Are in Effect
15	HF-03	Develop Leading Indicators That Contribute to Accidents
16	CIP-16	Common Corridor Usage (LRT/Freight) and How It Relates to Grade Crossings
17	DPE-04	Educational Programs and Outreach Assessment
18	ITS/PTC-05	Identify the Functional and Safety Requirements for Highway-Rail Grade Crossing ITS Applications
19	ITS/PTC-03	Identify Data Needs and Requirements for Information Flows Between Railroad Centers, Highway Centers, Railroad Users, and Highway Users
20	STP-03a	Pedestrian Decision Tree–Review Available Technology Applications
21	STP-06a	Obstacle/Intrusion Detection–Technology Survey*
22	HF-08	Development of New Form for Reporting Trespassing Fatalities/Incidents
23	CIP-24	Highway Median Barriers
24	HF-04	Needs Assessment for Emergency Response Teams*
25	HF-13	Collection of Data to Assess Likely Conditions for Rail Suicide/Trespassing
26	CIP-14	Standards for Signals for LRT Street Running Systems
27	HF-05	Comprehensive Model of Driver Behavior/Countermeasures Assessment
28	CIP-21	Vehicle Queuing at Grade Crossings Adjacent to Stop Sign-Controlled Intersections
29	ITS/PTC-06	IVI
30	CIP-13	Effectiveness and Application of Simultaneous versus Advanced Preemption
31	CIP-05	Performance Criteria for Use of LEDs in Flashing Light Devices at Highway-Rail Grade Crossings
32	HF-11	Evaluation Strategies for Improving the Implementation, Utilization, Effectiveness, and Impact of Grade Crossing Research in the U.S. Rail Industry
33	DPE-03	Innovative Training for Law Enforcement
34	HF-12	Development and Implementation of a Highway-Rail Intersection HF Research Results Database
35	HF-14	Assess Trauma of Railroad Employees
36	HF-09	Best Research Practices to Conduct HF Research in Highway-Rail Research
37	DGS-03	Using the Web to Advance Safety Initiatives
38	CIP-10	Modify Design of Existing Railroad Crossing Warning Devices
39	ITS/PTC-02	Improve Risk Assessment Models
40	HF-01	Context Evaluation: Developing a Consensus-Based Approach for Establishing Grade Crossing Research Guidelines and Standards in the U.S. Rail Industry
41	DGS-05	Synthesis of Current Grade Crossing Analyses
42	STP-05a	Securing Multimodal Rail Infrastructure*
43	STP-22a	Define Safe Hazmat Transport Issues at Grade Crossings*
44	DPE-02	Information Dissemination to Transportation Professionals

**Table 29. 2003 High-Urgency Research Needs Listed by Ballot Priority (continued)**

<b>45</b>	STP-17	DHS/TSA/FEMA Emergency Preparedness Coordination with FRA
<b>46</b>	STP-20a	Detect Chemical, Biological, Nuclear, and Explosive Materials*
<b>47</b>	STP-14	Develop Performance Measures to Improve Security and Decrease Risk
<b>48</b>	STP-18a	Cell Phone and Communication Availability–ID Technologies/Emergency Protocols*
<b>49</b>	STP-19	Credentialing of Transportation Employees

\*Research topics with associated research programs.

### 3.5 Summary of High-Urgency Research Needs

The 2003 Research Needs Workshop resulted in the identification of 113 research needs across six topic areas. After consolidating several research areas, the balloting process identified 49 high-urgency needs. Identified research needs support the continued development of a grade crossing research agenda that will allow FRA to make R&D decisions that are consistent with industry needs. The identified research needs will also enable FRA to select research projects that will have the greatest benefit for the highway-rail grade crossing community.

The CIP topic area continued to be of key interest and contained a large number of the identified high-urgency needs. Some recurring needs included pedestrian crossings and Americans with Disabilities Act (ADA) accessibility, audible warnings, and barrier devices. The HF topic area identified needs concerned with motor vehicle drivers and visual and audio warnings, as well as crossing gate and light technology to reduce grade crossing incidents. Pedestrian trespassing measures at highway-rail grade crossings also continued to be a high priority. New STP requirements included infrastructure security, emergency preparedness/security awareness, and hazmat concerns. The number of high-urgency needs in the DGS area was less than the 1995 workshop; however, crossing inventory and crash data needs continued to be a priority and a means of linking varied data elements. The availability, accuracy, and usefulness of grade crossing incident data, including pedestrian and trespass data requirements, complement trespass needs in the STP and DGS topic areas. GIS and Internet-based data collection systems have been identified as methods to advance safety initiatives in the area of DGS. Innovative technologies, such as video conferencing, kiosks, online services, and CD-ROM presentations, were identified as a means to streamline DPE efforts within public agencies, grade crossing practitioners, and the public. Enforcement activities and their effectiveness on reducing grade crossing incidents also continue to be high-urgency needs in this area. The ITS/PTC area focused on those needs associated with developing intelligent railroad systems that include IVI initiatives, testing train control system, and incorporating new digital communications technologies.

## **4. Discussion and Analysis of Identified Needs**

### **4.1 Priority Research Needs Statement Data Sorts**

Research need statements provided several pieces of information for each identified need. This section presents the results of those statements in a series of tables sorted by the following key factors: cost, ease of implementation, research objectives, relationship to previous research, organization performing current research, potential organization for performance of newly identified research, and applicability to high-speed rail.

Table 30 lists the high-urgency research needs by cost.

**Table 30. High-Urgency Research Needs Listed by Cost**

	Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives	Relationship to Current Research
<b>8 High Cost (over \$500,000) 16.3%</b>	7	DGS-01	High	Medium	Safety/Mobility/GC /Security	Supplemental
	8	CIP-04	High	Medium	Safety/Mobility	New
	13	HF-06	High	Difficult	Safety/Security	New
	37	HF-05	High	Difficult	Safety/Security	Supplemental
	42	DGS-03	High	Easy	Safety	New
	47	STP-05a [STP-05b-c]	High	Difficult	Safety/Mobility/GC/ES /Security	New
	49	STP-14	High	Medium	Safety/Mobility	New
	2	STP-19		Difficult	Safety/Mobility	Supplemental
<b>27 Medium Cost (over \$100,000) 55.1%</b>	3	CIP-09		Easy	Safety	New
	4	HF-10		Difficult	Safety	New
	5	CIP-22		Difficult	Safety	New
	6	HF-02		Medium	Safety	Supplemental
	10	CIP-27		Medium	Safety	Supplemental
	11	CIP-01		Medium	Safety	New
	12	CIP-18		Medium	Safety/Mobility/GC	New
	14	HF-07 [DPE-01]		Medium	Safety	New
	17	CIP-07		Medium	Safety	New
	18	DPE-04		Medium	Safety/Security	Supplemental
	19	ITS/PTC-05		Difficult	-	New
	24	ITS/PTC-03		Difficult	-	Supplemental
	25	HF-04 [STP-21]		Medium	Safety	New
	28	HF-13		Easy	-	Supplemental
	29	CIP-21		Medium	Safety	New
	30	ITS/PTC-06		Medium	-	Supplemental
	33	CIP-13		Medium	Safety	New
	35	DPE-03		Medium	Safety/Security	Supplemental
	36	HF-14		Easy	Safety	Supplemental
	38	HF-09		Medium	Safety	New
	39	CIP-10		Easy	Safety	New
	41	ITS/PTC-02		Medium	Safety/Security	Supplemental
	43	DGS-05		Medium	Safety/Mobility/GC/ES	New
	44	STP-22a [STP-22b-c]		Medium	Safety/Mobility/GC/ ES/Security	New
	45	DPE-02		-	Safety/Security	New
	46	STP-17		Medium	Safety/Mobility	Supplemental
	1	STP-20a [STP-20b-c]		Medium	Mobility/GC/ES/Security	Supplemental
<b>12 Low Cost (Under \$100,000) 24.5%</b>	16	CIP-02		Difficult	Safety	New
	20	CIP-16		Medium	Safety/Mobility	New
	21	STP-03a [STPb-c]		Easy	Safety/Mobility	Supplemental
	22	STP-06a [STP06-b]		Easy	Safety/Mobility/Security	Supplemental
	23	HF-08		Difficult	Safety/Mobility/Security	New
	26	CIP-24		Easy	Safety	Supplemental
	27	CIP-14		Easy	Safety/Mobility	New
	31	CIP-05		Easy	Safety	Supplemental
	32	HF-11		Difficult	Safety	New
	34	HF-12		Easy	Safety	New
	40	HF-01		Medium	Safety	New
	48	STP-18a [STP-18b-c]		Easy	Safety/Mobility/GC /Security	New
<b>2 No Cost Information 4.1%</b>	9	CIP-08 [STP-01a-d]		-	Safety	New
	15	HF-03		Medium	Safety	New

Table 31 presents a list of the high-urgency research needs sorted by ease of implementation categories.

**Table 31. High-Urgency Research Needs Listed by Ease of Implementation**

	Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives	Relationship to Current Research
<b>11 Difficult Research Needs Ease to Implement (22.4%)</b>	1	CIP-02	Low	Difficult	Safety	New
	3	HF-10	Medium	Difficult	Safety	New
	4	CIP-22	Medium	Difficult	Safety	New
	13	HF-06	High	Difficult	Safety/Security	New
	18	ITS/PTC-05	Medium	Difficult	-	New
	19	ITS/PTC-03	Medium	Difficult	-	Supplemental
	22	HF-08	Low	Difficult	Safety/Mobility/Security	New
	27	HF-05	High	Difficult	Safety/Security	Supplemental
	32	HF-11	Low	Difficult	Safety	New
	42	STP-05a [STP-05b-c]	High	Difficult	Safety/Mobility/GC/ES /Security	New
<b>24 Medium Research Needs Ease to Implement (49%)</b>	49	STP-19	High		Safety/Mobility	Supplemental
	5	HF-02	Medium		Safety	Supplemental
	6	CIP-27	Medium		Safety	Supplemental
	7	DGS-01	High		Safety/Mobility/GC /Security	Supplemental
	8	CIP-04	High		Safety/Mobility	New
	10	CIP-01	Medium		Safety	New
	11	CIP-18	Medium		Safety/Mobility/GC	New
	12	HF-07 [DPE-01]	Medium		Safety	New
	14	CIP-07	Medium		Safety	New
	15	HF-03	-		Safety	New
	16	CIP-16	Low		Safety/Mobility	New
	17	DPE-04	Medium		Safety/Security	Supplemental
	24	HF-04 [STP-21]	Medium		Safety	New
	28	CIP-21	Medium		Safety	New
	29	ITS/PTC-06	Medium		-	Supplemental
	30	CIP-13	Medium		Safety	New
	33	DPE-03	Medium		Safety/Security	Supplemental
	36	HF-09	Medium		Safety	New
	39	ITS/PTC-02	Medium		Safety/Security	Supplemental
	40	HF-01	Low		Safety	New
	41	DGS-05	Medium		Safety/Mobility/GC/ES	New
	43	STP-22a [STP-22b-c]	Medium		Safety/Mobility/GC/ES /Security	New
	45	STP-17	Medium		Safety/Mobility	Supplemental
	46	STP-20a [STP-20b-c]	Medium		Mobility/GC/ES /Security	Supplemental
	47	STP-14	High		Safety/Mobility	New
<b>12 Research Needs Ease to Implement (24.5%)</b>	2	CIP-09	Medium		Safety	New
	20	STP-03a [STPb-c]	Low		Safety/Mobility	Supplemental
	21	STP-06a [STP06-b]	Low		Safety/Mobility/Security	Supplemental
	23	CIP-24	Low		Safety	Supplemental
	25	HF-13	Medium		-	Supplemental
	26	CIP-14	Low		Safety/Mobility	New
	31	CIP-05	Low		Safety	Supplemental
	34	HF-12	Low		Safety	New
	35	HF-14	Medium		Safety	Supplemental
	37	DGS-03	High		Safety	New
	38	CIP-10	Medium		Safety	New
	48	STP-18a [STP-18b-c]	Low		Safety/Mobility/GC/ Security	New
<b>2 No Information (4%)</b>	9	CIP-08 [STP-01a-d]	-		Safety	New
	44	DPE-02	Medium		Safety/Security	New



Table 32 presents a list of the high-urgency research needs sorted by research objectives.

**Table 32. High-Urgency Research Needs Listed by Research Objectives**

	Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives	Relationship to Current Research
<b>23 Safety Research Needs (47%)</b>	1	CIP-02	Low	Difficult	Safety	New
	2	CIP-09	Medium	Easy	Safety	New
	3	HF-10	Medium	Difficult	Safety	New
	4	CIP-22	Medium	Difficult	Safety	New
	5	HF-02	Medium	Medium	Safety	Supplemental
	6	CIP-27	Medium	Medium	Safety	Supplemental
	9	CIP-08 [STP-01a-d]	-	-	Safety	New
	10	CIP-01	Medium	Medium	Safety	New
	12	HF-07 [DPE-01]	Medium	Medium	Safety	New
	14	CIP-07	Medium	Medium	Safety	New
	15	HF-03	-	Medium	Safety	New
	23	CIP-24	Low	Easy	Safety	Supplemental
	24	HF-04 [STP-21]	Medium	Medium	Safety	New
	28	CIP-21	Medium	Medium	Safety	New
	30	CIP-13	Medium	Medium	Safety	New
	31	CIP-05	Low	Easy	Safety	Supplemental
	32	HF-11	Low	Difficult	Safety	New
	34	HF-12	Low	Easy	Safety	New
	35	HF-14	Medium	Easy	Safety	Supplemental
	36	HF-09	Medium	Medium	Safety	New
	37	DGS-03	High	Easy	Safety	New
	38	CIP-10	Medium	Easy	Safety	New
	40	HF-01	Low	Medium		New
<b>7 Safety and Mobility Research Needs (14%)</b>	8	CIP-04	High	Medium		New
	16	CIP-16	Low	Medium		New
	20	STP-03a [STPb-c]	Low	Easy		Supplemental
	26	CIP-14	Low	Easy		New
	45	STP-17	Medium	Medium		Supplemental
	47	STP-14	High	Medium		New
	49	STP-19	High	Difficult		Supplemental
<b>8 Multiobjective Research Needs (16%)</b>	41	DGS-05	Medium	Medium		New
	42	STP-05a [STP-05b-c]	High	Difficult		New
	43	STP-22a [STP-22b-c]	Medium	Medium		New
	48	STP-18a [STP-18b-c]	Low	Easy		New
	11	CIP-18	Medium	Medium		New
	7	DGS-01	High	Medium		Supplemental
	21	STP-06a [STP06-b]	Low	Easy		Supplemental
	13	HF-06	High	Difficult		New
<b>6 Safety and Security Research Needs (12%)</b>	17	DPE-04	Medium	Medium		Supplemental
	27	HF-05	High	Difficult		Supplemental
	33	DPE-03	Medium	Medium		Supplemental
	39	ITS/PTC-02	Medium	Medium		Supplemental
	44	DPE-02	Medium	-		New
	22	HF-08	Low	Difficult		New
<b>1 Mobility, GC, Environmental Stewardship, and Security (2%)</b>	46	STP-20a [STP-20b-c]	Medium	Medium		Supplemental
<b>4 No Information (8%)</b>	18	ITS/PTC-05	Medium	Difficult		New
	19	ITS/PTC-03	Medium	Difficult		Supplemental
	25	HF-13	Medium	Easy		Supplemental
	29	ITS/PTC-06	Medium	Medium		Supplemental

Table 33 presents a list of high-urgency research needs by relationship to current research.

**Table 33. High-Urgency Research Needs Listed by Relationship to Current Research**

	Priority No.	Topic No.	Cost Range H, M, or L	Ease of Implementation	Research Objectives	Relationship to Current Research
<b>31 New Research Needs (63.3%)</b>	1	CIP-02	Low	Difficult	Safety	New
	2	CIP-09	Medium	Easy	Safety	New
	3	HF-10	Medium	Difficult	Safety	New
	4	CIP-22	Medium	Difficult	Safety	New
	8	CIP-04	High	Medium	Safety/Mobility	New
	9	CIP-08 [STP-01a-d]	-	-	Safety	New
	10	CIP-01	Medium	Medium	Safety	New
	11	CIP-18	Medium	Medium	Safety/Mobility/GC	New
	12	HF-07 [DPE-01]	Medium	Medium	Safety	New
	13	HF-06	High	Difficult	Safety/Security	New
	14	CIP-07	Medium	Medium	Safety	New
	15	HF-03	-	Medium	Safety	New
	16	CIP-16	Low	Medium	Safety/Mobility	New
	18	ITS/PTC-05	Medium	Difficult	-	New
	22	HF-08	Low	Difficult	Safety/Mobility/Security	New
	24	HF-04 [STP-21]	Medium	Medium	Safety	New
	26	CIP-14	Low	Easy	Safety/Mobility	New
	28	CIP-21	Medium	Medium	Safety	New
	30	CIP-13	Medium	Medium	Safety	New
	32	HF-11	Low	Difficult	Safety	New
	34	HF-12	Low	Easy	Safety	New
	36	HF-09	Medium	Medium	Safety	New
	37	DGS-03	High	Easy	Safety	New
	38	CIP-10	Medium	Easy	Safety	New
	40	HF-01	Low	Medium	Safety	New
	41	DGS-05	Medium	Medium	Safety/Mobility/GC/ES	New
	42	STP-05a [STP-05b-c]	High	Difficult	Safety/Mobility/GC/ES/Security	New
	43	STP-22a [STP-22b-c]	Medium	Medium	Safety/Mobility/GC/ES/Security	New
	44	DPE-02	Medium	-	Safety/Security	New
	47	STP-14	High	Medium	Safety/Mobility	New
	48	STP-18a [STP-18b-c]	Low	Easy	Safety/Mobility/GC/Security	
<b>18 Supplemental Research Needs (36.7%)</b>	5	HF-02	Medium	Medium	Safety	
	6	CIP-27	Medium	Medium	Safety	
	7	DGS-01	High	Medium	Safety/Mobility/GC/Security	
	17	DPE-04	Medium	Medium	Safety/Security	
	19	ITS/PTC-03	Medium	Difficult	-	
	20	STP-03a [STPb-c]	Low	Easy	Safety/Mobility	
	21	STP-06a [STP06-b]	Low	Easy	Safety/Mobility/Security	
	23	CIP-24	Low	Easy	Safety	
	25	HF-13	Medium	Easy	-	
	27	HF-05	High	Difficult	Safety/Security	
	29	ITS/PTC-06	Medium	Medium	-	
	31	CIP-05	Low	Easy	Safety	
	33	DPE-03	Medium	Medium	Safety/Security	
	35	HF-14	Medium	Easy	Safety	
	39	ITS/PTC-02	Medium	Medium	Safety/Security	
	45	STP-17	Medium	Medium	Safety/Mobility	
	46	STP-20a [STP-20b-c]	Medium	Medium	Mobility/GC/ES/Security	
	49	STP-19	High	Difficult	Safety/Mobility	

Table 34 presents a list of the high-urgency research needs by organization performing current research.

**Table 34. High-Urgency Research Needs Listed by Organization Performing Current Research**

	Priority No.	Topic No.	Organization of Current Research and/or Title	Potential Research Organization	Applicability to High-Speed Rail
13 Research Needs with Organization of Current Research (26.5%)	44	DPE-02	2 Problem Statements	FRA/FTA/FHWA	-
	19	ITS/PTC-03	AASHTO/ITE, FRA, AAR/APTA, FHWA JPO	See notes	Yes
	29	ITS/PTC-06	FHWA/FMCSA/NHTSA	FRA/Consult	Yes
	35	HF-14	FRA	FRA	Yes
	27	HF-05	FRA/FHWA	FRA Lead	Yes
	17	DPE-04	FRA/OLI	-	-
	33	DPE-03	FRA/OLI/IACP	FRA/FTA	-
	21	STP-06a [STP06-b]	FRA/Volpe/FTA	FRA	Yes
	49	STP-19	FTA	TSA/FTA/FRA/FHWA	Yes
	7	DGS-01	Old '95 D-3	FRA/FHWA	Yes
	20	STP-03a [STPb-c]	TCRP 69	FTA/FRA/FHWA	Yes
	31	CIP-05	TC, "LED Technology for Improved Conspicuity of Signal Lights at Highway/Railroad Grade Crossings"	-	Yes
	25	HF-13		FRA	Yes
36 Research Needs with No Organization of Current Research (73.5%)	1	CIP-02		-	Yes
	2	CIP-09		FHWA/FRA	Yes
	3	HF-10		FRA	Yes
	4	CIP-22		RR/FHWA/FRA	Yes
	5	HF-02		FRA	-
	6	CIP-27		FRA/TC	Yes
	8	CIP-04		-	Yes
	9	CIP-08 [STP-01a-d]		FHWA	Yes
	10	CIP-01		-	Yes
	11	CIP-18		-	Yes
	12	HF-07 [DPE-01]		FHWA/FRA	Yes
	13	HF-06		FRA	Yes
	14	CIP-07		Consortium	Yes
	15	HF-03		FRA	Yes
	16	CIP-16		-	No
	18	ITS/PTC-05		ITS/RR Comm.	Yes
	22	HF-08		FRA	Yes
	23	CIP-24		FHWA	Yes
	24	HF-04 [STP-21]		FRA/FHWA/FTA	Yes
	26	CIP-14		-	No
	28	CIP-21		-	Yes
	30	CIP-13		-	Yes
	32	HF-11		Rand Corp/PI	Yes
	34	HF-12		FRA/FHWA	Yes
	36	HF-09		FHWA/FRA	Yes
	37	DGS-03		Federal/State/Local	No
	38	CIP-10		-	Yes
	39	ITS/PTC-02		FRA/Volpe	Yes
	40	HF-01		FRA	Yes
	41	DGS-05		University Research	Yes
	42	STP-05a [STP-05b-c]		TSA/FTA/FRA/FHWA	Yes
	43	STP-22a [STP-22b-c]		FRA/FTA	-
	45	STP-17		FRA/FTA	Yes
	46	STP-20a [STP-20b-c]		DOD/DOE/DHS/TSA	Yes
	47	STP-14		DHS/TSA/FTA	Yes
	48	STP-18a [STP-18b-c]		FTA/FRA	Yes

Table 35 presents a list of the high-urgency research needs by potential research organization.

**Table 35. High-Urgency Research Needs Listed by Potential Research Organization**

	Priority No.	Topic No.	Organization of Current Research and/or Title	Potential Research Organization	Applicability to High-Speed Rail
<b>38 Research Needs with Potential Research Organization (78%)</b>	14	CIP-07	-	Consortium	Yes
	47	STP-14	-	DHS/TSA/FTA	Yes
	46	STP-20a [STP-20b-c]	-	DOD/DOE/DHS/TSA	Yes
	37	DGS-03	-	Federal/State/Local	No
	9	CIP-08 [STP-01a-d]	-	FHWA	Yes
	23	CIP-24	-	FHWA	Yes
	2	CIP-09	-	FHWA/FRA	Yes
	12	HF-07 [DPE-01]	-	FHWA/FRA	Yes
	36	HF-09	-	FHWA/FRA	Yes
	3	HF-10	-	FRA	Yes
	5	HF-02	-	FRA	-
	13	HF-06	-	FRA	Yes
	15	HF-03	-	FRA	Yes
	21	STP-06a [STP06-b]	FRA/Volpe/FTA	FRA	Yes
	22	HF-08	-	FRA	Yes
			TC, "LED Technology for Improved Conspicuity of Signal Lights at Highway Railroad Grade Crossings"		
	25	HF-13	FRA	FRA	Yes
	35	HF-14	FRA	FRA	Yes
	40	HF-01	-	FRA	Yes
	45	STP-17	-	FRA/FTA	Yes
	27	HF-05	FRA/FHWA	FRA Lead	Yes
	29	ITS/PTC-06	FHWA/FMCSA/NHTSA	FRA/Consult	Yes
	7	DGS-01	Old '95 D-3	FRA/FHWA	Yes
	34	HF-12	-	FRA/FHWA	Yes
	24	HF-04 [STP-21]	-	FRA/FHWA/FTA	Yes
	33	DPE-03	FRA/OLI/IACP	FRA/FTA	-
	43	STP-22a [STP-22b-c]	-	FRA/FTA	-
	44	DPE-02	2 Problem Statements	FRA/FTA/FHWA	-
	6	CIP-27	-	FRA/TC	Yes
	39	ITS/PTC-02	-	FRA/Volpe	Yes
	48	STP-18a [STP-18b-c]	-	FTA/FRA	Yes
	20	STP-03a [STPb-c]	TCRP 69	FTA/FRA/FHWA	Yes
	18	ITS/PTC-05	-	ITS/RR Comm.	Yes
	32	HF-11	-	Rand Corp/PI	Yes
	4	CIP-22	-	RR/FHWA/FRA	Yes
	19	ITS/PTC-03	AASHTO/ITE, FRA, AAR/APTA, FHWA JPO	See Notes	Yes
	49	STP-19	FTA	TSA/FTA/FRA/FHWA	Yes
	42	STP-05a [STP-05b-c]	-	TSA/FTA/FRA/FHWA	Yes
	41	DGS-05	-		Yes
<b>11 Research Needs with No Potential Research Organization (22%)</b>	1	CIP-02	-		Yes
	8	CIP-04	-		Yes
	10	CIP-01	-		Yes
	11	CIP-18	-		Yes
	16	CIP-16	-		No
	17	DPE-04	FRA/OLI		-
	26	CIP-14	-		No
	28	CIP-21	-		Yes
	30	CIP-13	-		Yes
			TC, "LED Technology for Improved Conspicuity of Signal Lights at Highway/Railroad Grade Crossings"		
	31	CIP-05			Yes
	38	CIP-10	-		Yes

Table 36 presents a list of the high-urgency research needs sorted by applicability to high-speed rail service.

**Table 36. High-Urgency Research Needs Listed by Applicability to High-Speed Rail**

	Priority No.	Topic No.	Organization of Current Research and/or Title	Potential Research Organization	Applicability to High-Speed Rail
<b>41 Research Needs Applicable to High-Speed Rail (83.7%)</b>	<b>1</b>	CIP-02	-	-	Yes
	<b>2</b>	CIP-09	-	FHWA/FRA	Yes
	<b>3</b>	HF-10	-	FRA	Yes
	<b>4</b>	CIP-22	-	RR/FHWA/FRA	Yes
	<b>6</b>	CIP-27	-	FRA/TC	Yes
	<b>7</b>	DGS-01	Old '95 D-3	FRA/FHWA	Yes
	<b>8</b>	CIP-04	-	-	Yes
	<b>9</b>	CIP-08 [STP-01a-d]	-	FHWA	Yes
	<b>10</b>	CIP-01	-	-	Yes
	<b>11</b>	CIP-18	-	-	Yes
	<b>12</b>	HF-07 [DPE-01]	-	FHWA/FRA	Yes
	<b>13</b>	HF-06	-	FRA	Yes
	<b>14</b>	CIP-07	-	Consortium	Yes
	<b>15</b>	HF-03	-	FRA	Yes
	<b>18</b>	ITS/PTC-05	-	ITS/RR Comm.	Yes
	<b>19</b>	ITS/PTC-03	AASHTO/ITE, FRA, AAR/APTA, FHWA JPO	See Notes	Yes
	<b>20</b>	STP-03a [STPb-c]	TCRP 69	FTA/FRA/FHWA	Yes
	<b>21</b>	STP-06a [STP06-b]	FRA/Volpe/FTA	FRA	Yes
	<b>22</b>	HF-08	-	FRA	Yes
	<b>23</b>	CIP-24	-	FHWA	Yes
	<b>24</b>	HF-04 [STP-21]	-	FRA/FHWA/FTA	Yes
	<b>25</b>	HF-13	TC, "LED Technology for Improved Conspicuity of Signal Lights at Highway/Railroad Grade Crossings"	FRA	Yes
	<b>27</b>	HF-05	FRA/FHWA	FRA Lead	Yes
	<b>28</b>	CIP-21	-	-	Yes
	<b>29</b>	ITS/PTC-06	FHWA/FMCSA/NHTSA	FRA/Consult	Yes
	<b>30</b>	CIP-13	-	-	Yes
	<b>31</b>	CIP-05	TC, "LED Technology for Improved Conspicuity of Signal Lights at Highway/Railroad Grade Crossings"	-	Yes
	<b>32</b>	HF-11	-	Rand Corp/PI	Yes
	<b>34</b>	HF-12	-	FRA/FHWA	Yes
	<b>35</b>	HF-14	FRA	FRA	Yes
	<b>36</b>	HF-09	-	FHWA/FRA	Yes
	<b>38</b>	CIP-10	-	-	Yes
	<b>39</b>	ITS/PTC-02	-	FRA/Volpe	Yes
	<b>40</b>	HF-01	-	FRA	Yes
	<b>41</b>	DGS-05	-	University Research	Yes
	<b>42</b>	STP-05a [STP-05b-c]	-	TSA/FTA/FRA/FHWA	Yes
	<b>45</b>	STP-17	-	FRA FTA	Yes
	<b>46</b>	STP-20a [STP-20b-c]	-	DOD/DOE/DHS/TSA	Yes
	<b>47</b>	STP-14	-	DHS/TSA/FTA	Yes
	<b>48</b>	STP-18a [STP-18b-c]	-	FTA/FRA	Yes
	<b>49</b>	STP-19	FTA	TSA/FTA/FRA/FHWA	

**Table 36. High-Urgency Research Needs Listed by Applicability to High-Speed Rail  
(continued)**

<b>3 Research Needs Not Applicable to High-Speed Rail (6.1%)</b>	<b>16</b>	CIP-16	-	-	
	<b>26</b>	CIP-14	-	-	
	<b>37</b>	DGS-03	-	Federal/State/Local	
<b>5 Research Needs with No Information (10.2%)</b>	<b>5</b>	HF-02	-	FRA	
	<b>17</b>	DPE-04	FRA/OLI	-	
	<b>33</b>	DPE-03	FRA/OLI/IACP	FRA/FTA	
	<b>43</b>	STP-22a [STP-22b-c]	-	FRA/FTA	
	<b>44</b>	DPE-02	2 Problem Statements	FRA/FTA/FHWA	

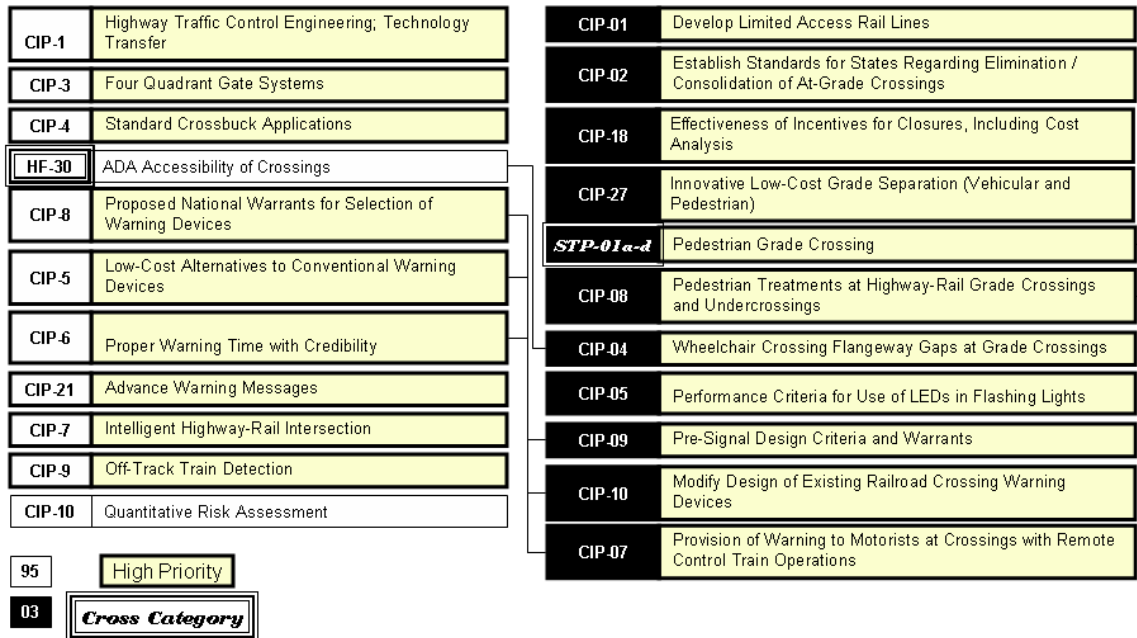
#### 4.2 Comparison of 1995 and 2003 Research Needs

This section presents a series of diagrams highlighting the research needs from the 1995 and 2003 Research Needs Workshops. Comparing the resulting needs of the two workshops illustrates the evolution of the grade crossing field and major trends or themes within the field.

The 1995 research needs are shown in bold text against a white background. The 2003 research needs are shown in white text against a black background. A heavy, bold line borders the high-priority needs identified in the 1995 and 2003 workshops. The diagrams highlight the needs from the 1995 workshop that were continued at the 2003 workshop. They also illustrate how research-need priorities have changed. The connecting lines between needs indicate a relationship within and across topic areas. Working groups produced need statements relating to other topics; these are indicated by italicized text.

Figure 6 illustrates that median barriers and low-cost crossing device methods are still a priority in the CIP area. Audible warnings did not reach priority status. Pedestrian treatments are a priority in the STP and CIP topic areas.

## CIP



**Figure 6. Comparison of 1995 and 2003 CIP Needs**

## CIP, continued

<b>HF-14A</b>	Train Horns		
<b>HF-14B</b>	Wayside Horns		
<b>CIP-11</b>	Audible Warning at Crossings		
<b>CIP-2</b>	Highway Median Barriers		
<b>CIP-19</b>	Low-Cost Intrusion Barriers		
<b>CIP-12</b>	Identification of Institutional Impediments to Grade Crossing Improvements		
<b>CIP-13</b>	Signal Status Monitoring		
<b>CIP-14</b>	Light Rail / Commuter Rail Pedestrian Gates		
<b>CIP-15</b>	ADA Compliance for Pedestrian Crossings		
<b>CIP-16</b>	Sight Distance Evaluation		
<b>CIP-17</b>	Innovative Low-Cost Grade Separation		
<b>CIP-18</b>	Video Monitoring/Detection System		
<b>CIP-20</b>	Humpback Crossing		
<b>HF-26</b>	More Effective Crossing Gates		
<b>D-9</b>	Foreign Experience with Warning Devices		
		<b>HF-23</b>	Use of Audible Warnings
		<b>CIP-13</b>	Effectiveness and Application of Simultaneous versus Advance Preemption
		<b>CIP-14</b>	Standards for Signals for LRT Street Running Systems
		<b>CIP-16</b>	Common Corridor Usage (LRT/Freight) and How It Relates to Grade Crossings
		<b>CIP-21</b>	Vehicle Queuing at Grade Crossings Adjacent to Stop Sign-Controlled Intersections
		<b>CIP-24</b>	Highway Median Barriers
		<b>CIP-22</b>	Replacement Criteria for Older Grade Crossing Warning Devices
		<b>CIP-11</b>	Work Zone Protection / Temporary Traffic Control Near Highway/Rail Grade Crossings
		<b>CIP-12</b>	Compilation of Public Relations Efforts in Crossing Closures
		<b>CIP-15</b>	Treatment of Multi-Use (Bike) Trails Crossing Adjacent to Highway-Rail Intersections
		<b>CIP-17</b>	Directional Transmission of Audible Warnings (Train Horn and Bell) in Quiet Zones
		<b>CIP-19</b>	Grade Crossing Clearinghouse Education
		<b>CIP-20</b>	Guidance on Demonstration Programs
		<b>CIP-03</b>	Four Quadrant Gates
		<b>CIP-06</b>	In-Roadway Lights as a Supplemental Safety Device
		<b>CIP-23</b>	Supplemental Audible Warning for High-Speed Rail and Second Train
		<b>CIP-25</b>	Standard Crossbuck Application
		<b>CIP-26</b>	Low-Cost Alternatives to Conventional Warning Devices

95

High Priority

03

Cross Category

Figure 6. Comparison of 1995 and 2003 CIP Needs (continued)



Figure 7 shows several HF research needs that were carried forward to the 2003 Research Needs Workshop. These included accident causation, accident effects, and driver risk perception. ADA concerns have gained priority. Although carried over, the audible-warning research need did not make the priority list.

## HF at Grade Crossings

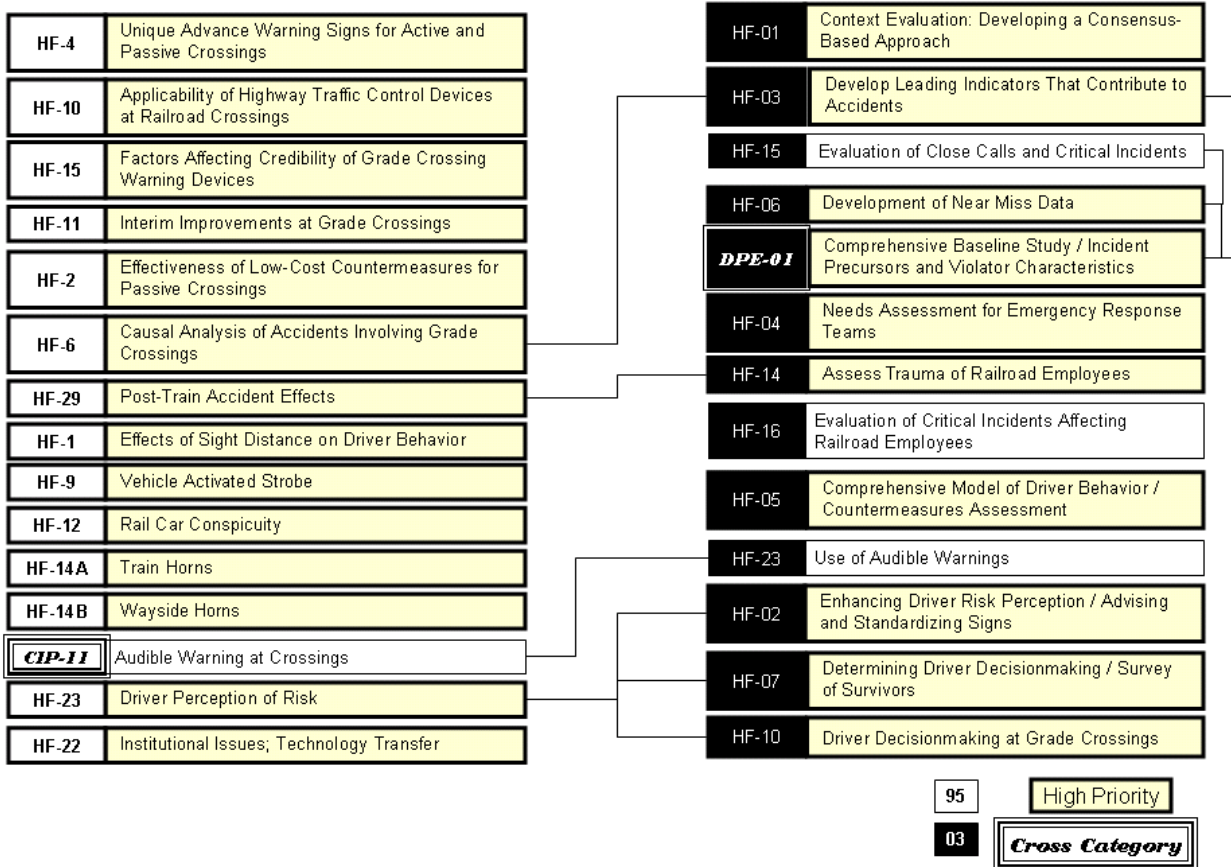
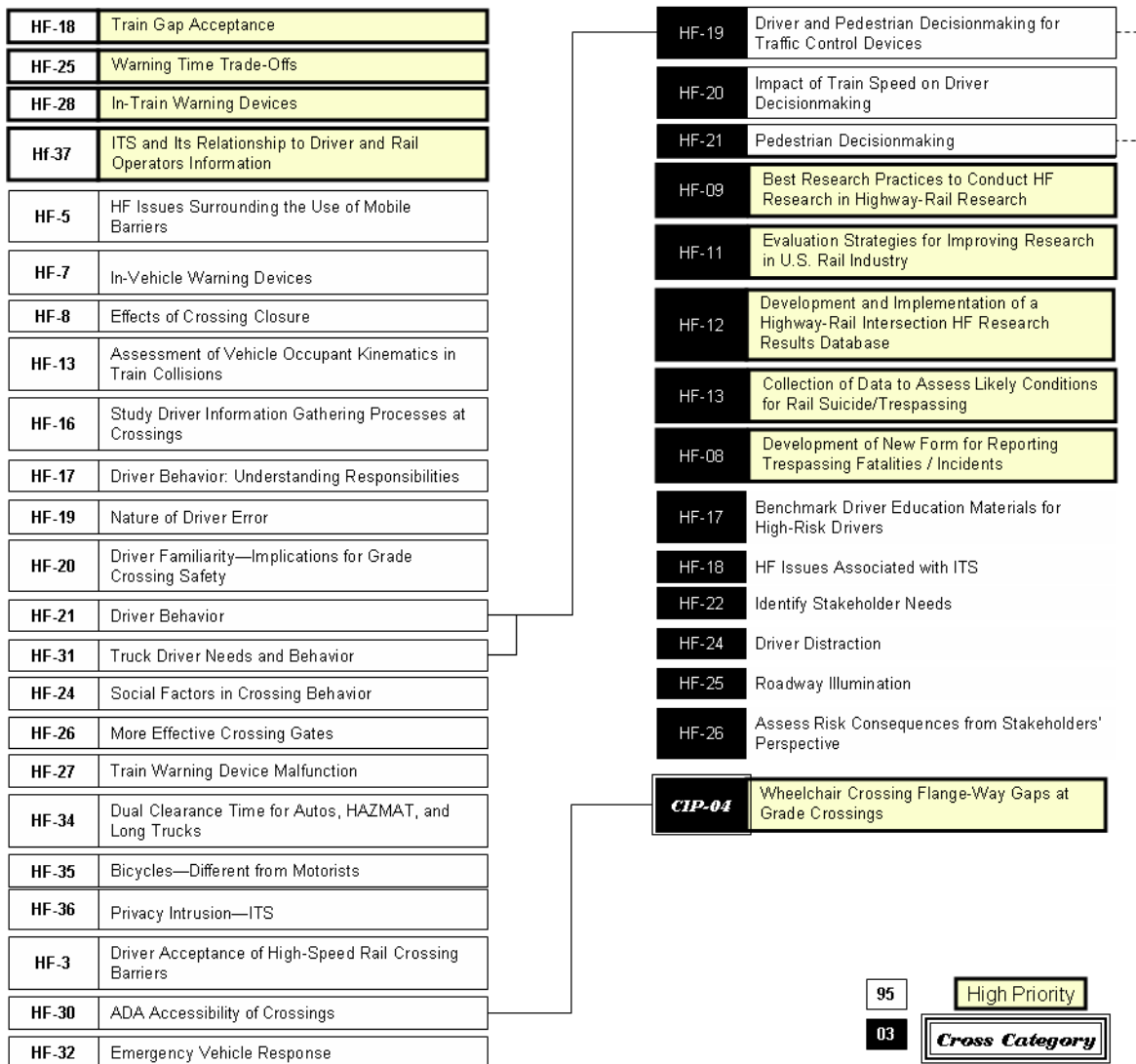


Figure 7. Comparison of 1995 and 2003 HF Needs

## HF at Grade Crossings, continued



**Figure 7. Comparison of 1995 and 2003 HF Needs (continued)**

Figure 8 illustrates that, although the STP topic area was new for 2003, related research also existed in other topic areas from the 1995 workshop.

## STP

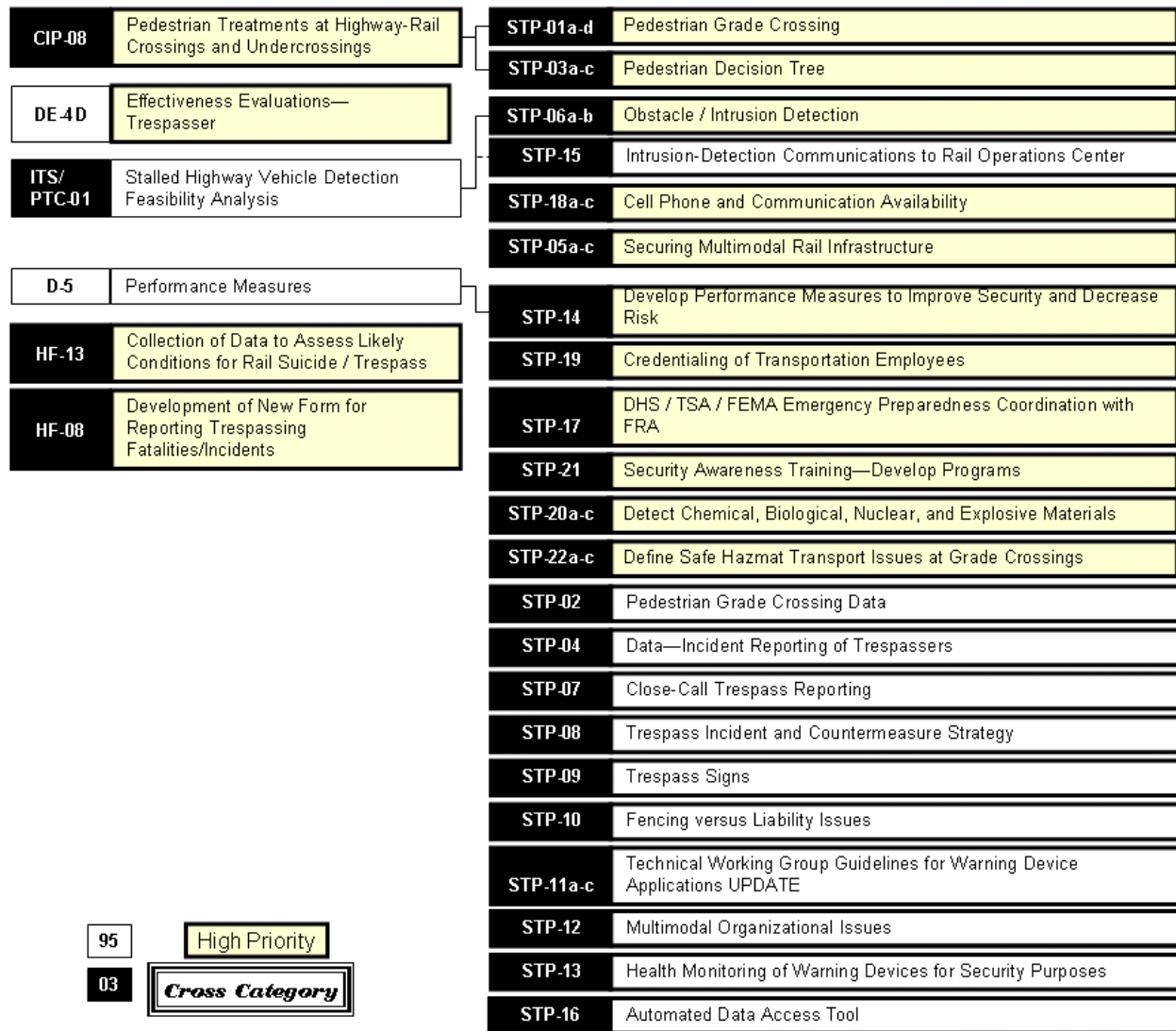
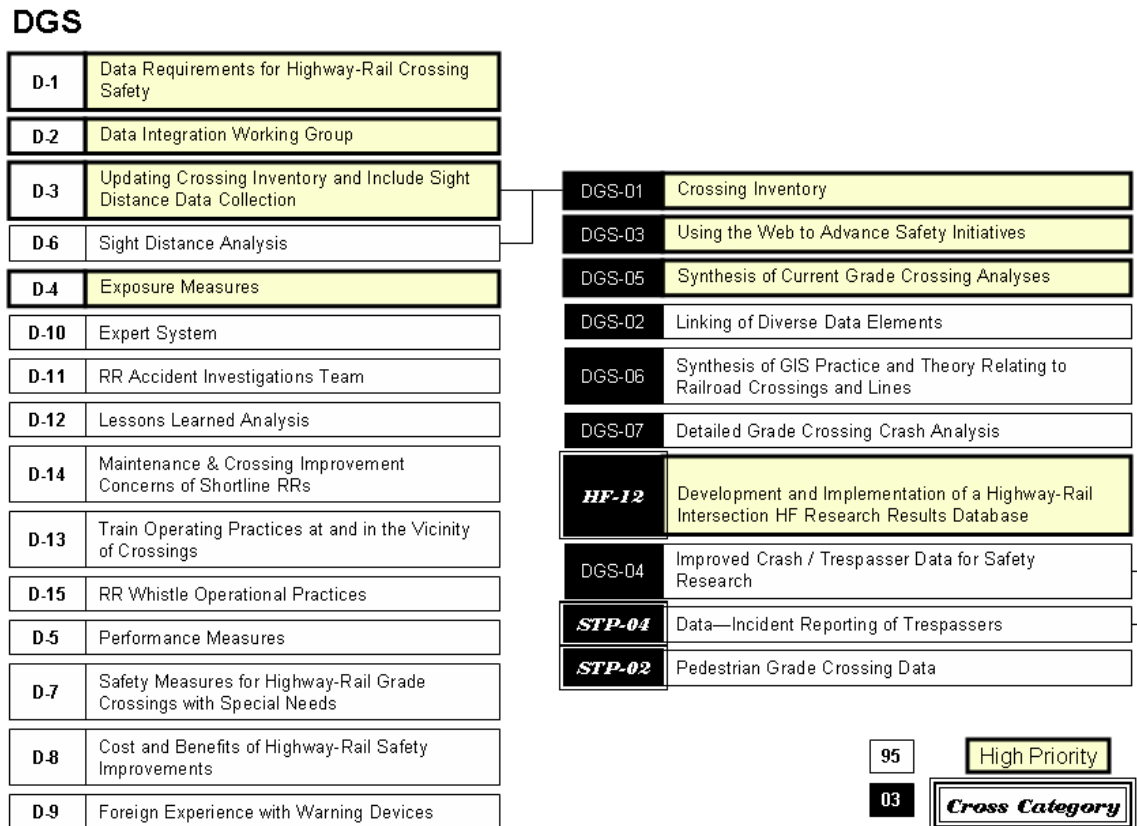


Figure 8. Comparison of 1995 and 2003 STP Needs

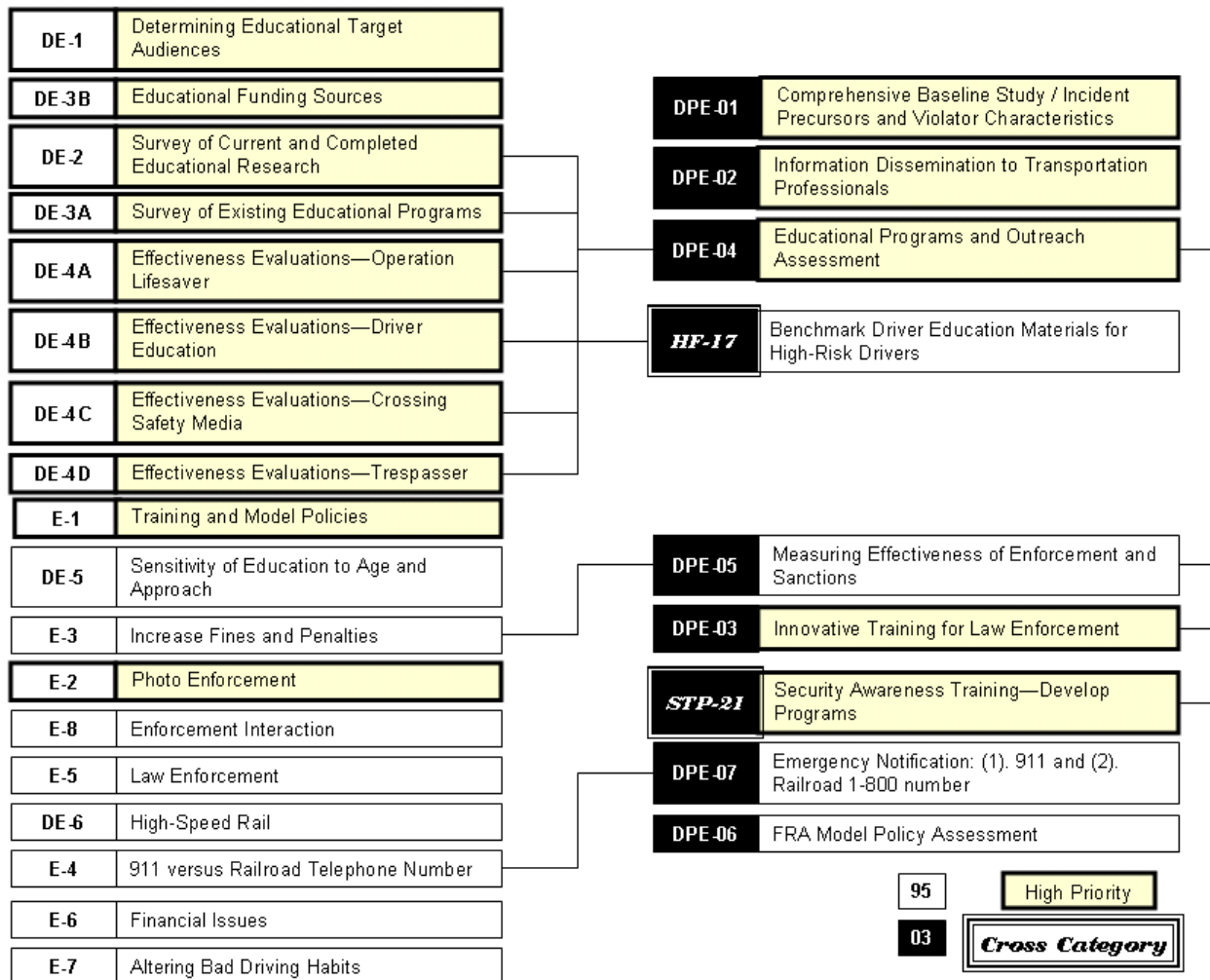
Figure 9 shows that crossing inventory data continues to be a priority need. Item D-3, Updating Crossing Inventory and Include Sight Distance Data Collection, was designated a high-priority need in the data category at the 1995 workshop. Item DGS-01, Crossing Inventory, was a top priority for the DGS category at the 2003 workshop. Trespasser data is a priority in both the STP and DGS topic areas.



**Figure 9. Comparison of 1995 and 2003 DGS Needs**

Figure 10 shows several evaluation research needs that were a high priority in 1995. In 2003, the need for program assessment continued but was consolidated into one research need: DPE-04, Educational Programs and Outreach Assessment. Grade Crossing Emergency Notification methods still did not rise to the high-priority category.

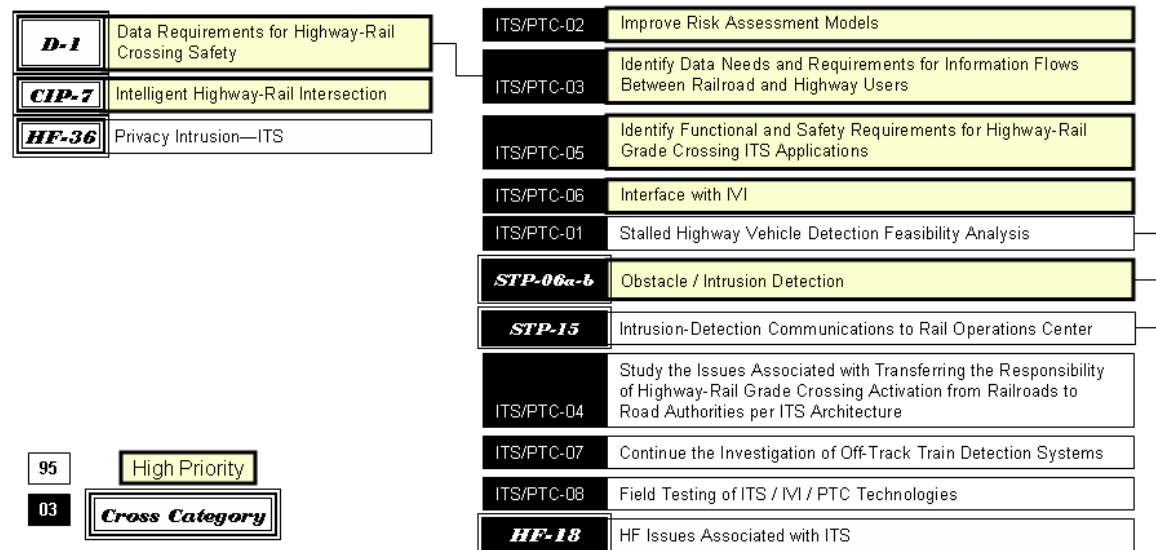
## DPE



**Figure 10. Comparison of 1995 and 2003 DPE Needs**

As shown in Figure 11, grade crossing data requirements continued to be a priority in the ITS/PTC area. The ITS/PTC topic was new for the 2003 workshop. Although vehicle detection feasibility analysis research was not determined to be a high-priority need, a related obstacle/intrusion detection need ended up as a high-priority item in the STP topic area.

## ITS/PTC



**Figure 11. Comparison of 1995 and 2003 ITS/PTC Needs**



## 5. Summary of Findings

### 5.1 R&D Trends and New Directions

FRA promotes innovation and progress in highway-rail grade crossing design and operation by stimulating and conducting research, disseminating information, and implementing research results. The 2003 Research Needs Workshop resulted in a combination of innovative research directions and a continuation of research with potential for improving the FRA's research objectives of safety, security, mobility, global connectivity, and environmental stewardship. The current 2003 workshop results contain statements of research needs that expand earlier research. For some topics, research progresses in an orderly, linear manner, building on previously completed research. For other items, research needs have expanded to new topics that require exploration. Some new topics emerged in 2003 that were not explicitly discussed at the previous workshop. Most prominently, this included topics of increasing importance—railroad security and GIS development.

During the course of the workshop, group leaders worked with their respective topic group members to carefully focus their collective attention on pressing research needs. The purpose of such research statements is to bring critical existing and emerging grade crossing issues of interest before policymakers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions. Another goal of these work groups was to serve as a seedbed for further discussion and analysis from a wider cross-section of practitioners. These results were used in the development of the U.S. DOT Action Plan for Highway-Rail Grade Crossing Safety produced by FRA and published in 2004.

Transportation agencies at all levels of government are concerned about the safety and security of the Nation's grade crossings and the adequacy of privately and publicly owned infrastructure and facilities. Many research needs statements address concerns of public agencies in relation to their investments in grade crossing facilities. Efforts of workshop delegates have identified areas where the collective knowledge of grade crossings can be expanded through future research efforts. Identified research needs support the continued development of a meaningful grade crossing research agenda and will allow FRA to make informed R&D decisions that will anticipate, and are consistent with, industry needs. Identified needs will also support the selection of research projects that will have the greatest utility for the grade crossing community.

The 2003 workshop delegates defined research that cut across topic boundaries, more so than at the previous workshop. Work groups were encouraged to communicate freely with each other to avoid a duplication of effort. This communication resulted in research needs statements that were of interest to several groups. In particular, two specific research needs types were trespass and data issues. The consensus among workshop delegates was that the workshop was a worthwhile step in developing an intermodal approach to improving highway-rail grade crossing safety and that the process should continue.

A reading of each research statement reveals numerous major crosscutting themes, including the importance of public involvement, the need for improved data, the need for evaluation and performance measures to gauge progress, the need to revisit the cost-effectiveness of traditional grade crossing warning device control measures, the importance of institutional arrangements, and the need for better coordination and integration among programs and organizations. The



emergence of unifying concepts that relate to goals, such as sustainability, stewardship, and environmental management, should also be examined closely. As evidenced by the priority needs established in this workshop, industry participants continue to place high priority on the safety of highway-rail grade crossings and the railroad system in general. Many participants identified research needs that share the goal of reducing incidents and casualties. Several identified research needs address safety concerns in all phases of railroad operations through research, development, and demonstrations, as well as regulation and enforcement activities. Highlights for the research need topic areas included the following:

1. **CIP:** The CIP area, which supports a robust grade crossing infrastructure, continues to be a key area containing a majority of identified high-priority needs. Recurring needs include pedestrian crossings and ADA accessibility, warning device selection and timing, audible warnings, and barrier devices. Standards and incentives for at-grade crossing closure and separation for vehicles and pedestrians are a high priority. Aging infrastructure is addressed in research regarding modifications to existing warning devices.
2. **HF:** HF-related grade crossing projects address issues regarding motor vehicle drivers and visual and audio warnings, as well as crossing gate and light technology to reduce incidents.
3. **STP:** The 2003 workshop included a security discussion topic, which yielded about 18 percent of the high-priority needs. Pedestrian treatments at highway-rail grade crossings continued to be a high priority. New STP needs included infrastructure security, security risk management, emergency preparedness/security awareness, threat detections, and hazmat concerns.
4. **DGS:** Although the number of needs in this category was reduced from the 1995 workshop, crossing inventory and crash data needs continued to be a priority, as well as a means of linking diverse data elements. Availability, accuracy, variability, and usefulness of grade crossing incident data, including pedestrian and trespass data requirements, complement trespass needs in the STP and DGS topic areas. GIS and Internet-based data collection systems have been identified as a means of advancing safety initiatives.

GIS was added to the Data category for this workshop. GIS offers the potential to capture a wealth of data that can be useful to public sector and private organizations interested in highway-rail grade crossings.

5. **DPE:** The use of innovative new technologies, such as video conferencing, simulation, kiosks, online services, and CD-ROM presentations, is a way to streamline efforts internally within public agencies, as well as to industry practitioners and the public. Enforcement activities and their effectiveness continue to be priorities.
6. **ITS/PTC:** The ITS/PTC topic area captured needs associated with the development of intelligent railroad systems that encompass IVI programs, vehicle

intrusion detection, and train control system testing; incorporate new digital communications technologies; and emphasize highway-rail connectivity. These research areas have the potential to improve the safety, security, and efficiency of freight, intercity passenger, and commuter railroads. ITS needs also extend to the HF and STP areas.

Past research efforts have brought about a better understanding of the design and operation of grade crossings and the relationship between highway rail and other transportation components. A lot of work still remains to be done. Workshop results, along with FRA strategic and action plans, will guide the identification of specific research projects. Work in the areas of security and GIS implementation will be highly visible research issues over the next several years. In addition, it is necessary to continue the work on developing technologies and techniques that are useful at crossing and corridor level projects, as well as identifying and disseminating best practices in institutional arrangements to promote the integration of efforts.



## Abbreviations and Acronyms

AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
BLE	Brotherhood of Locomotive Engineers
CIP	Crossing Improvement and Closure
DGPS	Differential Global Positioning System
DGS	Data and Geographical Information Systems
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
DPE	Driver/Public Education and Enforcement
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FOX	Florida Overland Express
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GIS	Geographic Information Systems
GC	Global Connectivity
GPS	Global Positioning System
Hazmat	Hazardous Material
HF	human factors
HRI	Highway-Rail Intersection
HSRA	High-Speed Rail Association
IACP	International Association of Chiefs of Police
ITS	Intelligent Transportation Systems
ITS JPO	Intelligent Transportation Systems Joint Program Office
ITS/PTC	Intelligent Transportation Systems and Positive Train Control
IVI	Intelligent Vehicle Initiative
JPO	Joint Program Office
LED	light emitting diode
LRT	Light Rail Transit
MBTA	Massachusetts Bay Transportation Authority
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative on Highway Research Programs
NCSRO	National Committee of State Railway Officials
NCUTC	National Committee on Uniform Traffic Control
NHTSA	National Highway Traffic Safety Administration
NS	Norfolk Southern
NTSB	National Transportation Safety Board
OCC	Operation Command Center

OLI	Operation Lifesaver, Incorporated
ORD	Office of Research and Development (FRA)
OST	Office of the Secretary of Transportation
PDF	Portable Document Format
PRC	Peer Review Committee
PRESS	Passenger Rail Equipment Safety Standards
R&D	Research & Development
RCO	Remote Controlled Operation System
RD&D	Research, Development, and Demonstration
RITA	Research and Innovative Technology Administration
ROW	right-of-way
STP	Security and Trespass Prevention
TC	Transport Canada
TSA	Transportation Security Administration
Volpe Center	John A. Volpe National Transportation Systems Center