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Safety of Highway-Railroad Grade Crossings

Research Needs Workshop Volume I

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John A. Volpe National Transportation Systems Center
Cambridge, MA 02142



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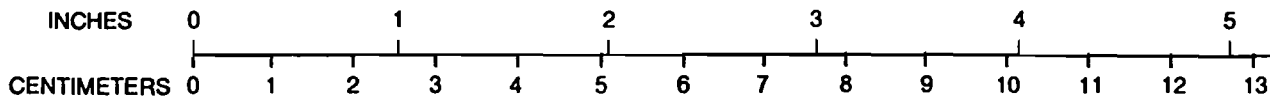
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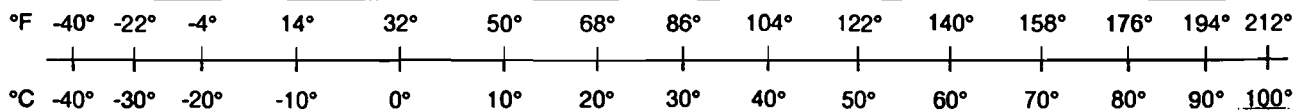
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Brian Bowman	Transportation Research Board, A3A05 Chairman, Highway-Railroad Grade Crossing Safety Committee
Rhonda Crawley	U.S. Department of Transportation Federal Transit Administration (FTA)
Bruce George	U.S. Department of Transportation Federal Railroad Administration (FRA) Office of Safety
Leroy Jones	Brotherhood of Locomotive Engineers
Sid Louick	U.S. Department of Transportation Federal Highway Administration (FHWA)
Anitra McLanahan	U.S. Department of Transportation National Highway Traffic Safety Administration (NHTSA)
Tom Raslear	U.S. Department of Transportation Federal Railroad Administration (FRA) Office of Research and Development
Tom Simpson	Railway Progress Institute/Operation Lifesaver, Inc.
Donald Slemmer	Operation Lifesaver, Inc. - State of Ohio
Otto Sonefeld	National Committee of State Railway Officials (NCSRO) and American Association of State Highway and Transportation Officials (AASHTO)
Chuck Taylor	Association of American Railroads (AAR) Research & Technology Division
Bill Walsh	U.S. Department of Transportation National Highway Traffic Safety Administration (NHTSA)

Anya A. Carroll, Project Leader for the Volpe Center Highway/Railroad Grade Crossing Safety Research Program, was the report team leader and provided overall direction to the conduct of the workshop.

Janelle L. Helser, a Northeastern University Cooperative Education student, provided technical support to the culmination of the workshop and generation of the subsequent report.

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ACRONYMS AND ABBREVIATIONS

The following list contains acronyms and abbreviations pertinent to the subject of highway-rail grade crossing safety, as found in this report.

3-E	Engineering, Education, and Enforcement
A&M	Agriculture and Mining
A3AO5	TRB, Highway-Railroad Grade Crossing Safety Committee
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
ATCS	Automatic Train Control System
AVL	Automatic Vehicle Locator
BLE	Brotherhood of Locomotive Engineers
BTS	Bureau of Transportation Statistics
CIP	Crossing Improvement (engineering) Programs
D	Data
DE	Driver (public) Education
DOT	Department of Transportation
E	Enforcement
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GC	Grade Crossing
H	High Cost (>\$500,000)
HAZMAT	Hazardous Material
HF	Human Factors
H-R	Highway-Rail
HSR	High Speed Rail
IACP	International Association of Chiefs of Police
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation Systems
IVHS	Intelligent Vehicle Highway System
L	Low Cost (<\$100,000)
LACMTA	Los Angeles County Metropolitan Transit Authority
M	Medium Cost (\$100,000 - \$500,000)
MTA	Metropolitan Transit Authority
MUTCD	Manual on Uniform Traffic Control Devices
N	No
NCHRP	National Committee on Highway Research Programs
NCSRO	National Committee of State Railway Officials
NCUTC	National Committee on Uniform Traffic Control
NHTSA	National Highway Traffic Safety Administration
NSA	National Sheriffs Association
NTSB	National Transportation Safety Board
NYSDOT	New York State Department of Transportation
NYS&W	New York Southern and Western

ACRONYMS AND ABBREVIATIONS (continued)

OLI	Operation Lifesaver Incorporated
OST	Office of the Secretary of Transportation
PCS	Positive Control System
PIEV	Perception - Intellect - Emotion - Volition
PTS	Positive Train Control
PUC	Public Utilities Commission
R&D	Research and Development
R&T	Research and Technology
RN	Research Number
RPI	Railway Progress Institute
RRs	Railroads
RSPA	Research and Special Programs Administration
SCRRA	Southern California Regional Rail Authority
SUP	Supplemental
TCRP	Transit Cooperative Research Program
TCS	Train Control System
TRB	Transportation Research Board
TRP	Technology Reinvestment Program
UP	Union Pacific
U.S. DOT	United States Department of Transportation
Volpe	John A. Volpe National Transportation Systems Center
Xings	Crossings
Y	Yes

EXECUTIVE SUMMARY

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

To achieve the objective of developing an intermodal consensus of highway-rail grade crossing research needs, a multi-organizational steering committee was nominated by the FRA. The Steering Committee, in turn, nominated approximately one hundred and twenty individuals to speak and/or attend the workshop. As a result of this activity, seventy-five delegates participated in the workshop. Table E-1 provides a distribution of delegates by organization.

Table E-1. Distribution of Workshop Delegates by Organization

NUMBER	ORG. TYPE	NUMBER	ORG. TYPE
13	State Representatives	3	NTSB
11	Railroad Representatives	3	U.S. DOT/NHTSA
8	U.S. DOT/RSPA	2	Canada(One RR/One Gov't)
7	Consultants	2	Railroad Union
7	U.S. DOT/FRA	2	TRB
7	Vendors	1	U.S. DOT/FHWA
5	Academia	1	U.S. DOT/OST
3	Light Rail	-	-

These seventy-five workshop delegates synthesized ninety-two formal research needs within five topical areas. These areas were: Crossing Improvement (engineering) Program (CIP); Data (D); Enforcement (E); Human Factors (HF); and Driver (public) Education (DE). Of these ninety-two established research needs, the workshop delegates identified thirty-nine to be of high urgency for the enhancement of grade crossing safety. During a plenary session of the workshop, the delegates established a priority ranking of the thirty-nine highly urgent research needs. The priority ranking, shown in Figure E-1, should be considered preliminary. Only forty-five prioritization opinion surveys were received by the Volpe Center for analysis. This reflects the views of only 60% of the workshop delegates and indicates the need for a second survey to substantiate the preliminary results. It should also be noted that five of the research needs identified (HF-18 and DE-4A through DE-4D) were write-ins on the survey form and therefore received a significantly lower response rate than the other research needs.

PRIORITY	TITLE
1	Highway Traffic Control Engineering; Technology Transfer
2	Low-Cost Alternatives to Conventional Warning Devices
3	Proper Warning Time With Credibility
4	Data Requirements for Highway-Rail Grade Crossing Safety
5	Factors Affecting Credibility of Grade Crossing Warning Devices
6	Four Quadrant Gate Systems
7	Effectiveness of Low-Cost Countermeasures for Passive Crossings
8	Effects of Sight Distance on Driver Behavior
9	Photo Enforcement
10	Applicability of Highway Traffic Control Devices at Railroad Crossings
11	Intelligent Highway-Rail Intersection
12	Update Crossing Inventory and Include Sight Distance Data Collection
13	Highway Median Barriers
14	Advance Warning Messages
15	Determining Educational Target Audiences
16	Training and Model Policies
17	Unique Advance Warning Signs for Active & Passive Crossings
18	Causal Analysis of Accidents Involving Grade Crossings
19	Standard Crossbuck Applications
20	Proposed National Warrants For Selection of Warning Devices
21	Institutional Issues; Technology Transfer
22	Driver Perception of Risk
23	Warning Time Trade-Offs
24	Train Horns
25	Exposure Measures
26	Data Integration Working Group
27	Off-Track Train Detection
28	ITS and Its Relationship to Driver and Rail Operators Information
29	Wayside Horns
30	Survey of Current & Completed Educational Research
31	Rail Car Conspicuity
32	Survey of Existing Educational Programs
33	Interim Improvements at Grade Crossings
34	In-Train Warning Devices
35	Educational Funding Sources
36	Post Train Accident Effects
37	Train Gap Acceptance
38	Vehicle Activated Strobe
39, 40, 41 & 42	Educational Effectiveness Evaluations to Include Operation Lifesaver, Driver Education, Crossing Safety and Trespasser Programs

**Figure E-1. Preliminary Listing of Highly Urgent Research Needs
by Priority Ranking and Title**

Table E-2 depicts the distribution of the highly urgent research needs by topical area. As shown, the Human Factors topical area holds 46% of all highly urgent research needs identified.

Table E-2. Distribution of Highly Urgent Research Needs by Topical Area

HIGHLY URGENT NEEDS	TOPICAL AREA
18	Human Factors
10	Crossing Improvement (engineering) Programs
5	Driver (public) Education
4	Data
2	Enforcement

All highly urgent needs have been sorted by cost, High Speed Rail (HSR) applicability and research type. Tables E-3 through E-5 exhibit the results of these analyses. Only the top ten research needs by sort category are shown, although the overall priority rank of each need is listed. These results have not been formally reviewed by the Steering Committee or workshop delegates.

The low-cost range category of < \$100,000 holds 15% of the high urgency research needs identified. The Driver (public) Education topical area is predominant (50%) within this subcategory of cost. The medium-cost range category holds 59% of all research needs identified and Human Factors holds 61% of this share. Only 13% of the high urgency needs were within the high-cost range > \$500,000. Also, 13% of high urgency needs were not identified by a cost subcategory. Table E-3 lists the top ten lowest-cost needs in the high urgency category sorted by priority rank within each category.

The high urgency needs applicable to HSR encompass approximately 59% of all highly urgent needs identified. The top ten needs that were identified to be applicable to HSR within the high urgency category are shown in Table E-4 and are sorted by priority rank.

The supplemental research needs identified consist of 41% of the high urgency research needs. The new research initiatives consist of 56% of the high urgency needs. Table E-5 lists the top ten supplemental research needs within the high urgency category sorted by priority rank.

Table E-3. Top Ten Lowest Cost Needs in the High Urgency Category

RN #	COST	PRIORITY	TITLE
DE-1	L*	15	Determining Educational Target Audiences
CIP-4	L	19	Standard Crossbuck Applications
D-4	L	25	Exposure Measures
DE-2	L	30	Survey of Current and Completed Educational Research
HF-28	L	34	In-Train Warning Devices
DE-3B	L	35	Educational Program Funding Sources
CIP-5	M**	2	Low-Cost Alternatives to Conventional Warning Devices.
HF-15	M	5	Factors Affecting Credibility of GC Warning Devices
CIP-3	M	6	Four Quadrant Gate Systems
HF-1	M	8	Effects of Sight Distance on Driver Behavior

* -- L = Low Cost <\$100,000; ** -- M = Medium Cost >\$100,000 to \$500,000

Table E-4. Top Ten Needs Applicable to HSR in the High Urgency Category

RN #	HSR	PRIORITY	TITLE
CIP-1	Yes	1	Highway Traffic Control Engineering Technology Transfer
D-1	Yes	4	Data Requirements for Highway-Rail GC Safety
HF-15	Yes	5	Factors Affecting Credibility of GC Warning Devices
CIP-3	Yes	6	Four Quadrant Gate Systems
CIP-7	Yes	11	Intelligent Highway-Rail Intersection
D-3	Yes	12	Grade Crossing Inventory
CIP-21	Yes	14	Advance Warning Messages
DE-1	Yes	15	Determining Educational Target Audiences
E-1	Yes	16	Enforcement Training and Model Policies
HF-6	Yes	18	Causal Analysis of Accidents Involving GCs

Table E-5. Top Ten Supplemental Research Needs in the High Urgency Category

RN #	TYPE	PRIORITY	TITLE
CIP-5	SUP*	2	Low-Cost Alternatives to Conventional Warning Devices
E-2	SUP	9	Photo Enforcement
CIP-2	SUP	13	Highway Median Barriers
E-1	SUP	16	Enforcement Training and Model Policies
CIP-4	SUP	19	Standard Crossbuck Applications
HF-25	SUP	23	Warning Time Trade-Offs
HF-14A	SUP	24	Train Horns
CIP-9	SUP	27	Off-Track Train Detection
HF-14B	SUP	29	Wayside Horns
DE-2	SUP	30	Survey of Current and Completed Educational Research

* -- SUP = Supplemental

A summary of the observations for high urgency needs is given below:

- Seventy-four percent (74%) of the high urgency research needs are within the low- to medium-cost range.
- Most high urgency research needs identified are applicable to HSR.
- New research initiatives consist of 56% of the high urgency needs and are dominated by the Human Factors topical area.

In addition, “all other urgency” research needs were analyzed as a group to include medium, low and unspecified urgency categories. The results of this analysis support the observations of the high urgency needs. The results are as follows:

- 82% of “all other urgency” research needs fall in the low- to medium-cost range.
- Most research needs in the “all other urgency” category are applicable to HSR.
- Human Factors dominates the new research needs within the “all other urgency” research needs identified.

Analysis of the ninety-two (92) research needs identified indicates that a number of the needs overlap significantly and/or could be assigned to common areas of research. This suggested an overall structure for an integrated research program with two general themes, (1) Crossing Improvement (engineering) Programs and (2) Enforcement and Education, under which subcategories of common areas of research could be assigned. This general structure is described in Figure E-2.

1.0 CROSSING IMPROVEMENT (ENGINEERING) PROGRAMS
1.1 WARNING DEVICES - NEW/IMPROVED TECHNOLOGIES
1.1.1 ACTIVE SYSTEMS
1.1.2 TRAIN ACOUSTICS/CONSPICUITY
1.1.3 BARRIER SYSTEMS
1.1.4 PASSIVE SYSTEMS
1.1.5 ITS CONCEPTS
1.2 WARNING DEVICES - CREDIBILITY/WARNING TIME
1.3 WARNING DEVICES - NATIONAL WARRANTS/GUIDELINES
1.4 WARNING DEVICES - HIGHWAY SIGNAL TECHNOLOGY TRANSFER
1.5 DRIVER/CREW BEHAVIOR (HUMAN FACTORS)
1.6 DATA & ANALYSES
2.0 ENFORCEMENT AND EDUCATION
2.1 ENFORCEMENT
2.2 EDUCATION

Figure E-2. General Structure of an Integrated Research Program

Using the general structure described in Figure E-2 as a basis, an integrated research program was developed by selecting individual or combined research needs and assigning them to the areas of research in the general structure. This integrated program is described in Table E-6. The table indicates the specific research needs that comprise each area of research by their reference code and the status of the research in terms of whether it is new or supplemental to other ongoing research. The table also shows the applicable section of the U.S. DOT Action Plan for Rail-Highway Grade Crossing Safety that addresses related research.

Table E-6. Integrated Research Program for Crossing Safety

REFERENCE BY RN #	RESEARCH AREA	STATUS	REFERENCE BY ACTION PLAN #
<i>ACTIVE SYSTEMS</i>			
CIP-5/HF-26	More Effective and Low-Cost Warning Devices	Sup	VD1/G3/I1/Q4
CIP-21/HF-4/HF-9	Advanced Warnings	New	
CIP-9	Off - Track Train Detection	Sup	VE2G6
D-9/DE-6	High Speed Rail Studies	Sup	G8
<i>TRAIN ACOUSTICS/CONSPICUITY</i>			
HF-14A/HF-14B/CIP-11/D-15	Acoustic Warning Devices	Sup	G4/VD-2/J
HF-12	Rail Car Conspicuity	Sup	G2/VD4/G1/I2
<i>BARRIER SYSTEMS</i>			
CIP-3/CIP-2/CIP-19/HF-5	Barrier System Research	Sup	A2/A3/IVC
CIP-17	Innovative Low-Cost Grade Separation	Sup	A3
<i>PASSIVE SYSTEMS</i>			
CIP-4/HF-2	Effective Signs and Countermeasures for Passive Crossings	Sup	G5/IIC
<i>ITS CONCEPTS</i>			
CIP-7/HF-7/HF-37	ITS Applications to Crossing Safety	Sup	A4
CIP-18	Video Monitoring/Detect (priority unidentified)	Sup	VE1
<i>WARNING DEVICES - CREDIBILITY/WARNING TIME</i>			
CIP-6/HF-15/HF-23/HF-25/HF-18	Warning Device Credibility and Warning Time	New	
<i>WARNING DEVICES - NATIONAL WARRANTS/GUIDELINES</i>			
CIP-8	Proposed National Warrants for the Selection of Warning Devices	Sup	IID
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements	Sup	IF
HF-11	Interim Improvements at Grade Crossings	New	
<i>WARNING DEVICES - HIGHWAY SIGNAL TECHNOLOGY TRANSFER</i>			
CIP-1/HF-10/HF-22	Highway Traffic Control Devices at Crossings	New	

Table E-6. Integrated Research Program for Crossing Safety (cont.)

REFERENCE BY RN #	RESEARCH AREA	STATUS	REFERENCE BY ACTION PLAN #
<i>DRIVER/CREW BEHAVIOR</i>			
HF-1	Effects of Sight Distance on Driver Behavior	New	
HF-28	In-Train Warning Devices	New	
HF-29	Post Train Accident Effects	New	
<i>DATA & ANALYSES</i>			
D-1 to D-4	Improved Grade Crossing Data Resources	Sup	VI
HF-6	Causal Analysis of Accidents Involving Grade Crossings	New	
CIP-10	Quantitative Risk Assessment	Sup	G8
<i>ENFORCEMENT</i>			
E-1	Training and Model Policies	Sup	L2
E-2	Photo Enforcement	Sup	G7/C1
E-3	Increased Fines and Penalty Assessment	Sup	C1
E-4	911 Versus Railroad Telephone Number	Sup	VF/M
<i>EDUCATION</i>			
DE-1 to DE-4D	Comprehensive Education Program	Sup	III/F/VB/G8

Significant results of the current analyses on all research needs identified include the following:

- Seventy-seven percent of all research needs identified were within the low- to medium-cost range, suggesting that cost-effective research can be conducted without large expenditures of public funds.
- Most research needs identified are applicable to HSR.
- The Human Factors topical area provided 43% of all needs identified and dominates (60%) of the new research initiatives. Therefore, this topical area should receive increased emphasis in the future.

Further examinations of all preliminary research needs identified at the workshop and other current research programs will continue. It was the consensus of the workshop delegates that this activity was a worthwhile first step in developing an intermodal approach to improving highway-rail grade crossing safety and that the process should continue.

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1. INTRODUCTION

This report documents the purpose, process, analyses, and preliminary results of the Highway-Railroad Grade Crossing Safety Needs Workshop sponsored by the Federal Railroad Administration (FRA), Office of Research and Development, and held at the Volpe National Transportation Systems Center (Volpe Center) on April 10-13, 1995. The first full day of the workshop included fifteen multi-organizational presentations on grade crossing issues covering five topical areas including: (1) Driver (public) Education; (2) Enforcement; (3) Human Factors; (4) Crossing Improvement (engineering) Programs; and (5) Data. The second day was dedicated solely to the identification of intermodal highway-rail grade crossing safety research needs by groups assigned to the five topical areas. The third day encompassed a plenary session at which a review of the research needs identified by the respective topical area groups was presented by the Chairpersons of each group. A priority ranking of the highly urgent needs was also completed by all workshop delegates in attendance.

The remainder of this chapter discusses the purpose of the workshop and the process established to plan for and conduct the workshop. Chapter 2 exhibits all research needs identified at the workshop and the process by which this was accomplished. Chapter 3 presents preliminary results obtained from the analyses of the research needs identified. Chapter 4 presents observations of the workshop in a concise format. The appendices provided in Volume II of this report include specific information about the delegates in attendance, information disseminated to workshop attendees, and all papers presented during the workshop.

1.1 PURPOSE

The Rail-Highway Crossing Safety: Action Plan Support Proposals, released June 13, 1994, presents a multi-faceted, multi-modal approach for improving safety at our nation's highway-rail crossings. It is multi-faceted in that it presents enforcement, engineering, education, research, promotional, and legislative initiatives addressing crossings of both light and conventional rail rights-of-way by public and private streets and highways. It is multi-modal in that contributions to its preparation have been made by four U.S. DOT Administrations, i.e., NHTSA, FTA, FHWA and FRA, working together with the same interest: safety at crossings. During formation of the Action Plan ideas from many outside sources, individuals, railroads, and states were received, considered and often incorporated or adapted, in whole or in part. The Action Plan identifies six major initiatives encompassing fifty-five individual proposals. The major initiatives are:

1. Increased Enforcement of Traffic Laws at Crossings
2. Rail Corridor Crossing Safety Improvement Reviews
3. Increased Public Education and Operation Lifesaver
4. Safety at Private Crossings
5. Data and Research
6. Trespass Prevention

The data and research portion of the Action Plan states that good data is an essential ingredient to good decision-making. Research and data processing and analysis must insure that timely and accurate information needed by decision makers is available. Therefore, to address these needs the U.S. DOT proposed to host research round tables and/or workshops. The purpose of the Highway-Rail Grade Crossing Safety Research Needs Workshop was to meet this need for the U.S. DOT. The specific purpose of the workshop, as documented on page 22 of the Action Plan, is as follows:

“ V. Data and Research

A. Host Research Round Tables/Workshops

1. The goals, procedures and findings of Federal crossing related research are always of interest to the industry, state officials and academia. Government sponsored research, and the researchers involved, can also benefit from exchange of ideas, i.e., topical workshops (not just a series of briefings) with the affected industry and interest groups. A workshop will be planned to bring together highway safety, law enforcement, rail and transit industry officials, governor’s highway safety representatives, academia and consultants with Federal researchers to discuss current and projected research and needs.”

1.2 BACKGROUND

To achieve the objectives of the workshop, the following multi-organizational Steering Committee was nominated by the FRA and organized by the Volpe Center. Their function was to develop the format for the workshop:

<u>Name</u>	<u>Organization</u>
Brian Bowman	Transportation Research Board, A3A05, Chairman, Highway-Railroad Grade Crossing Safety Committee
Rhonda Crawley	U.S. Department of Transportation, Federal Transit Administration (FTA)
Bruce George	U.S. Department of Transportation, Federal Railroad Administration (FRA), Office of Safety
Leroy Jones	Brotherhood of Locomotive Engineers
Sid Louick	U.S. Department of Transportation, Federal Highway Administration (FHWA)
Anitra McLanahan	U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA)
Tom Raslear	U.S. Department of Transportation, Federal Railroad Administration (FRA), Office of Research and Development
Tom Simpson	Railway Progress Institute/Operation Lifesaver, Inc.
Donald Slemmer	Operation Lifesaver, Inc. - State of Ohio
Otto Sonefeld	National Committee of State Railway Officials (NCSRO) and American Association of State Highway and Transportation Officials (AASHTO)

<u>Name</u>	<u>Organization</u> (Continued)
Chuck Taylor	Association of American Railroads, Research & Technology
Bill Walsh	U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA)

The first meeting of the Steering Committee for the Highway-Railroad Grade Crossing Safety Research Needs Workshop was on November 7, 1994. Attendance at the workshop was suggested to be limited to 50 or 60 nominated delegates to ensure positive participation and feedback. To promote a wide range of views at the workshop, it was planned to bring together Federal researchers with representatives of highway safety, law enforcement, rail and transit industry, management and labor, governors' highway safety councils, academia, and consultants. It was proposed that the workshop be held at the Volpe Center in Cambridge, MA.

The Steering Committee agreed that it was necessary to inform the workshop participants and exchange information on historical perspectives of research, current research activities, and research that may impact the development of High Speed Rail (HSR) in the U.S. It was proposed that presentations to accomplish this be given on the first day of the workshop.

The Committee identified the following five topical areas and issues that should be addressed in the workshop:

1) Driver (public) Education

- target audiences
- messages used
- messengers
- how to measure media effectiveness

2) Enforcement

- public awareness of laws
- local/regional/national enforcement programs
- acquiring participation by the public and law enforcement agencies
- identification of enforcement impact benefits
- options/techniques/strategies in use
- technology assistance and judicial issues

3) Human Factors

- driver decision-making
- driver behavioral change
- driver education (OLI)
- cultural variations nationwide
- passive and active signs/signals used
- baseline establishment of test protocol for new devices

4) Crossing Improvement (engineering) Program

- corridor programs
- selecting crossings
- selecting devices
- consolidation
- allocation of funds
- ADA issues

5) Data

- accident data
- inventory data
- near hit data
- drivers & vehicles (demographics)
- program evaluation
- problem identification and evaluation
- accident causation with respect to roadway drivers at both passive and active crossings

The Steering Committee identified the following agencies and/or organizations involved with each of the topical areas outlined above to assist in identifying speakers and topic Chairpersons:

<u>Topic</u>	<u>Responsible Organization</u>
Driver (public) Education Enforcement	NHTSA/OLI
Human Factors	NHTSA/FTA/FRA
	FHWA/FRA/National Transportation Safety Board (NTSB)
Crossing Improvement (engineering) Programs	FRA/AAR/FHWA
Data	FRA/NHTSA/Bureau of Transportation Statistics (BTS)

It was determined by the Steering Committee that each topical area be addressed by 2 or 3 speakers. The items to be covered by each speaker are shown below:

Speaker #1 - Historical Perspective

- Issue statement
- Topic history
- Test and research protocols
- Implementation issues

Speaker #2 - Current Research

- Current research activities (domestic and foreign)
- Data needs

Speaker #3 - Innovation

Innovations past and present
High speed rail implications

The Committee concluded that each organization represented on the Committee should nominate appropriate speakers and approximately five or six individuals to attend. The Volpe Center had responsibility for communication among Steering Committee members and for conducting the workshop.

Chairpersons for the five topical areas designated by the Steering Committee are listed in Table 1-1 below:

Table 1-1. Chairpersons By Topical Area

NAME	TOPICAL AREA	ORGANIZATION
Tom Simpson	Driver (public) Education	RPI/OLI
Linda Meadow	Enforcement	LA County MTA
Bob Winans	Human Factors	U.S. DOT/FHWA
Chuck Taylor	Crossing Improvement (engineering) Programs	AAR
Brian Bowman	Data	TRB

The Steering Committee nominated 33 speakers to be involved at the workshop. From these nominations the Volpe Center was able to confirm fifteen speakers, indicated in Table 1-2 below:

Table 1-2. Confirmed Speakers by Topical Area and Speaker Number

NAME	ORGANIZATION	TOPIC	SPEAKER NUMBER
John Killpack	Global Exchange	Driver (public) Education	1
Barbara Brody	Department of Education	Driver (public) Education	3
Yvonne Shull	U.S. DOT/NHTSA	Enforcement	1
Capt. Les Reel	Ohio Highway Patrol	Enforcement	2
Lou Hubbaud	LA County MTA	Enforcement	3
Hans Korve	Korve Engineering	Enforcement	3
Neil D. Lerner	COMSIS	Human Factors	1
Tom Raslear	U.S. DOT/FRA	Human Factors	2
John Tolman	BLE	Human Factors	3
Tom Zeinz	Illinois Central Railroad	Crossing Improvement	1
John Sharkey	Illinois Central Railroad	Crossing Improvement	2
Hoy Richards	Richards and Associates	Crossing Improvement	3
Bill Berg	University of Wisconsin	Data	1
Terry Klein	U.S. DOT/NHTSA	Data	2
Linda Meadow	LA County MTA	Data	3

As seen in Table 1-2, the topical area of Driver Education only had two speakers and the Enforcement area had four. The Steering Committee nominated approximately one hundred and twenty individuals to attend the workshop, of which seventy-five ultimately participated. Table 1-3 indicates the distribution of delegates by organizational type. The specific list of delegates can be found in Volume II, Appendix A.

Table 1-3. Distribution of Workshop Delegates

# OF DELEGATES	ORGANIZATION TYPE
13	State Representatives
11	Railroad Representatives
9	U.S. DOT/RSPA
7	Consultants
7	U.S. DOT/FRA
7	Vendors
5	Academia
3	Light Rail
3	National Transportation Safety Board
3	U.S. DOT/NHTSA
2	Canada(One RR/One Gov't)
2	Railroad Union Representatives
2	Transportation Research Board
1	U.S. DOT/FHWA
1	U.S. DOT/OST

The confirmed delegates were polled as to their choice within the five topical areas. The distribution of delegate assignments to the topical area groups is shown in Table 1-4. The workshop coordinator rotated between groups to promote an exchange of research ideas between the groups. Further details on the delegates involved in each topical area, including name and organization, can be found in Chapter 2.

Table 1-4. Distribution of Delegates by Topical Area

TOPICAL AREA	NUMBER OF DELEGATES
Driver (public) Education	9
Enforcement	10
Human Factors	15
Crossing Improvement (engineering) Programs	22
Data	18

Volume II, Appendix B contains the information that was provided to all delegates when they registered for the workshop. This information included the final agenda, the U.S. DOT's Highway-Railroad Grade Crossing Safety Action Plan and a blank research needs form.

To enhance the sharing of information among participants, the confirmed speakers were asked to submit their papers for distribution to all delegates prior to the conference. Twelve of fifteen papers were received and disseminated before the conference. The last three were available on the first full day of the conference. The papers presented at the workshop can be found in Volume II, Appendices D through H in order of their presentation during the workshop and segregated by topical area.

1.3 WORKSHOP FORMAT

This section describes the workshop process by means of the agenda. A registration/reception was held at the Holiday Inn, Government Center, in Boston, MA, on Monday evening. On Tuesday, after opening remarks, a keynote address, and a technical briefing, fifteen presentations were given covering the five topical areas mentioned earlier. On Wednesday, the delegates were divided into groups and were tasked with developing research needs for their topical areas. That afternoon each topical area group ranked their identified research needs in terms of high, medium, and low urgency. On Thursday, the Chairpersons of each topical area discussed in detail their groups' highly urgent research needs. Discussions followed and the research needs were prioritized on a scale of one to five, one being the highest priority with the additional constraint of no more than ten ones per ballot. The detailed agenda for the workshop is presented on the following pages.

AGENDA

Monday, April 10, 1995

REGISTRATION / RECEPTION

Location: Holiday Inn, Government Center
5 Blossom St. / Boston, MA

Tuesday, April 11, 1995

REGISTRATION

Location: Volpe Center Auditorium

WELCOME TO THE VOLPE CENTER

Ron Madigan - Host

Director, Office of Systems Engineering / Volpe Center

OPENING REMARKS

Bruce George

Chief, Highway-Rail Crossing and Trespasser Division / FRA

**GRADE CROSSING SAFETY RESEARCH IMPLICATIONS
FOR HIGH SPEED RAIL**

John Hitz

Chief, Accident Prevention Division / Volpe Center

DRIVER (PUBLIC) EDUCATION

Tom Simpson, Railway Progress Institute/Operation Lifesaver - Chair

John Killpack - Historical Perspective

Global Exchange

Barbara Brody - Innovation

Department of Education

ENFORCEMENT

Linda Meadow, LA County MTA - Chair

Yvonne Shull - Historical Perspective

NHTSA

Les Reel - Current Research

Ohio Highway Patrol

Lou Hubbaud - Innovation

LA County MTA

Hans Korve - Innovation

Korve Engineering

Tuesday, April 11, 1995 (cont.)

HUMAN FACTORS

Bob Winans, FHWA - Chair

Neil D. Lerner - Historical Perspective
COMSIS

Tom Raslear - Current Research
FRA

John Tolman - Innovation
Brotherhood of Locomotive Engineers

CROSSING IMPROVEMENT (ENGINEERING) PROGRAMS

Chuck Taylor, Association of American Railroads - Chair

Tom Zeinz - Historical Perspective
Illinois Central Railroad

John Sharkey - Current Research
Illinois Central Railroad

Hoy Richards - Innovation
Richards & Associates

DATA

Brian Bowman, Transportation Research Board - Chair

Bill Berg - Historical Perspective
University of Wisconsin

Terry Klein - Current Research
NHTSA

Linda Meadow - Innovation
LA County MTA

WRAP-UP

Wednesday, April 12, 1995

GENERAL MEETING

Location: Volpe Center Auditorium

Explanation of Day's Events

Anya Carroll

Workshop Coordinator / Volpe Center

ROUNDTABLE DISCUSSIONS

Location: Volpe Center Individual Break-Out Rooms

Identify Research Needs

PRIORITIZE URGENT RESEARCH NEEDS

Within Each Topical Area Group

RECONVENE

Location: Volpe Center Auditorium

Distribute Roundtable Results

Thursday, April 13, 1995

CHAIRPERSONS' PRESENTATIONS

Location: Volpe Center Auditorium

Review of Research Needs Identified Per Topical Area

Discussion of Urgent Research Needs Identified Per Topical Area

Linda Meadow - Enforcement

LA County MTA

Thomas Simpson - Driver (public) Education

Railway Progress Institute / Operation Lifesaver

Bob Winans - Human Factors

FHWA

Chuck Taylor - Crossing Improvement (engineering) Programs

Association of American Railroads

Brian Bowman - Data

Transportation Research Board

DISCUSS AND PRIORITIZE RESEARCH NEEDS

Individual Participants Prioritize All Urgent

Research Needs Identified (Worksheets Provided)

ADJOURNMENT

2. IDENTIFIED RESEARCH NEEDS

2.1 INTRODUCTION

The identification of research needs was initiated on the first day with the presentation of fifteen papers to the entire delegation, in the five topical areas mentioned earlier. Most of the papers presented were distributed to the delegates before they arrived at the workshop in order to stimulate thoughts and/or discussions. The pre-distribution of papers and the presentations led to interesting discussions which provided ideas for research needs. The key issues raised during these discussions are summarized in Chapter 3.

The seventy-five workshop delegates submitted approximately one hundred and thirty-five preliminary research ideas after the presentations. The basis for these preliminary ideas was a generic research needs form distributed to the delegates in the registration packet. This activity formulated the initial ideas with which each topical area group began their discussions on the second day of the workshop. A copy of the blank generic form can be found in Volume II, Appendix B. The form called for certain issues to be addressed in the development of formal research needs. Information requested on the form is listed below:

Research Need Title
Problem Statement Definition
Research Objectives to be obtained
Relationship to current research activities:
 Is the need new or supplemental to ongoing research?
 If the latter is true, identify the organization and title of the current research
Identify potential benefits of the research need
Identify the urgency of the need, either HIGH, MEDIUM or LOW
Identify the cost to conduct the research based on the structure as shown:
 HIGH =>\$500,000
 MEDIUM = \$100,000 to \$500,000
 LOW =< \$100,000
Identify, if possible, the organization to conduct the research
Indicate the applicability to high speed rail service
Other comments (e.g., implementability)

During formal discussions of the research need form with the entire group, it was established that one labor year of effort is worth \$120,000 to \$150,000 as a basis for determining the cost of the research needs. The next day, the delegates separated into topical area groups led by the area expert chairperson and facilitator, per assignments as shown in Volume II, Appendix B.

Each topical area group spent the morning developing procedures to be used to complete the formulation of research needs by the end of the day. Some groups then categorized the initial ideas into subcategories and formulated their own additional ideas. Some groups relied only on the initial ideas submitted. The groups then continued the process by consolidating the ideas generated into a formal research needs format. The number of resulting research needs identified are summarized in Table 2-1.

Table 2-1. Distribution of All Research Needs Identified

RN #	TOPICAL AREA
10	Driver (public) Education
8	Enforcement
38	Human Factors
21	Crossing Improvement (engineering)
15	Data

As can be seen in the following sections for each topical area, the delegates chose various degrees of consolidation for their identified research needs. For example, the Data and Enforcement groups chose generic topics encompassing several research needs, whereas the Crossing Improvement (engineering) Program group chose to identify a specific topic dedicated to each research need. The Human Factors group used a broad approach, but still identified the largest number of research needs. The Driver (public) Education group identified specific topics for each research need but linked them by alpha-subcategories, for example, DE-4 A, DE-4 B, DE-4 C and DE-4 D. Each group was satisfied with the amount of time allocated for the development of the research needs and acknowledged the importance of the facilitators in the process. The topical area groups synthesized a total of ninety-two formal research needs within the five topical areas.

The later part of the afternoon was dedicated to prioritization within each topical area group of the highly urgent research needs identified. Of the ninety-two established research needs, the workshop delegates identified thirty-nine to be of high urgency for the enhancement of grade crossing safety.

The following sections of this chapter exhibit all of the formal research needs identified, grouped by topical area. The information presented is included on the standard research need forms prepared for each research need identified during the second day of the workshop. The complete information on each research need can be found in the remainder of this chapter and should be used for reference as needed. Each of the following sections first indicates the delegates and their organizations that comprised each topical area group. Also listed are the topical area chair, the speakers, and the facilitators. Following this listing, the specific research needs identified are displayed in numerical order. The research needs identified are listed by section in the following manner:

<u>Section Number</u>	<u>Research Needs by Topical Area</u>
2.2	Driver (public) Education
2.3	Enforcement
2.4	Human Factors
2.5	Crossing Improvement (engineering) Programs
2.6	Data

The research needs presented in the following sections are then analyzed by research need number and title in Chapter 3.

2.2 DRIVER (PUBLIC) EDUCATION

Table 2-2 identifies the delegates responsible for identifying the Driver (public) Education research needs.

Table 2-2. Delegates in Driver (public) Education Group by Organization

NAME	ORGANIZATION
Lt. Ron Beck	MO State Highway Patrol
Bruce George	U.S. DOT/FRA/Safety
John Killpack*	Global Exchange
Elaine Lyte	U.S. DOT/Volpe/Facilitator
Stephanie Markos	U.S. DOT/RSPA/Volpe
Ernie Oliphant	Highway & Rail Consulting Services
Phil Poichuk	Transport Canada (Government)
Cliff Shoemaker	Union Pacific Railroad
Tom Simpson**	RPI/OLI

* - Speakers ** - Chairperson

The complete information developed by the group for each research need is provided on the following pages. The research needs are listed in order of their alphanumeric designator to simplify the analysis in Chapter 3.

DRIVER EDUCATION

Research Need # DE - 1

TITLE: Determining Target Audiences

Problem Statement:

Target audiences are unknown.

Research Objective:

Define specifics of the target audiences regarding both crossing safety and trespass prevention. (Specific audiences for enforcement, judicial, engineering, and public information programs.)

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Will assist in development and targeting of educational programs.
- Will benefit implementing agencies.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: NHTSA/OLI

Other Comments: Applicable to High Speed Rail Service YES

Implementation: Easy

Research Need # DE - 2

TITLE: Survey of Current and Completed Research

Problem Statement:

Number and extent of existing public education research projects are unknown in this and other countries.

Research Objective:

Perform survey of existing public education research projects.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/Volpe

Title of Current Research: High Speed Rail - Grade Crossing Safety Research

Potential Benefits of Identified Research Need:

- Avoids duplication of effort and identifies innovative efforts.
- Will save limited resources of initiating agencies.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA/Volpe

Other Comments: Applicable to High Speed Rail Service YES

Implementation: Easy

DRIVER EDUCATION

Research Need # DE - 3A

TITLE: Survey of Existing Programs

Problem Statement:

Number and extent of existing public information programs, materials and organizations that might be relevant to crossing safety and trespass prevention programs are unknown.

Research Objective:

Perform survey of existing public information programs, materials and organizations, media campaigns, print, video, radio, etc.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Will avoid duplication of effort and materials.
- May identify potential partnerships.
- Implementing agencies benefit.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: OLI/NHTSA/Volpe

Other Comments: Applicable to High Speed Rail Service _____

Implementation: Moderate

Research Need # DE - 3B

TITLE: Funding Sources

Problem Statement:

Funding is limited.

Research Objective:

Identify potential alternate funding sources, i.e., corporate contributors, grant programs, government sources, special interest.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Provide funding to promote public information and driver education programs.
- Benefits public safety and the sponsors.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA/Volpe

Other Comments: Applicable to High Speed Rail Service _____

Implementation: Moderate

DRIVER EDUCATION

Research Need # DE - 4A **TITLE: Operation Lifesaver Program Evaluation**
Problem Statement:

The effectiveness of current public education programs needs to be determined.

Research Objective:

Test Operation Lifesaver programs to identify most effective approaches.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- More efficient use of resources.
- Better targeted education.
- Eliminate duplication.
- Benefit drivers, Operation Lifesaver, the law enforcement community, government, railroads, and the general public.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

Implementation: Difficult

Research Need # DE - 4B

TITLE: Driver Education Evaluation

Problem Statement:

The effectiveness of current public education programs needs to be determined.

Research Objective:

Test driver education materials and curricula to identify the most effective approaches.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- More efficient use of resources.
- Better targeted education.
- Elimination of duplication.
- Benefit law enforcement community, new drivers and educators.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

Implementation: More difficult

DRIVER EDUCATION

Research Need # DE - 4C

TITLE: Crossing Safety Media Evaluation

Problem Statement:

The effectiveness of current public education programs needs to be determined.

Research Objective:

Test crossing safety media campaigns to identify most effective approaches, and potential effects of multiple messages.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- More efficient use of resources.
- Better targeted education.
- Elimination of duplication.
- Benefit drivers, Operation Lifesaver, government, railroads, the law enforcement community, and the general public.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

Implementation: Easy

Research Need # DE - 4D

TITLE: Trespassing Media Evaluation

Problem Statement:

The effectiveness of current public education programs needs to be determined.

Research Objective:

Test trespassing media campaigns to identify most effective approaches, and potential effects of multiple messages.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- More efficient use of resources.
- Better targeted education.
- Elimination of duplication.
- Benefit potential trespassers, railroads, law enforcement community.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

Implementation: Easy

DRIVER EDUCATION

Research Need # DE - 5

TITLE: Sensitivity of Education to Age and Approach

Problem Statement:

The most appropriate age/life stage for crossing safety and trespasser education needs to be identified.

Research Objective:

Identify the most appropriate age(s)/life stage(s) and approaches for crossing safety and trespasser education.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- More effective education.
- Better use of resources.
- Benefit drivers, potential trespassers, law enforcement community, educators and sponsors.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: U.S. Department of Education

Other Comments: **Applicable to High Speed Rail Service** YES
Implementation: Easy

Research Need # DE - 6

TITLE: High Speed Rail

Problem Statement:

Existing public education programs do not address high speed rail operations either for crossing safety or trespass prevention programs.

Research Objective:

Determine public information needs regarding high speed rail operations, and the best methods of delivery.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/Volpe

Title of Current Research: High Speed Rail - Grade Crossing Safety Research

Potential Benefits of Identified Research Need:

- Facilitate the advent of safer high speed rail operations in communities.
- Benefit accrues to communities and high speed rail passengers and crew.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA/Volpe

Other Comments: **Applicable to High Speed Rail Service** YES
Implementation: Moderate

2.3 ENFORCEMENT

Table 2-3 identifies the delegates responsible for identifying the Enforcement research needs.

Table 2-3. Delegates in Enforcement Group by Organization

NAME	ORGANIZATION
Kenneth W. Beljen	NYS&W Railway
Randall L. Dickinson	U.S. DOT/FRA/Safety
Lou Hubbaud*	LA County MTA
Hans Korve*	Korve Engineering
Linda Meadow**	LA County MTA
Marilyn Mullane	U.S. DOT/RSPA/Volpe/Facilitator
Capt. Les Reel*	Ohio Highway Patrol
Yvonne Shull*	Orange County Deputy Sheriff
Mike Smith	U.S. DOT/NHSTA
Capt. William Yodice	NJ Traffic Bureau

* - Speakers ** - Chair

The complete information developed by the group for each research need is provided on the following pages. The research needs are listed in order of their alphanumeric designator to simplify the analysis in Chapter 3.

ENFORCEMENT

Research Need # E - 1

TITLE: Training and Model Policies

Problem Statement:

Historically, law enforcement agencies have done little or no enforcement in the railroad environment. In order to encourage the agencies to adopt enforcement into their routine traffic safety and enforcement programs, model policies must be developed and available to assist in the implementation of this type of enforcement. These policies should include grade crossing enforcement procedures for both vehicles and pedestrians, trespasser enforcement, and general information on the unique problems associated with the railroad environment. Law enforcement agencies typically do not recognize or place a high priority on rail safety issues or enforcement. This problem is often due to the lack of knowledge related to these issues and the laws pertaining to the enforcement of rail violations. With increasing emphasis on crime and reduced budgets, law enforcement executives must constantly search for effective methods of deploying their resources.

Research Objective:

- General information unique to railroad environment and operations.
- Model policy for grade crossing enforcement.
- Model policy for trespassing enforcement.
- Compile statistics and make them available to law enforcement administrators regarding rail incidents and their consequences.
- Develop a model enforcement training program that includes multi-agency cooperation, field officer training in the applicable state statutes and local ordinances, community benefits, and economic impact.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: International Association of Chiefs of Police

Title of Current Research: Model Policy for Railroad Trespass Enforcement

Potential Benefits of Identified Research Need:

Increase law enforcement's participation in railroad-related violations. The integration of railroad enforcement into currently used traffic safety programs should decrease rail incidents, injuries, and deaths. Law enforcement administrators may place a higher priority on railroad enforcement. Forming multi-agency task forces for this problem will promote effective utilization of resources throughout an increased geographical area. The use of multi-agency efforts will result in a higher level of enforcement and public awareness.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA, IACP, National

Sheriffs' Association (NSA)

Other Comments: **Applicable to High Speed Rail Service** YES

Easily implemented through the National Law Enforcement Organizations.

ENFORCEMENT

Research Need # E - 2

TITLE: Photo Enforcement

Problem Statement:

Photo enforcement proves to be highly effective in reducing grade crossing violations. However, lack of state or national standards to recognize photo enforcement as a valid enforcement procedure causes implementation problems. Photo enforcement must become recognized by legislators, judicial officers, law enforcement executives, and field officers. There are many options to choose from at grade crossings. Some guidelines and standards for photo enforcement implementation are needed. To increase the effectiveness of photo enforcement, movable technology should be developed. Front and rear license plates enhance the number of identified vehicles with this type of enforcement. Legislation is needed to address the issue of both front and rear license plates. Law enforcement authorities in rural areas are challenged to enforce the laws in a typically large geographic area with limited resources. Photo enforcement could greatly increase the effectiveness of rural enforcement with little increase in resources necessary. Research needs to be conducted on the use of digital camera systems to provide rapid data transfer and ease of analysis.

Research Objective:

- Develop model legislation to gain legislative support at the state and Federal level.
- Develop guidelines and standards for photo enforcement (definition of violator, system installation, detection systems).
- Determine feasibility of mobile enforcement equipment and/or pilot project.
- Continue to develop technology (digital camera).
- Develop model legislation for front and rear license plates.
- Identify and test photo enforcement in rural environment.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Research: LACMTA

Title of Current Research: Grade Crossing Safety Improvement Program/Rail
Transit Enforcement Act

Potential Benefits of Identified Research Need:

- Increase law enforcement participation in railroad-related violations.
- Higher level of enforcement, public awareness, and quick response to problems.
- Decrease rail incidents, injuries, and deaths.
- More cost-effective.
- Improve utilization of law enforcement resources in rural areas.
- Consistent enforcement at grade crossings.
- Rapid data transfer and violation analysis.
- Easy equipment installation.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: LACMTA, FRA,
FTA, FHWA

Other Comments: Applicable to High Speed Rail Service _____

ENFORCEMENT

Research Need # E - 3

TITLE: Increase Fines and Penalty Assessment

Problem Statement:

The fines associated with grade crossing violations are not commensurate with the potential catastrophic consequences of the violation. There is no subsequent action for a violator other than a fine. Agencies enforcing crossing violations receive no benefit to aggressively enforce crossing violations.

Research Objective:

Fines should be raised to the highest level on the bail schedule and graduate for repeat offenders. Offenders should be required to attend an appropriate traffic school. Increase fines or a penalty assessment on the fine should be returned to the agency for continuing enforcement.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: California MTA.

Title of Current Research: Proposed California Legislation, Rail Transit Act.

Potential Benefits of Identified Research Need:

- Increased attention to crossing violations by law enforcement.
- Increased compliance by motorists at crossings.
- Potential reduction in crossing violations and accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

<\$100,000

Possible Responsible Organization to Conduct Research Need: FTA

Other Comments: Applicable to High Speed Rail Service YES

Research Need # E - 4

TITLE: 911 Versus Railroad Telephone Number

Problem Statement:

The public has no easy way to communicate with railroads about problems of a particular grade crossing. With the advent of 911, a new opportunity for the public to communicate is available. Drawbacks of the system, however, are that the 911 staff does not always have access to the appropriate railroads, nor the knowledge of the crossing location.

Research Objective:

Review all 911 procedures, identify and/or establish railroad phone numbers, identify railroad grade crossing numbers, establish procedures for handling phone calls, develop training manual for dispatchers and train all 911 staff.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Improved communication with RRs and/or the public.
 - Faster response time for law enforcement/emergency crews.
- Reduced crossing downtime in case of malfunction.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA

Other Comments: Applicable to High Speed Rail Service YES

ENFORCEMENT

Research Need # E - 5

TITLE: Law Enforcement

Problem Statement:

Provide opportunities for crossing improvement evaluation for consistent safety by law enforcement officers.

Research Objective:

- Provide a measurable method where innovative concepts that work have a chance to survive.
- Sharing of proven ideas.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Officers will be more likely to buy into the change.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

Research Need # E - 6

TITLE: Financial Issues

Problem Statement:

New ideas of railroad crossing enforcement costs. What would be the best mechanism to funnel enforcement revenue to offset operating maintenance? How best to share costs with governments involved?

Research Objective:

- Collect data on existing problems in government, speeding tickets, etc.
- Recommend a plan that would work.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

LOW

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

ENFORCEMENT

Research Need # E - 7

TITLE: Altering Bad Driving Habits

Problem Statement:

- Bad driving habits contribute to crossing accidents.
- General lack of respect.
- Confusion over signals and warning devices.

Research Objective:

- Determine the effectiveness of methods to alter bad driving habits.
- Reinforce penalty concepts such as a ticket.
- Bad publicity.

Relationship to Current Research:

Organization Conducting Current Research: NHTSA
Title of Current Research: Seat Belt Campaign

SUPPLEMENTAL

Potential Benefits of Identified Research Need:

- Provide direction for remedial action and address prevention.
- Reduce crossing accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW
< \$100,000

Possible Responsible Organization to Conduct Research Need: NHTSA

Other Comments: Applicable to High Speed Rail Service YES

Research Need # E - 8

TITLE: Enforcement Interaction

Problem Statement:

Judicial boundaries reduce enforcement effectiveness.

Research Objective:

Determine:

- Practical solutions to allow for "sharing" resources, such as to erect a sound enforcement strategy.
- Financial sharing.
- Availability of Railroad Enforcement to participate.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

LOW

Cost to Conduct Research Need:

LOW
<\$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

2.4 HUMAN FACTORS

Table 2-4 identifies the delegates responsible for identifying the Human Factors research needs.

Table 2-4. Delegates in Human Factors Group by Organization

NAME	ORGANIZATION
Rick Bartoskewitz	Texas A&M University
David Daley	U.S. DOT/RSPA/Volpe/Facilitator
Neil Lerner*	COMSIS
Herbert S. Levinson	Transportation Consultant
Jerry Masters	Burlington Northern Railroad
David Mayer	National Transportation Safety Board
Mark Mironer	U.S. DOT/RSPA/Volpe
Jordan Multer	U.S. DOT/RSPA/Volpe
Phil Olekszyk	U.S. DOT/FRA/Safety
Tom Raslear*	U.S. DOT/FRA/R&D
Donald F. Remaley	Safetran Systems Corporation
Steve Richards	University of Tennessee - Transportation Center
Eugene Russell	Kansas State University
John Tolman*	Brotherhood of Locomotive Engineers
Bob Winans**	U.S. DOT/FHWA

* - Speakers ** - Chairperson

The complete information developed by the group for each research need is provided on the following pages. The research needs are listed in order of their alphanumeric designator to simplify the analysis in Chapter 3.

HUMAN FACTORS

Research Need # HF - 1

TITLE: Effect of Sight Distance on Driver Behavior

Problem Statement:

Drivers need adequate sight distance to make good decisions when approaching passive grade crossings. Passive grade crossings on rural, low volume roads do not provide adequate sight distance due to brush and other obstructions on the road or railroad right-of-way or on private property.

Research Objective:

Research is needed to document enhanced safety at crossings when sight distance improvements are made.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- To encourage identification of crossings where improvements and maintenance (e.g., brush clearing) are needed, and to spur such activity.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 2

TITLE: Effectiveness of Low-Cost Countermeasures for Passive Crossings

Problem Statement:

There is a need for effective, low-cost countermeasures at passive crossings. Such countermeasures might include pavement markings, textural surface treatments, illumination, new traffic sign designs, and improved crossbuck placement.

Research Objective:

To find effective, low-cost countermeasures for passive crossings, where active devices are not otherwise warranted.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Large range of warning devices would be available for much less cost than active devices currently available.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

HUMAN FACTORS

Research Need # HF - 3

TITLE: Driver Acceptance of High Speed Rail Crossing Barriers

Problem Statement:

Driver acceptance of traffic delays incurred due to significantly increased delay time incurred due to use of crossing barriers.

Research Objective:

Determine amount of increase in delay time to driver, and driver reaction and acceptance, or non-acceptance.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Promote safety of high speed rail.

Urgency of Research Need:

LOW

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 4

TITLE: Unique Advance Warning Signs for Active and Passive Crossings

Problem Statement:

Drivers have greater responsibility at passive crossings to determine if a train is at or near the crossing. It can be difficult for motorists to determine if a crossing is active or passive, especially at night. Drivers may allow their vehicles to come too close to these crossings before realizing that this extra care is needed.

Research Objective:

To determine the need for unique advance warning signs for active and passive crossings and driver response to such signs.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Decreased risk at passive grade crossings, particularly at night in rural areas.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

HUMAN FACTORS

Research Need # HF - 5

**TITLE: Human Factor Issues
Surrounding the Use of Mobile Barriers**

Problem Statement:

Movable barriers used to temporarily close certain crossings in conjunction with nighttime whistle bans, or other situations, will possibly create inconveniences and other issues for the motorists and local residents.

Research Objective:

Determine what problems and/or issues are created and recommend possible solutions. Also determine safety impact by the use of such devices.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/Volpe

Title of Current Research: Mobile Barrier Evaluation Test Plan

Potential Benefits of Identified Research Need:

- Enhance motorist safety during nighttime whistle ban and other temporary closures.

Urgency of Research Need:

LOW

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 6

**TITLE: Causal Analysis of Accidents
Involving Grade Crossings**

Problem Statement:

Accident statistics often fail to get at the real causes of accidents, because accident reports tend to focus on what happened, not why it happened. Accidents at crossings should be viewed as to system failure that causes a driver to make a poor decision. Only through in-depth analysis of accidents can these basic causes (and system weaknesses) be found. Near accidents and non-train accidents should be included in this analysis.

Research Objective:

Determine basic causes of accidents at crossings.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Increased knowledge of accident causes would permit the design (and/or analysis) of more effective traffic control devices and educational programs.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 7

TITLE: In-Vehicle Warning Devices

Problem Statement:

In-vehicle warning devices to alert drivers to trains at or near crossings are technically feasible and will likely become available as ITS technology becomes widespread. However, little is known about their effectiveness in capturing driver attention and affecting driver behavior at crossings, especially given driver workload associated with ITS technology.

Research Objective:

To determine effectiveness of in-vehicle warning devices, and to study the driver workload associated with these devices.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FHWA/FRA/Volpe

Title of Current Research: Vehicle Proximity Alerting Device Prototype Testing

Potential Benefits of Identified Research Need:

- Would optimize effectiveness of ITS warning devices and protect against unsafe levels of driver workload.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

Research Need # HF - 8

TITLE: Effects of Crossing Closures

Problem Statement:

Closing grade crossings often impacts driver behavior in a number of ways. These include changes in routes to accommodate closures as well as accidents caused by unawareness of the closing. These impacts need to be examined.

Research Objective:

Determine impacts of crossing closures in terms of:

1. Accidents at closed crossing;
2. Increased accidents at nearby crossings; and
3. Driver acceptance.

These can be addressed through accident records and driver surveys.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- This would lead to a better understanding of the effects of closing grade crossings, so that a more informed decision can be made as to whether a crossing should be closed.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

HUMAN FACTORS

Research Need # HF - 9

TITLE: Vehicle Activated Strobe

Problem Statement:

Passive crossings are being upgraded, but slowly. As a low-cost solution to an otherwise passive crossing, a demonstration of the effectiveness of a vehicle activated strobe light can establish whether this increases a driver's attention to the highway-rail crossing.

Research Objective:

Establish the effectiveness of a vehicle activated strobe light for the vehicle driver.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- If effective, the use of this type of passive crossing improvement could decrease the incidents of accidents at passive crossings.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: Texas DOT

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 10

**TITLE: Applicability of Highway Traffic Control
Devices at Railroad Grade Crossings**

Problem Statement:

Compliance to active and passive railroad grade crossing devices is lacking due to the poor impact on driver behavior relative to roadway traffic control devices. There is confusion over the meaning of the indications of these railroad devices because they conflict with similar indications in a roadway setting.

Research Objective:

To determine appropriateness and applicability of roadway traffic control devices including roadway traffic signals, stop signs, and yield signs in traffic control at railroad crossings.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Improved motorist compliance of right-of-way at railroad crossings.
- Reduced fatalities, injuries, and accidents with attendant economic benefits and liability reduction.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 11 TITLE: Interim Improvements at Grade Crossings

Problem Statement:

The time lag between identification of a crossing deficiency and remedial action can normally be two years, considering necessary approvals to be secured.

Research Objective:

Determine appropriate short-term remedial actions, implemented by the roadway authority and railway authority. Establish an action hierarchy relative to roadway use, alternative availability and geography.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Lives saved via timely identification of hazard, liability reduction via timely identification of hazard.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 12

TITLE: Rail Car Conspicuity

Problem Statement:

Considerable research has been conducted to assess the feasibility of using retroreflective rail car markings to enhance the nighttime visibility of trains. The results are favorable regarding the maintainability of new materials, but only limited work has been done to identify and refine an optimal marking system or systems with respect to human factors considerations.

Research Objective:

1. Conduct additional human factors laboratory evaluations of candidate rail car marking systems.
2. Field test (and measure driver response to) selected rail car marking systems.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/AAR/Volpe

Title of Current Research: Retroreflective Rail Car Markings

Potential Benefits of Identified Research Need:

- Reduction in train-vehicle accidents, especially nighttime, run-into-train accidents.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/AAR/Volpe

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 13

**TITLE: Assessment of Vehicle Occupant-Kinematics in Train Collisions
(For the Purpose of Developing Locomotive Engine Safety Design Features)**

Problem Statement:

Train-vehicle collisions tend to be very severe, often resulting in the death or serious injury of the vehicle occupants. The precise nature of the occupant kinematics during these train-vehicle collisions has not been studied to determine if the major occupant traumas are a result of deceleration/acceleration forces, penetration of the occupant compartment, ejection, etc. Also, it is not known what features of the locomotive design (frontal profile) may contribute to the severity of crashes, and whether attenuation devices on the front of the locomotive may reduce accident severity.

Research Objective:

1. Determine the crash kinematics elements of train-vehicle accidents which produce fatalities and serious injuries.
2. Identify locomotive design features (frontal cross section) which contribute to occupant trauma.
3. Assess safety improvements and retro-fit treatments for locomotives to mitigate occupant injuries.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduction in accident severity (i.e., reduced injuries and fatalities).
- Reduction in train crew injuries.
- Reduction in train crew post-accident stress.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: NHTSA/FRA/AAR

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 14A

TITLE: Train Horns

Problem Statement:

Train horns at highway-rail grade crossings represent either a primary means of identification of a train at a crossing (passive crossing conditions) or a secondary means of identification (active crossing condition). Are horns effective? What is the driver's response (reaction to the horn)? Do different conditions affect the response and/or the reaction of the driver to the horn, i.e., windows up, windows down, heater on, limited visibility, new "quieter" cars, etc.?

Research Objective:

1. Evaluate the effectiveness of variable train horns and volume under variable conditions, i.e., driver and vehicle effects.
2. Measure drivers' reactions to the sound of the train horns and their responses.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/Volpe

Title of Current Research: Audible Warning Device Research

Potential Benefits of Identified Research Need:

- The FRA has established certain regulatory requirements for train horns and this type of research can help validate these or start a process of review of the regulations.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 14B

TITLE: Wayside Horns

Problem Statement:

Wayside horns are being evaluated by the UP in Nebraska and the LACMTA in Los Angeles. No guidelines exist for their implementation. No measures of effectiveness have been defined. The current wayside horn demonstration projects do not address the community concern about train noise. A research project that can place a wayside horn that will also automatically vary the horn noise for ambient noise conditions will help address the community issue.

Research Objective:

Address comprehensively the issue of wayside horns as it relates to community objections, guidelines and standards.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/Volpe/UP, LACMTA

Title of Current Research: Audible Warning Device Research

Potential Benefits of Identified Research Need:

- Wayside horns direct sound down proper cones for highway-rail users. Their use depends on community acceptance and effectiveness.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 15 **TITLE: Factors Affecting Credibility of Grade Crossing Warning Devices**

Problem Statement:

Effectiveness of warning devices at grade crossings is partly determined by the credibility of those warnings. False alarms, “long” gaps between when the warning device indicates a train approaching and the actual arrival of the train, reduce the effectiveness of the devices for motorists. Motorists may not rely on the devices for information.

Research Objective:

Establish the conditions that affect credibility of the information value of warning devices. This should include examining how credibility varies with train frequency.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Maximize effectiveness of warning devices currently in place.
- Enable traffic engineers and rail and signal engineers to reduce or eliminate factors that reduce credibility and to increase those factors that increase credibility.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

**Research Need # HF - 16 TITLE: Study Driver “Information Gathering”
Processes at Crossings**

Problem Statement:

Much has been written about the driver’s information needs at rail crossings, and the potential negative consequences when these needs are not met. It has been difficult to actually measure or observe how drivers gather information as they negotiate crossings of different types. Eye-tracking technology has been used for this purpose in other areas of highway safety research.

Research Objective:

Investigate use of eye-tracking cameras or other technologies to provide good, hard data on driver behavior - scan patterns, head movements, which signs they read or ignore, etc. - at a variety of crossings and under different conditions.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Significantly better understanding of driver behavior at highway-rail grade crossings.
- The findings would have many implications for future traffic control devices and highway design research.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service _____

HUMAN FACTORS

Research Need # HF - 17 **TITLE: Driver Behavior: Understanding Responsibilities**

Problem Statement:

What are the driver's perceptions of the risks at highway/rail crossings?

Research Objective:

Determine driver knowledge of highway/rail crossing warning/traffic control devices, risks, laws, and appropriate behavior.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduced highway/rail crossing accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: NHTSA

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 18

TITLE: Train Gap Acceptance

Problem Statement:

Motorists typically accept a gap between other motor vehicles of 6-7 seconds. However, optimal warning times for active warning devices are between 20-40 seconds. This results in warning times that are too long. Additionally, motorists at passive crossings must decide how fast the train is approaching the grade crossing and whether to stop, accelerate through the crossing or maintain speed through the crossing. Making this decision is difficult and erroneous decisions can result in accidents.

Research Objective:

Evaluate the factors that affect the motorist's decision to stop or drive through the grade crossing based upon the rate at which the train approaches the crossing.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Could result in additional warning devices or information aids to help the motorist more accurately judge the train's arrival time at the crossing.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 19

TITLE: Nature of Driver Error

Problem Statement:

Previous research has developed models of driver Perception-Intellect-Emotion-Volition (PIEV) processes that can be applied to highway railroad grade crossings. This research has also identified how "violations" of these models (i.e., driver errors) can be causative factors in grade crossing accidents. Any effort to modify existing engineering, education and enforcement practices, or to develop new 3-E practices, should have available information on the specific types and causes of driver errors that lead to grade crossing accidents.

Research Objective:

Develop quantitative data on the nature of driver errors, e.g., signal detection theory, which can be used as an input to current and future research efforts.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Traffic engineers, highway design engineers and other professionals involved in grade crossing design and operation will have a better understanding of the nature and occurrence of driver errors.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA/NCHRP

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 20

TITLE: Driver Familiarity - Implications for Grade Crossing Safety

Problem Statement:

One concern is that a driver at an unfamiliar crossing, under some conditions, may be unable to properly perceive stimuli, make a decision, and execute the decision because they have no previous experience at the crossing. Similarly, drivers at a familiar crossing may become too accustomed to conditions at the crossing, such that a change is not perceived and acted upon.

Research Objective:

Examine the issue of driver familiarity within the overall context of existing driver behavior models. Quantify the contribution of driver familiarity as a causal factor in grade crossing accidents.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Improved knowledge and understanding of driver familiarity/unfamiliarity, and its implications for highway design, traffic control devices and other safety practices.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 21

TITLE: Driver Behavior

Problem Statement:

Why do drivers take risks at highway/rail crossings?

Research Objective:

Determine cause of risky behavior at highway/rail crossings and demographic profiles of drivers who drive around gates.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduce highway/rail crossing accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA/NHTSA

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 22

TITLE: Institutional Issues: Technology Transfer

Problem Statement:

When are effective passive and active warning/traffic control devices applicable to highway/rail intersections?

Research Objective:

Determine which highway/highway intersection warning/traffic control devices are applicable to highway/rail intersections.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Lower costs due to availability of highway/highway warning/traffic control devices.
- Increased credibility through common understanding of warning/traffic control devices.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 23

TITLE: Driver Perception of Risk

Problem Statement:

1. What key stimuli influence a driver's decision to slow/go/no go, i.e., subjective evaluation of risk?
2. What level of perceived risk determines whether or not the driver stops or goes at a crossing?

Research Objective:

Determine above.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduced near hits.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/FHWA/NHTSA

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 24

TITLE: Social Factors in Crossing Behavior

Problem Statement:

1. Risky actions are influenced by the presence of passengers and the actions of other traffic.
2. Local norms evolve that condone poor actions.
3. Driver attitudes about etiquette and compliance have degenerated.

Research Objective:

1. Identify the factors that pressure drivers into risky performance.
2. Develop countermeasures and evaluate them.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Broadly, safer driver behavior at all types of crossings.
- Fewer accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FTA/FHWA/NHTSA

Other Comments: Applicable to High Speed Rail Service _____

HUMAN FACTORS

Research Need # HF - 25

TITLE: Warning Time Trade-Offs

Problem Statement:

Different crossing users have different time requirements. A typical driver may require only a brief warning time, but a large truck may require more warning time. High speed rail applications may require much longer warning times, especially if the train operator is allowed time to brake if a vehicle intrudes upon the crossing. Excessively long warning times may affect compliance.

Research Objective:

1. Determine the effects of different warning times on overall safety and compliance.
2. Define optimal times for various applications.
3. Investigate methods for minimizing conflicts (e.g., multiple signals, vehicle recognition, etc.).

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: University of Tennessee

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Improved safety and compliance.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/FHWA/ NHTSA

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 26

TITLE: More Effective Crossing Gates

Problem Statement:

Drivers frequently drive around automatic gates. Changes to the size, shape, and overall appearance of the gate might make a more effective physical or psychological barrier.

Research Objective:

Develop and evaluate innovative gate designs and features.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: University of Tennessee & others

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Reduced accidents at gated crossings.
- Greater compliance at crossings - fewer drives around gates.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 27 TITLE: Train Warning Device Malfunctions

Problem Statement:

Even though locomotive horns and headlights may function properly when the trains leave the yard, they may fail en route. The following are concerns:

- 1) What increased risks are created for users of grade crossings under these conditions?
- 2) With what frequency do these events occur?
- 3) What can/should train crews do when these conditions are detected?

Research Objective:

See above.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduced risks to motorists and train crews due to malfunctioning warning devices.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/AAR

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 28

TITLE: In-Train Warning Devices

Problem Statement:

Several proposals exist for placing warning devices in locomotive cabs to advise the crew when crossings are blocked. With all of the tasks and instruments the engineer must attend to, is this likely to be effective?

Research Objective:

1. Determine safety effectiveness.
2. Determine if engineer and/or crew task overload is likely.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA/Volpe Center

Title of Current Research: Locomotive Cab Ergonomics

Potential Benefits of Identified Research Need:

- Prevent task overload of engineer and permit optimal safety performance.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA/Volpe

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 29

TITLE: Post Train Accident Effects

Problem Statement:

1. No standard industry approach to addressing post accident trauma of train crews.
2. Performance effects of such trauma are not well documented, but anecdotal evidence indicates potential for major debilitation.

Research Objective:

1. Measurement of performance effects.
2. Determine potential effects of specialized, mandatory employee counseling.
3. Determine potential benefits of peer and/or group intervention/therapy.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Return to safe operating performance and stable emotional health of valuable employee.
- Public safety assurance.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/Railroad/Labor

Other Comments: Applicable to High Speed Rail Service YES

Research Need # HF - 30

TITLE: ADA Accessibility of Crossings

Problem Statement:

SEE ATTACHED PROPOSAL SUBMITTED ON NEXT TWO PAGES

Research Objective:

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____



United States Architectural and Transportation Barriers Compliance Board

1331 F Street, NW • Washington, DC 20004-1111 • 202-272-5434 (Voice) • 202-272-5449 (TDD) • 202-272-5447 (FAX)

DATE: 6 April 1995

TO: Anya A. Carroll, Workshop Coordinator
John A. Volpe National Transportation Systems Center
USDOT/Research and Special Programs Administration

FROM: Lois E.L. Thibault (x32)
US Architectural and Transportation Barriers Compliance Board

SUBJECT: *Highway-railroad Grade Crossing Safety Research Needs Workshop*

ATTACHMENT: Proposed Research Problem Statement

The US Architectural and Transportation Barriers Compliance Board (the Access Board) is an independent Federal agency charged with developing guidelines for the accessibility of newly-constructed and altered buildings and facilities under the Americans with Disabilities Act of 1990. In 1991, the Board issued--and the Departments of Justice and Transportation adopted--the *ADA Accessibility Guidelines (ADAAG)*. In 1992, the Board proposed amendments to *ADAAG* to include coverage of new construction and alterations in the public right-of-way; adoption of this and other sections is pending. The Access Board also has enforcement responsibilities under the Architectural Barriers Act of 1968, which generally applies the *Uniform Federal Accessibility Guidelines (UFAS)* to work funded with Federal monies, such as that supported under the Highway-aid Act.

Amendments to *ADAAG* proposed in December 1992 (revised and republished in June 1994) as *Section 14 Public Rights-of-Way* included a 2-1/2-inch maximum width for the flangeway gap at pedestrian-railroad grade crossings. This requirement is already contained in *ADAAG Section 10 Transportation Facilities*. Comments from public works and railway interests suggest that a flangeway gap of almost 4 inches is in fact required at some pedestrian crossings on freight lines. This is a substantial barrier to use by persons in wheelchairs.

Please consider the attached Research Problem Statement in your workshop. The Access Board would be pleased to support a research project in this area with its technical expertise in the design and construction of accessible buildings, facilities, and transportation systems. Thank you.

PROPOSED RESEARCH PROBLEM STATEMENT

USDOT/Research and Special Programs Administration
John A. Volpe National Transportation Systems Seminar

Title: Technology Applications for Accessible At-Grade Rail Crossings

Problem: Horizontal flangeway gaps at pedestrian/rail crossings may be as wide as 4 inches where heavy freight must be accommodated; light rail requires as much as 2-1/2 inches of clearance. There have been several reports of wheelchair entrapment at such crossings. The ADA Accessibility Guidelines (ADAAG) limit horizontal gaps in the accessible route to 1/2 inch. New, highly maneuverable wheelchairs may have front wheels with a diameter of 3 inches or less. Wheels of any diameter may swivel and drop into the flangeway when they hit an obstruction. Although gap fillers are available for locations where railcars travel at very low speeds, as in railyards, no products are manufactured for more demanding environments characterized by heavy freight loadings and moderate to high speeds. As light rail systems, transit malls, and transit-oriented development expand, there will be a great increase in pedestrian crossings of rail lines.

Objective: This project should 1) identify and assess the most promising technologies or research directions for the development of a product or system to render at-grade rail crossings accessible for persons using wheelchairs and 2) formulate a plan for research, development, testing, and demonstration.

Key Words: Flangeway, at grade-crossings, rail, ADA, accessibility, wheelchairs

Related Work: None known

Urgency/Priority: High. A guideline proposing technical specifications for the accessibility of public rights-of-way has been proposed by the Access Board and will be considered next year for adoption by the Department of Justice as the standard for regulations implementing title II of the ADA.

Cost: \$150,000

User Community: Grade crossing manufacturers, FRA, AMTRAK, railroads and transit agencies, state public utility commissions, state highway engineers

Implementation: This study should be used to program and fund [a] research and development project[s].

Effectiveness: An accessible at-grade crossing product would eliminate the need for overpass/underpass construction or alternative routings where public sidewalks are interrupted by rail lines.

Submitted by: Lois E.L. Thibault, US Architectural and Transportation Barriers Compliance Board

HUMAN FACTORS

Research Need # HF - 31

TITLE: Truck Driver Needs and Behavior

Problem Statement:

Truck drivers face problems of different vehicle performance abilities and design features. Sight distance is often impaired, especially at oblique rail crossings.

Research Objective:

The research should identify the problems under various crossing geometries and identify possible corrective actions relative to traffic controls, intersection geometries, or cab configuration or design.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Improve safety of large trucks, including better response times.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

**LOW
< \$100,000**

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 32

TITLE: Emergency Vehicle Response

Problem Statement:

Emergency vehicle drivers often behave as if they are exempt from regulations at grade crossings.

Research Objective:

Determine how often this actually occurs, how it can be prevented, and educational resources needed.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduce accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

**LOW
< \$100,000**

Possible Responsible Organization to Conduct Research Need: FHWA

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 33 TITLE: Effect of Demographic Variables on Driver Behavior

Problem Statement:

Initial FRA research has suggested that demographic variables influence total accident occurrence. There is little information on how differing groups make decisions, obey regulations, accept gaps, and/or experience risky behavior.

Research Objective:

Conduct field trials of driver perception and/or response behavior at active and passive controlled crossings, to see how differing sections of the driving population respond.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA

Other Comments: Applicable to High Speed Rail Service _____

Research Need # HF - 34 TITLE: Dual Clearance Time for Autos, HAZMAT and Long Trucks

Problem Statement:

Clearance times differ for autos, HAZMAT/long trucks. Driver acceptance of waiting times versus safety needs to be considered.

Research Objective:

Determine warning time, appropriate design of traffic control system, special device to accommodate this problem.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Decrease truck accidents.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA

Other Comments: Applicable to High Speed Rail Service YES

HUMAN FACTORS

Research Need # HF - 35 TITLE: Bicycles - Different from Motorists

Problem Statement:

Bicycles add another element to the mix of traffic crossing intersections. Dealing with them at rail crossings may require changes in stopping, as well as traffic control placement.

Research Objective:

Assess the traffic control and performance needs of bicycles, including cyclist response to warning signs.

Relationship to Current Research: **NEW**

Potential Benefits of Identified Research Need: **NONE IDENTIFIED**

Urgency of Research Need: **LOW**
Cost to Conduct Research Need: **LOW**
< \$100,000

Possible Responsible Organization to Conduct Research Need: FHWA

Other Comments: Applicable to High Speed Rail Service

Research Need # HF - 36 TITLE: Privacy Intrusion - ITS

Problem Statement:

Modern ITS technology may require automatic vehicle modification or similar in-vehicle technologies. This may be perceived as invasion of privacy by some of the public.

Research Objective:

The research should identify driver response to the automatic vehicle identification and other technologies that may intrude on privacy. This calls for surveys of drivers' attitudes.

Relationship to Current Research: **NEW**

Potential Benefits of Identified Research Need: **NONE IDENTIFIED**

Urgency of Research Need: **LOW**
Cost to Conduct Research Need: **LOW**
< \$100,000

Possible Responsible Organization to Conduct Research Need: FHWA

Other Comments: Applicable to High Speed Rail Service

HUMAN FACTORS

Research Need # HF - 37 TITLE: ITS and its Relationship to Driver and Rail Operators Information

Problem Statement:

As ITS is developed, appropriate grade crossing traffic/train safety should be integrated into this architecture. Driver and train crew needs, expectancies, task loading, etc., should be identified.

Research Objective:

Evaluate how a driver will react to highway information and in-vehicle information. Determine how additional information demands made upon train crews, i.e., use of technologies available today including autoscope, cab signals, operation center, train controls, affect their performance.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Safety (reduced accidents).
- Congestion management.
- Avoiding future 'retrofit' if grade crossings were added to the ITS architecture as an afterthought.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service YES

2.5 CROSSING IMPROVEMENT (ENGINEERING) PROGRAMS

Table 2-5 identifies the delegates responsible for identifying the Crossing Improvement (engineering) Programs research needs.

Table 2-5. Delegates in Crossing Improvement (engineering) Programs Group by Organization

NAME	ORGANIZATION
Ellen Canter	UNISYS/Facilitator
Rick J. Cantwell	ConRail
R. Andrew Davis	OMNI Products, Inc.
Thomas Donahey	Iowa DOT
Jeff Gordon	U.S. DOT/RSPA/Volpe
Hugh Henry	Association of American Railroads
John Hitz	U.S. DOT/RSPA/Volpe
Lawrence Jackson	National Transportation Safety Board
Donald Laschkewitsch	Rail Program Planning Division
Bill Liddell	Canadian Pacific Rail System
Dick Mather	Oregon Public Utilities Commission
Leroy Meisel	Missouri DOT
G. Rex Nicholson	TransTech Group
Hoy Richards*	Richards and Associates
Jeff Schultz	Washington State DOT
John Sharkey*	Illinois Central Railroad
Debbie Swanson	U.S. DOT/RSPA/Volpe
Chuck Taylor**	Association of American Railroads
Francis G. Welsh	Union Switch & Signal Inc.
Tom Zeinz*	Illinois Central Railroad

* - Speakers ** - Chairperson

The complete information developed by the group for each research need is provided on the following pages. The research needs are listed in order of their alphanumeric designator to simplify the analysis in Chapter 3.

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 1

**TITLE: Highway Traffic Control Engineering
Technology Transfer**

Problem Statement:

The selection and specification of highway traffic devices and traffic control strategies at highway/rail intersections are frequently considered separate and apart from the traditional practice of highway traffic control engineering. While much of the past research and literature has focused on the unique characteristics of highway/rail intersections, there is a growing perception that these intersections are but a subset of highway/highway intersections. Generally, the application of more traditional highway traffic control principles and strategies could improve motorist comprehension of the driving decision and tasks they are expected to perform. Also, the consistency of driver education and law enforcement efforts may be aided.

Research Objective:

- Assess the similarities of highway/rail intersections with highway/highway intersections.
- Determine if the “message” being conveyed to motorists at Highway/Rail Intersections is consistent with their comprehension of the expected behavior response.
- Determine whether more traditional highway/highway intersections’ control strategies (use of Stop or Yield signs, use of standard 3-position traffic signals) would improve the consistency of compliance, education and/or enforcement.
- Determine whether redefining of traditional highway/rail crossing signals as regulatory devices rather than warning devices would improve the consistency of compliance, education and/or enforcement.
- Determine the role that highway capacity issues should play in traffic device selection at highway/rail intersections.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Integration of highway-rail traffic control systems with roadway traffic management systems.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 2

TITLE: Highway Median Barrier

Problem Statement:

Median barriers prevent highway traffic from driving around railroad crossing gates. Highway agencies resist the use of median barriers because of additional cost and the introduction of additional traffic obstructions.

Research Objective:

Do possible benefits (accident reduction) outweigh the costs associated with additional roadway maintenance (e.g., snow removal) and vehicle collisions with barriers. Also need to assess alternative designs and design standards.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA

Title of Current Research: Highway Median Barriers

Potential Benefits of Identified Research Need:

- Reduce accidents that involve vehicles driving around gates.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 3

TITLE: Four Quadrant Gate Systems

Problem Statement:

Four quadrant crossing gates are being proposed for high speed rail and complex, high volume grade crossings. Trial installations are underway or being planned. For four quadrant gate systems, there is an immediate need to review exit gate control issues as well as to monitor and evaluate.

Research Objective:

Short Term:

1. Failure modes analysis;
2. Exit gates to fail up or down;
3. Control logic/definition of vehicle detection system inputs & outputs, exit gate system inputs and outputs; and
4. Monitor results of four quadrant crossing gate trial installations in Connecticut, North Carolina, and California.

Longer Term:

1. Examination of life cycle costs of four quadrant and barrier systems; and
2. Develop critical warrant.

Relationship to Current Research:

NEW

Organization Conducting Current Research: FRA/FTA

Title of Current Research: _____

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

LOW

\$100,000 - \$500,000

< \$100,000

Longer-term items

Short-term items

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 4

TITLE: Standard Crossbuck Applications

Problem Statement:

The use of the standard black and white crossbucks as a traffic control device requires motorists to yield to opposing rail traffic. This is often misunderstood by both the motorist and law enforcement officer. The black and white crossbuck installed with flashing lights can lead to driver misinterpretation, especially at night, of the message being displayed.

Research Objective:

1. Evaluate the use of the standard crossbucks alone or in combination with a standard yield sign at passive locations.
2. Evaluate the use of the standard yield sign in place of the crossbuck at a passive location.
3. Evaluate the use of an alternative sign to the standard crossbuck at passive location.
4. Evaluate the use and/or change (including color) of the standard black and white crossbuck at active location.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: Texas A&M/FRA/FHWA

Title of Current Research: Alternative Passive Signs/Buckeye Crossbuck

Potential Benefits of Identified Research Need:

- Improve safety
- Increase credibility

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 5

TITLE: Low-Cost Alternatives to Conventional Warning Devices

Problem Statement:

Approximately 2/3 of the crossings have passive devices. The resources are not available to install conventional warning devices at low density highways.

Research Objective:

Find effective low-cost system that may be used at low density crossings which would warn the motorist of an approaching train or a train occupying the crossing. Research may include the cost/benefit of systems that only detect trains occupying crossings at night. Cost/benefit/risk analysis of system designed to be reliable but not necessarily considered fail safe. Evaluate any compromising of current systems.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Provide warning of trains to motorists at crossings that would normally not rate conventional warning devices.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 6

TITLE: Proper Warning Time with Credibility

Problem Statement:

Over 38% of all fatal accidents occur at crossings with flashing lights or gates. Many human factors reports have highlighted a lack of credibility associated with the flashing lights. Motor vehicle drivers of passenger vehicles will accept a warning time of 7 to 10 seconds or less. Hazardous material trucks and buses require a warning of 15 to 30 seconds. A variable time is needed.

Research Objective:

This research would:

1. Identify the role of time in loss of credibility.
2. Define the time needed by various vehicles to clear.
3. Evaluate existing systems to determine various levels of warning.

For example:

- Flashers could flash initially and go solid.
- Traffic signals could use amber, red flashing and solid.
- Circuit or detection systems would have to be analyzed.

4. This phase would provide for prototype testing in the field if the first three phases indicate that the systems are feasible.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Re-establish credibility with highway-rail signals that could result in a significant reduction in accidents at signalized crossings.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

MEDIUM

> \$500,000

\$100,000 - \$500,000

Phase 4

Phase 1-3

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 7

TITLE: Intelligent Highway-Rail Intersection

Problem Statement:

The U.S. railroad industry and the signal and communication supply industry are examining alternatives to move away from track circuit based signal activation. Other systems within the industry include Global Positioning Satellite Systems. This type of system transports directional radar AVL for determining train location, speed, direction and indication of which track the train is on. These innovations should be investigated and evaluated for use on the design of the intelligent highway-rail intersection.

Research Objective:

1. To investigate and evaluate ITS/ATCS (PTS/PCS) systems that have application in the development of traffic contact, alerting, and motorist's information systems at and on the approach of the highway-rail intersection.
2. To develop and publish a "handbook" of information related to the application of these systems to the highway-rail intersection.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: Texas A&M, IVHS

Title of Current Research: Integration of IVHS/TCS

Potential Benefits of Identified Research Need:

- Improve probability at the highway-rail intersection
- Improve safety at and on the approach to the intersection

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

It is critical to the implementation of ITS technologies with grade crossing safety that a Washington led task force be established and maintained. This task force should coordinate grade crossing safety needs with the ITS community, including FHWA, ITS America, etc.

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 8 TITLE: Proposed National Warrants for the Selection of Warning Devices

Problem Statement:

There are limited criteria and warrants for the installation of warning devices at grade crossings except for the guidance provided by the MUTCD, actual state policies and standards where available. This research is intended as the first step towards the development of such warrants.

Research Objective:

- 1) Investigate existing warrants.
- 2) Assess implementation problems and costs.
- 3) Develop proposed national warrants for vehicular and pedestrian crossings.

Relationship to Current Research:

UNIDENTIFIED

Potential Benefits of Identified Research Need:

- Assemble existing warrants, criteria, and policies.
- Develop proposed national warrants for crossing protection devices.

Urgency of Research Need:

UNIDENTIFIED

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service NO

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 9

TITLE: Off-Track Train Detection

Problem Statement:

The combination of new, lightweight railroad rolling stock, rail lubrication, changes in rail and wheel profiles have resulted in false deactivations of warning systems. While trains are at the crossing this can cause momentary loss of track shunting. This problem is expected to worsen due to increased use of lightweight cars.

Research Objective:

Identify cost-effective off-track train presence detection systems. This should begin with development of functional and performance (reliability) specifications, and evaluations of prototype systems against those specifications.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: _____

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Increases confidence in credibility of warning systems by elimination of false deactivation of warning systems.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 10

TITLE: Quantitative Risk Assessment

Problem Statement:

There is a need for quantitative analysis of risks at various grade crossings as a basis for determining priorities for crossing improvements and assessing effectiveness of innovative crossing warning system alternatives.

Research Objective:

Develop quantitative risk assessment methodology for grade crossings.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA

Title of Current Research: High Speed Rail Crossing Safety Issues

Potential Benefits of Identified Research Need:

- Benefits highway vehicle identification of most cost-effective risk reduction options.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: DOT (FHWA/FRA)

Other Comments: Applicable to High Speed Rail Service: YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 11

TITLE: Audible Warning at Crossings

Problem Statement:

The sounding of train horns at crossings is considered such a nuisance that many communities have passed local ordinances to eliminate whistling, without regard to safety implications. Many existing state laws dictate on-board horn function based on train distance that may lead to excessive horn use. In addition, questions have been raised as to whether or not current horns are the most effective audible warning systems.

Research Objective:

1. Determine need for audible warning at a crossing.
2. If need is confirmed:
 - a) Determine functional need specifications for an effective audible warning system to protect motorists.
 - b) Evaluate prototype systems.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA

Title of Current Research: Action Plan Items G4, J, Appendix II

Potential Benefits of Identified Research Need:

- Maintain public safety while reducing or eliminating a public nuisance.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service: _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 12 TITLE: Identification of Institutional Impediments to Grade Crossing Improvements

Problem Statement:

1. Innovative streamlining opportunities available for crossing improvements are being limited by institutional barriers (real and perceived).
2. Applications of non-traditional traffic control devices/methods (i.e., median barriers) are being prematurely rejected or disregarded due to preconceived opinions, procedures and liability concerns.

Research Objective:

1. Identification of obstacles that restrict implementation of grade crossing improvements:
 - MUTCD approval process
2. Approval processes for testing of new equipment

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- More rapid implementation of low-cost initiatives.
- Reduce number of accidents.
- Innovative crossing safety strategies and technology.

Urgency of Research Need:

UNIDENTIFIED

Cost to Conduct Research Need:

LOW

<\$100,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 13

TITLE: Signal Status Monitoring

Problem Statement:

Crossing device malfunctions have important implications for device credibility. Current means rely heavily on the public and law enforcement officers. Quick response to signal problems, especially on high density roads and streets, requires near real-time reporting. Advanced communication technology may provide an “automated” system for highway-rail signal status monitoring.

Research Objective:

1. Test and evaluate low-cost remote monitoring of highway-rail signal status.
2. Determine cost-effectiveness of proposal systems (include traffic delay, congestion, emergency vehicles, and increase maintenance costs).

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Increased device credibility.

Urgency of Research Need:

UNIDENTIFIED

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service: _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 14 TITLE: Light Rail/Commuter Rail Pedestrian Gates

Problem Statement:

Pedestrians in the vicinity of passenger stations on commuter and light rail transportation systems are in a high risk category for accidents. A way to safeguard pedestrians in these situations is to use gates. Pedestrian gates have no standards or design criteria.

Research Objective:

1. Develop Standards and/or design criteria for the installation of pedestrian gates or other strategic components for commuter and light rail passenger systems.
2. Design should include channelization to direct pedestrians to gates and to prevent passage with a train present.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: TCRP Projects A-5 & A-13

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Reduce pedestrian deaths.

Urgency of Research Need:

UNIDENTIFIED

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 15 TITLE: ADA Compliance for Pedestrian Crossings

Problem Statement:

Horizontal flange-way gaps at pedestrian crossings may be as much as 4 inches which could allow front wheels of wheelchairs to drop into the gap. ADA limits horizontal gaps to 1/2 inch.

Research Objective:

1. Assess costs and alternatives including education and awareness programs and technology improvements.
2. Identify and assess the most promising technology or system to render at-grade rail crossings accessible for persons using wheelchairs.
3. Formulate an implementation plan that is feasible and economical.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

UNIDENTIFIED

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 16

TITLE: Sight Distance Evaluation

Problem Statement:

While a connection has frequently been alleged, it has never been conclusively demonstrated whether or to what degree restricted stopping sight distances may be a significant factor in highway-rail grade crossing collisions. Is this truly a cause of grade crossing accidents or merely indicative of other factors, such as driver inattention and/or a lack of motorist comprehension (especially at passive crossings) of their duty to yield the right-of-way to trains? The preponderance of literature on this subject, including *NCHRP Report #50* and the *Railroad-Highway Grade Crossing Handbook*, is devoid of any consideration of the regulatory function or meaning of the traffic control devices provided at highway-rail intersections in their respective discussions of stopping sight distance.

Research Objective:

1. Determine whether a quantitatively or statistically significant correlation exists between restricted stopping sight distances at highway-rail intersections and the frequency of crossing collisions and, if so, to what extent.
2. If a significant correlation is found to exist, determine whether the nature of such restriction (such as standing rail equipment on an adjacent track, buildings or other fixed structures, seasonal vegetation, etc.) is of any particular relevance. If due to fixed structures or vegetation, is it primarily related to such obstructions on or off the railroad and/or roadway right-of-way (i.e., situations that either the railroad or highway authority have any effective control over)?
3. If restricted stopping sight distances are found to be a significant problem, assess how significant the problem may be in terms of cost or difficulty to correct. Develop cost-effective countermeasures and/or design guidelines with particular consideration given to the types of countermeasures that would normally be taken were this a highway-highway intersection.
4. Examine and assess the relationship between sight distances, traffic control devices and highway capacity at highway-rail intersections as same relate to the selection of traffic control devices and/or any discerned need to develop improved traffic control devices or strategies.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduction in crossing crashes.
- More efficient highway traffic flow.
- Enhance crossing improvement investment decision making processes.
- Confirm, or cause reassessment of, priority and/or urgency of pursuing other identified research needs in related areas.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA, RRs

Other Comments: Applicable to High Speed Rail Service _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 17 TITLE: Innovative Low-Cost Grade Separation

Problem Statement:

Grade separation is the only completely effective protection for grade crossings, especially for high speed full service. The cost of grade separation must be decreased before it can be more fully implemented.

Research Objective:

Develop innovative designs, materials, construction practices, etc., to lower the cost of grade separations.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: Several FRA sponsored demos

Title of Current Research: Low-Cost Separation

Potential Benefits of Identified Research Need:

- The motoring public, rail passengers, train crews, surrounding communities.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/FHWA

Other Comments: **Applicable to High Speed Rail Service** YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 18 TITLE: Video Monitoring/Detection System

Problem Statement:

Video systems may be used to provide advance information to train crews and operations centers in time to take collision avoidance actions if the crossing is blocked. Such systems can also be used in conjunction with 4 quadrant gates. They can also continuously and automatically monitor high risk crossings and provide alarms to the dispatch center if anomalous conditions arise.

Research Objective:

Develop and demonstrate video systems for intrusion detection and monitoring of crossing stations.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: NYSDOT/CALTRAN/LACMTA

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Everyone involved in rail transportation - train crew, dispatch center, passengers, etc.

Urgency of Research Need:

UNIDENTIFIED

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: NYSDOT/AAR/Any 1010

Corridor State

Other Comments: Applicable to High Speed Rail Service

YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 19

TITLE: Low-Cost Intrusion Barriers

Problem Statement:

Intrusion barriers can effectively improve safety at high speed rail crossings. However, their costs must be reduced. Not only are the installation costs high, but the life cycle maintenance costs may also be very costly. The overall life cycle costs for these systems may in fact exceed the cost of grade separation. The cost issue needs to be defined better in order to guide further research.

Research Objective:

1. Perform life cycle cost analyses of barriers in comparison to other alternatives to determine their cost-effectiveness and to guide where further research into these systems may be warranted.
2. Develop low-cost barriers as appropriate, based on initial cost study.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: FRA

Title of Current Research: ISTEA 1036

Potential Benefits of Identified Research Need:

- Motoring public, rail passengers, train crews.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: FRA

Other Comments: Applicable to High Speed Rail Service YES

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 20

TITLE: Humpback Crossing

Problem Statement:

There are no minimum clearance criteria for vehicles such as low boy trucks that result in some vehicles being hung up at crossings.

Research Objective:

Develop minimum clearance for low undercarriage vehicles based on grade crossing profiles.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Low vehicles will not become hung up on crossings and possibly be hit by trains.

Urgency of Research Need:

LOW

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

CROSSING IMPROVEMENT PROGRAMS

Research Need # CIP - 21

TITLE: Advance Warning Messages

Problem Statement:

The motoring public does not have adequate or credible advance warning nor proper information of what to expect at a highway/railroad grade crossing.

Research Objective:

Develop new advance warning signage or system to tell the motoring public what to expect at the crossing such as:

- Operative advance rumble strips.
- Changeable message signs on direction of train and track used, etc.
- The type of warning devices at the crossing.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Low vehicles will not become hung up on crossings and possibly hit by trains.
- Provide credible and accurate information to the motorist to reduce accidents.
- Increase confidence to the motorist concerning the warning devices.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: **Applicable to High Speed Rail Service** YES

2.6 DATA

Table 2-6 identifies the delegates responsible for identifying the Data research needs.

Table 2-6. Delegates in Data Group by Organization

NAME	ORGANIZATION
Frann Bell	National Transportation Safety Board
Bill Berg*	University of Wisconsin
Brian Bowman**	Transportation Research Board
Matt Brooks	Indiana DOT
Richard Brown	Iowa DOT
Dennis Burkheimer	Iowa DOT
Fred Coleman	University of Illinois
Jim Curry	Engineering Management Consultants
Mahmood Fateh	U.S. DOT/FRA/R&D
Bernadine Hayes	UNISYS/Facilitator
Susan Kirkland	Ohio DOT
Terry Klein*	U.S. DOT/NHTSA
Andrew Kleine	U.S. DOT/OST
Norman Knable	U.S. DOT/RSPA/Volpe
Fred Loehfelm	Wireless Technology
Joe Noffsinger	ConRail
Ed Pederson	SCRRRA
John Smith	U.S. DOT/RSPA/Volpe
Jim Sotille	U.S. DOT/FRA/Safety

* - Speakers ** - Chairperson

The complete information developed by the group for each research need is provided on the following pages. The research needs are listed in order of their alphanumeric designator to simplify the analysis in Chapter 3.

DATA

Research Need # D - 1

Title: Data Requirements for Highway-Rail Grade Crossing

Problem Statement:

Current highway-rail grade crossing information is fragmented into many different databases located in various organizations. This information is also not coordinated in terms of what is collected. Multiple public and private organizations (customers of the data) have diverse data needs. Data necessary for some types of critical assessments are not being collected. New technology offers opportunities for more broad-based and cost-effective data collection and management, which are not currently being fully utilized. In addition, the various modes (FRA, NHTSA, FHWA) that currently collect these data are only informally coordinated in terms of data collected and required.

Research Objective:

- Identify data requirements for a broad range of safety studies (e.g., accident causation, development of target populations, countermeasure evaluation, program cost-effectiveness) and issues important to users and customers both internal and external to DOT.
- Evaluate current data elements and data collection and/or management systems.
- Evaluate new data collection, storage, retrieval technologies.
- Develop recommendations for specific data to be collected, how it will be collected and managed, and organizations responsible for these activities.

Relationship to Current Research:

SUPPLEMENTAL/NEW

Potential Benefits of Identified Research Need:

- Permits risk assessments, evaluations and benefit/cost analyses that are currently not possible due to lack of data.
- Permits single point of contact for better servicing of customer information needs.
- Reduces cost of data collection and management.
- Facilitates decision making and permits more cost-effective safety programs and activities.
- Promotes intermodal collaboration in the development and implementation of effective countermeasures to mitigate the highway-rail crossing safety problem.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: Team FRA-NHTSA-FHWA-BTS

Other Comments: **Applicable to High Speed Rail Service** YES

DATA

Research Need # D - 2

TITLE: Data Integration Working Group

Problem Statement:

Grade crossing safety issues involve multiple modes that currently have no single point of contact for defining and establishing data needs.

Research Objective:

- Create multimodal team to define and establish data needs.
- Reduce duplication of data collection by different modes.
- Create data system that provides information that meets internal and external customer needs.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduce duplications.
- Data consistency.
- Data more available and easier to use.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: FRA, FHWA, NHTSA,
internal & external customers, (states, municipalities, universities, railroads)

Other Comments: Applicable to High Speed Rail Service _____

Research Need # D - 3

TITLE: Grade Crossing Inventory

Problem Statement:

The railroad grade crossing inventory was established in the early 1970s and relies on the voluntary update of the railroads and roadway agencies. In addition there are data items, such as sight distance, that could be added to the inventory and that would result in the ability for enhanced data use. The current inventory is inaccurate in its operational and geometric descriptors, political jurisdiction, train data and train detection information. The result is inaccurate prioritization of crossings for safety improvements and the selection of inappropriate countermeasures.

Research Objective:

Update the FRA inventory requiring actual ADT data, updated geometric and operational data and additional data items such as sight distance and percentage ADT growth factors.

Relationship to Current Research:

SUPPLEMENTAL/NEW

Organization Conducting Current Research: FRA

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- Increased accuracy of accident prediction formula.
- Enhanced ability to select appropriate countermeasures.
- Accurate summaries of accident occurrence by crossing and warning device type.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

HIGH

> \$500,000

Possible Responsible Organization to Conduct Research Need: FHA/FRA

Other Comments: Applicable to High Speed Rail Service _____

DATA

Research Need # D - 4

TITLE: Exposure Measures

Problem Statement:

Although extensive data is available on train-vehicle collisions at railroad crossings, valid measures to represent the exposure of vehicles and trains to collisions are not available. To permit a more meaningful interpretation of this data this issue should be addressed.

Research Objective:

Develop relevant exposure measures of vehicles and of trains to crash risk. These measures are applicable to existing data and/or could be generated for future accident data. The potential use is countermeasure effectiveness and assessing benefit/cost ratios.

Relationship to Current Research:

SUPPLEMENTAL/NEW

Organization Conducting Current Research: NHTSA

Title of Current Research: _____

Potential Benefits of Identified Research Need:

- A more complete interpretation of accident data may help define other research needs, as well as assist in setting priorities for funding.

Urgency of Research Need:

HIGH

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA/NHTSA/Volpe

Other Comments: Applicable to High Speed Rail Service _____

Research Need # D - 5

TITLE: Performance Measures

Problem Statement:

The Federal Government is moving toward greater use of performance measures to evaluate the effectiveness of programs. There are currently no clear, agreed upon performance measures for rail-highway crossing safety programs.

Research Objective:

To develop performance measures by which we can assess the effectiveness of rail-highway safety programs. The measures should include accident statistics, driver response, near-hits, non-train accidents, and conflicts.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FRA/FHWA/Volpe

Other Comments: Applicable to High Speed Rail Service _____

DATA

Research Need # D - 6

TITLE: Sight Distance Analysis

Problem Statement:

Sight distance is widely acknowledged as a causal factor in rail-highway grade crossing accidents, but data on sight distance is not collected at accident sites and is not used in accident prediction formulas.

Research Objective:

To determine the effect of sight distance as it relates to rail-highway grade crossing safety under conditions of season, accident investigation, and utilization in accident prediction formulas.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/Universities/
State DOTs

Other Comments: Applicable to High Speed Rail Service _____

Research Need # D - 7

TITLE Safety Measures for Highway-Rail Grade
Crossings with Special Needs

Problem Statement:

Many grade crossings have similar characteristics that create needs which are not currently being addressed due to the lack of cost-effectiveness of traditional special warning system design requirements. These unique crossings include those where a high volume highway is immediately adjacent to the railroad right-of-way. Another instance is where a low volume road crosses a high-speed, high volume, double-main track. Both of these conditions have view obstructions due to vehicle configuration and crossing angle.

Research Objective:

- Analyze driver information needs based on unique crossing characteristics.
- Evaluate application and/or design guidelines that would be potentially cost-effective in meeting the unique needs of drivers.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Reduce accident occurrence at grade crossings that are not presently being addressed under current programs.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA/RPI

Other Comments: Applicable to High Speed Rail Service YES

DATA

Research Need # D - 8

TITLE: Cost and Benefits of Highway-Rail Safety Improvements

Problem Statement:

Data on the full costs and benefits of highway-rail safety improvements is incomplete and underutilized in resource allocation decisions. The ability to determine the cost/benefits for each of the users (i.e., railroads, roadway, public) is necessary to help allocate costs.

Research Objective:

To determine the full cost and benefits, as well as their distribution, of common rail-highway safety improvement countermeasures to aid in resource allocation and achieve safety improvement goals.

Relationship to Current Research:

UNIDENTIFIED

Potential Benefits of Identified Research Need:

- Will enable states to make more informed resource allocation decisions and allow us to wisely assess new technologies.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FRA/FHWA/Volpe/Univ.

Other Comments: Applicable to High Speed Rail Service _____

Research Need # D - 9

TITLE: Foreign Experience with Warning Devices

Problem Statement:

Foreign countries have experience with alternative warning devices. The effectiveness of these devices in these foreign countries can be extrapolated for use in the U.S. without performing installation and testing.

Research Objective:

Obtain data to determine:

- The effectiveness of devices used in foreign countries.
- How that effectiveness can be translated into expected U.S. accident occurrence.

Relationship to Current Research:

SUPPLEMENTAL

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

DATA

Research Need # D - 10

TITLE: Expert System

Problem Statement:

Train-vehicle accident data is obtained from a number of sources, including: state, county, and local police; railroad companies; and the FRA. The circumstances of train accidents require specialty training given to investigators to help identify accident causes. These skills are not present in the police departments or with many of the railroad companies or their representatives. Without the proper expertise at the accident scene, there is frequently loss of vital information. This vital information can be used to assist in tort suits and in identifying required upgrades.

Research Objective:

To develop an expert system (including a computer program to assist and prompt a relatively inexperienced data collector) to collect expert data at an accident site.

Relationship to Current Research:

UNIDENTIFIED

Potential Benefits of Identified Research Need:

NONE IDENTIFIED

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

UNIDENTIFIED

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

Research Need # D - 11

TITLE: RR Accident Investigations Team

Problem Statement:

Train - vehicle accident data is obtained from a number of sources, including: state, county, and local police; railroad agencies, and the FRA. The circumstance of train accidents requires specialty training given to investigators to help identify accident causes. These skills are not present in the police departments or with many of the railroad companies or their representatives. Without the expertise at the accident scene there is frequently a loss of vital information that can be used to assist in tort suits and in identifying required upgrades.

Research Objective:

Establish trained accident investigation teams strategically placed in each state to respond to train-vehicle accidents.

Relationship to Current Research:

UNIDENTIFIED

Potential Benefits of Identified Research Need:

- Enhanced data for defense in tort litigations.
- Improved data for identification of required countermeasures.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000 - \$500,000

Possible Responsible Organization to Conduct Research Need: FHWA/FRA

Other Comments: Applicable to High Speed Rail Service _____

DATA

Research Need # D - 12**TITLE: “Lessons Learned” Analysis****Problem Statement:**

Considering the lead time for the research and development funding cycle from concept to implementation, the 50% reduction in fatalities goal may depend on the successful application of “lessons learned” from the past.

Research Objective:

Perform a comprehensive analysis of the available historical data (grade crossing accident data) to distill the “lessons learned” concerning the relative effectiveness of available treatments. Identify the device applications of “what works” in the new goal to further reduce fatalities by 50% within 10 years.

Relationship to Current Research:**SUPPLEMENTAL/NEW****Potential Benefits of Identified Research Need:**

- Cost-effective accomplishment of the new goal of 50% reduction in fatalities within 10 years.

Urgency of Research Need:**MEDIUM****Cost to Conduct Research Need:****LOW****< \$100,000****Possible Responsible Organization to Conduct Research Need: FRA/FHWA/Volpe****Other Comments: Applicable to High Speed Rail Service _____****Research Need # D - 13****TITLE: Train Operating Practices at
and in the Vicinity of Crossings****Problem Statement:**

Obtain data that can be used to determine actual train operational practices in the vicinity of crossings. This is primarily concerned with switching consist storage and low speed operations.

Research Objective:

To obtain data on:

- The distance of consist storage away from the roadway.
- Flagging operations for low speed or little used crossings.

Relationship to Current Research:**NEW****Potential Benefits of Identified Research Need:**

- Compilation of a database that can be used to help identify highway visibility and operational problems resulting from adherence and/or deviation from railroad operations.

Urgency of Research Need:**LOW****Cost to Conduct Research Need:****LOW****< \$100,000****Possible Responsible Organization to Conduct Research Need: _____****Other Comments: Applicable to High Speed Rail Service _____**

DATA

Research Need # D - 14

**TITLE: Maintenance & Crossing Improvement
Concerns of Shortline Railroads**

Problem Statement:

Shortline railroads are frequently under funded and have problems in performing required maintenance and crossing improvement functions. Complicating this fact are requirements that used warning equipment cannot be reused at another crossing without extensive rehabilitation.

Research Objective:

Obtain data to determine:

- Cost-effective methods of rehabilitating used warning device equipment.
- Cost sharing strategies that will enable the upgrade of shortline crossings.

Relationship to Current Research:

NEW

Potential Benefits of Identified Research Need:

- Increased surface crossing conditions.
- Enhanced warning devices for shortline crossings.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

LOW

< \$100,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

DATA

Research Need # D - 15

TITLE: Railroad Whistle Operational Practices

Problem Statement:

The Florida whistleban study was effective in demonstrating that whistle practice could reduce accidents. Since it is effective, there should be a study on whistle operational practices and their effect on the train crew and roadway uses. The following are issues that need to be resolved:

- Locations of whistle boards are not responsive to train speed resulting in different times between whistle application to train arrival.
- Research is currently being done on stationary whistles and their impact on traffic and environmental noise pollution. Could this concept be widely applied?
- What data is required to determine the best method of infusing whistle sound into large truck cabs and environmentally closed vehicles? Is this a candidate for ITS concepts?
- Are train crews reluctant to use the whistle due to possible hearing loss effects?

Research Objective:

Obtain data to determine:

- Location of whistle boards as a function of train operating speeds.
- Effectiveness of stationary whistles.
- Actual train crew whistle practices.

Relationship to Current Research:

SUPPLEMENTAL

Organization Conducting Current Research: Anderson & Associates

Title of Current Research: Automated Horn System Research

Potential Benefits of Identified Research Need:

Determine the need for optimizing current train whistle practice.

Urgency of Research Need:

MEDIUM

Cost to Conduct Research Need:

MEDIUM

\$100,000-\$500,000

Possible Responsible Organization to Conduct Research Need: _____

Other Comments: Applicable to High Speed Rail Service _____

3. DISCUSSION AND ANALYSIS OF IDENTIFIED RESEARCH NEEDS

This chapter provides a discussion and analysis of the identified research needs from the Highway-Railroad Grade Crossing Research Needs Workshop. The initial section, 3.1 - *Key Issues Identified*, reviews some of the major issues identified and discussed during the first day of the workshop. These issues formed the basis for many of the research needs identified during the course of the workshop. The issues are shown by the five topical areas. The research needs subsequently identified in response to these issues are also presented, as applicable.

Section 3.2 provides an analysis of all research needs identified according to their urgency, i.e., high, medium, low and unidentified, by research need number and title only. For explicit information on any research need identified, see Chapter 2, Sections 2.2 through 2.6.

The process of prioritizing the highly urgent research needs is discussed in Section 3.3. The highly urgent research needs are presented in tabular form by research number, title and rank as shown in Section 3.4. Finally, results of analyses completed on "all other urgency" research needs are shown in Section 3.5 by type of analysis.

3.1 KEY ISSUES IDENTIFIED

A review of some of the major issues identified and discussed during the first day of the workshop is presented in this section. Many of these issues formed the basis for the development of identified research needs. The issues are reviewed by the five topical areas. Specific research needs subsequently identified to address these concerns are also presented, as applicable.

3.1.1 Driver (public) Education Issues and Comments

The following is a list of issues and comments raised during discussions following the presentations by: John Killpack of Global Exchange on a historical perspective of Driver (public) Education; and Barbara Brody of the Vermont Department of Education on innovative approaches to Driver (public) Education. Copies of the Driver (public) Education papers presented are provided in Volume II, Appendix D.

Issues Identified:

Who should be the target audience?

- Continued education for all drivers.
- Teenage drivers need special education.
- Low-cost educational programs are available (e.g., The Vermont Mock Crash cost \$3,500.00, of which \$1,500.00 went to the four rescue groups involved).

What message should be used?

- Emotional messages seem to be the key to getting the attention of the motoring public.

What does the public perceive about crossing warning devices now?

- The public has a disregard for passive signs.
- The public expects to see active warning devices as a minimum.
- The public has a disregard for the train horn as a warning device.
- A comment was made as to a program to get the public involved in grade crossing issues as follows:

The "Blockage Law" in Oregon has gotten the public involved. Some municipalities have encouraged drivers to note length of track blockages, and if it exceeds the Law's allowable maximum, the railroads are fined.

Research Needs Subsequently Identified that Address Above Issues:

DE-1	Determining Educational Target Audiences
DE-2	Survey of Current and Completed Educational Research
DE-3A	Survey of Existing Educational Programs
DE-4A-D	Educational Effectiveness Evaluations

3.1.2 Enforcement Issues and Comments

The following is a list of issues and comments raised during discussions following the presentations by: Yvonne Shull of NHTSA on a historical perspective of enforcement; Les Reel of the Ohio Highway Patrol on current enforcement research; and Lou Hubbaud, of the LA County MTA, and Hans Korve, of Korve Engineering, on innovative approaches to enforcement. Copies of the Enforcement papers presented are provided in Volume II, Appendix E.

Issues Identified:

Who should be the target audience for Enforcement Education?

- Education of Law Enforcement Officials is needed.
- Education of Judicial Officials is needed.

Two nationwide examples of how to accomplish these tasks were mentioned:

- 1) In 1986 a regional workshop in Albany was held. Through the efforts of the state coordinator and ConRail, a special train with judges onboard was run. This provided an excellent opportunity for the judges to understand the current situation.
 - 2) The Operation Lifesaver Program has conducted similar programs, where judges and prosecutors are invited to ride on the train and from inside the train they can observe the violations that are occurring via video cameras. This process makes the issue much more real for them.
- Enforcement techniques for drivers should differ for passive versus active warning devices at crossings.
 - Targeting enforcement efforts for law enforcement officials in terms of these criteria: urban versus rural; type of crossing; and type of roadway.

- Public access to notification procedures of appropriate officials in the event of problems at crossings. Who does the public call? A few nationwide examples were given as follows:

Comment: At present Oregon requires the railroads to submit to the public utility on January 1st, phone numbers which police departments and the general public may call if there's a problem. Many of the railroads now have business cards with 800 numbers for this specific purpose. This system has worked out very well. It was noted, however, that it is important when passing out business cards/phone numbers to alert people that they are not calling the local dispatcher.

Comment: A participant from Texas noted that their state notification system does go directly to the State Police, and this process has worked very well. The police and county constables are familiar with the program. They credit their success to having the notification come through the police. Not only do people need to be aware of the right number, but the call needs to go to the right person.

Comment: Years ago in Palm Beach Florida, a demonstration project was performed locally where the police were asked to emphasize grade crossings for about a month. During that period, the local news media highlighted police efforts in this area. Whenever there was a citation the media would publicize it, resulting in a dramatic increase in obedience to traffic control devices. Unfortunately when the emphasis by police and media ended, the compliance by motorists decreased as well. If we could maintain such efforts continually it would be a very positive step.

What are the issues pertaining to fines for crossing violators?

- No fines should be levied on a driver who encounters malfunctioning gates.
- The problem of social facilitation was raised. If somebody runs around a gate other traffic will try to follow. If a detector and logic circuitry were in place, a light or alarm could be set off to let other motorists know that this person has been caught even if a camera isn't there.
- The motoring public needs to be involved in the allocation of grade crossing fines, and the fines should be directed to further enhance enforcement.

What are the issues pertaining to photo enforcement at crossings?

- Photo enforcement is less expensive than video enforcement. Photo enforcement is a credible technique. It is currently used for violations at red lights. Some states require more information to be shown when video enforcement is used.
- A comment was made as to the endorsement of photo enforcement as shown below:

In terms of the legislation question, as part of the Rail Summit Secretary Peña endorsed this legislation and the idea that each state should have legislation to: 1) explain and condone the use of photo enforcement for citations; and 2) return a portion of the money back to the states and the law enforcement agencies. The LACMTA is trying to work with the U.S. DOT to make that happen nationwide.
- Some states do not require front license plates on motor vehicles. The photo enforcement currently in use in Los Angeles uses the front license plates for

identification of the vehicles. There would be a need to adjust the technique in order to attempt to capture an image of a rear license plate on a motor vehicle.

What are the regulatory issues pertaining to crossings?

- In Canada the crossbuck is in the final stages of being moved up into the regulatory signs area of the MUTCD.
- The actual trend in Europe on that issue is that with warning devices they're going the other way and using the traffic signal as the primary regulatory device and the crossbuck as a warning. For active crossings they treat it as an intersection and use the crossbuck to identify what it is (a railroad crossing) and then possibly supplement it by a gate depending on train speed, traffic, train frequency, type of intersection, etc.

What are the issues pertaining to the use of traffic control devices at crossings?

- The following exchange of ideas was made pertaining to the use of traffic signals at crossings:

In Oregon, there was a situation on tracks where there would be a steady green all day, even for a few days. When the train came, people were so used to the green that they'd continue through even when the train was coming. This caused a number of accidents. Should traffic lights at railroad crossings be activated all of the time?

This is an important issue. When the interval between trains is fifteen minutes or longer, the standard is to go with a two section head as opposed to a three section head. This would mean the motorist would see a blank traffic signal until the amber and then red lights come on; green would never appear. In Dusseldorf, Germany they've had such a light there for three years, with trains coming every 15 minutes, 18 hours a day, and there has never been an accident.

Comments: The following comments address current research, a perspective on light rail research, and data issues for light rail systems:

The TCRP is a project currently being performed for the Transportation Research Board (TRB). First off, the project reviewed the operations of approximately ten light rail systems in North America to identify their practices. This process included shooting a video of their systems "through the operator's eye." That is, a camera with audio capabilities was placed in the cab. This video provided critical perspective and was very enlightening. The same thing was performed at all of the cross streets, with the video shooting from both the auto driver's and pedestrian's perspective. A number of projects resulted from this research. A separate chapter was written for the manual of uniform traffic control devices that will cover light rail crossings. This chapter is soon to be voted on by the TCRP panel and will then be submitted to MUTCD for their June '95 meeting in Seattle. It will be considered for adoption into the 1997 manual update. Guidelines were also developed both in terms of design and operation.

Interesting research is being performed in the area of traffic devices, e.g., devices that tell pedestrians which way the train is coming or which way to look when the train is coming. It will be important to set up a process to test such devices and evaluate them in a consistent manner. One thing that was found when collecting accident data is that there is no consistent form of data because the standards are not tough enough and not applied uniformly. At present, when working with such data, a considerable amount of time is spent interpreting it.

Research Needs Subsequently Identified that Address Above Issues:

E-1	Training and Model Enforcement Policies
E-3	Increase Fines and Penalty Assessment
E-2	Photo Enforcement
E-5	Law Enforcement
HF-10	Applicability of Highway Traffic Control Devices at Railroad Grade Crossings
CIP-1	Highway Traffic Control Engineering Technology Transfer

3.1.3 Human Factor Issues and Comments

The following is a list of issues and comments raised during discussions following the presentations by: Neil Lerner of COMSIS on a historical perspective of human factor concerns; Tom Raslear of the FRA's Office of Research and Development on current issues in human factors research; and John Tolman of the Brotherhood of Locomotive Engineers on innovative issues in human factors, i.e., the effect of accidents and incidents on locomotive engineers and crews. Copies of the Human Factors papers presented are provided in Volume II, Appendix F.

Issues Identified:

The need to consider additional warning times for special conditions was mentioned.

The credibility of active signal warning devices is a key issue for obtaining appropriate driver response at grade crossings.

Is there anything that can be done to warning devices to improve the signal to noise ratio?

From the point of view of the signal analysis theory presented, there are a few things that can be done. For instance, illumination can be provided at grade crossings because that's going to make the train, as it enters into the intersection/crossing, more distinguishable from its background. Anything that is done on the train increases the signal to noise ratio. For example, if bells and whistles are added the signal to noise ratio will increase; if they are taken away the ratio moves in the opposite direction.

Putting things at the grade crossing may in fact add to the visual clutter and decrease the signal to noise ratio. More uniformity in train appearance will help the signal to noise ratio.

A model of this is contained in Tom Raslear's paper (Volume II, Appendix F). It is not a finished product but more of a suggestion. It provides a more rational approach to capturing all of the psychological information and all of the potential engineering information that one has available and puts it into use where one can manipulate variances and determine trade-offs.

Research Needs Subsequently Identified that Address Above Issues:

HF-25	Warning Time Trade-offs
CIP-6	Proper Warning Time with Credibility
HF-2	Effectiveness of Low-Cost Countermeasures for Passive Crossings

3.1.4 Crossing Improvement (engineering) Program Issues and Comments

The following is a list of issues and comments raised during discussions following the presentations by: Tom Zeinz of the Illinois Central Railroad on a historical perspective of Crossing Improvement (engineering) Program concerns; John Sharkey of the Illinois Central Railroad on current research on Crossing Improvement (engineering) Programs; and Hoy Richards of Richards & Associates on innovative approaches to Crossing Improvement (engineering) Programs. Copies of the Crossing Improvement (engineering) Program papers presented are provided in Volume II, Appendix G.

Issues Identified:

What are the institutional barriers currently existing?

- Institutional barriers exist to test innovative warning devices at grade crossings under real world conditions.
- The comment was made that there is a real need for warrants on grade crossing warning device applications.
- The institutional component does seem to be a significant problem.
- Since the whole effort of reinventing government is occurring now, the idea of instituting government advisory committees should probably be investigated. The MUTCD is good, but the processes it uses need to be examined.

What is the AAR doing to foster innovation at crossings?

- An AAR task force is examining the island circuit, and they are looking at manufacturers of island detection systems. It has been suggested that the task force look at the reliability of the directional stick logic circuit as related to exposure.
- AAR will produce a white paper shortly on technical upgrades for highway-rail grade crossings.
- A new research item was suggested for the AAR: determining the height of median barriers at crossings.

Comment: If new communication systems are used they will be extremely valuable in the event of any type of accident, not just at grade crossings. Being able to access the accident sites and determine the number injured and how/where to dispatch the injured is practical. These new onboard communication systems will be great for grade crossings and others as well.

Research Needs Subsequently Identified that Address Above Issues:

CIP-8	Proposed National Warrants for the Selection of Warning Devices
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements

3.1.5 Data Issues and Comments

The following is a list of issues and comments raised during discussions following the presentations by: Bill Berg of the University of Wisconsin on a historical perspective of data issues; Terry Klein of NHTSA on current research on data issues; and Linda Meadow of Los Angeles County MTA on innovative techniques to obtain data. Copies of the Data papers presented are provided in Volume II, Appendix H.

Issues Identified:

Warning time credibility was again mentioned as a key issue to be addressed.

What are the issues that need to be addressed to obtain useful data about crossing accidents?

- The use of behavioral analysis was suggested to determine passive crossing sign effectiveness due to the very low expected accident rate normally seen at these crossings.
- Drivers may in fact be trying to do what's right but they don't have the correct information, enough information, or they don't have the information at the time they need it. The suggestion was made to increase railroad employee education via a quantitative procedure to measure site distance for motorists.
- The comment was made that exposure data is a critical issue for crossing research.

Comments: A suggestion was made to continue the NHTSA data research effort to include frontal versus side impact issues.

The question was posed in reference to winter months and their possible relationship to higher accident rates due to increased hours of darkness. There could possibly be a relationship, however, 65% of the higher incidents of crashes/fatal accidents occurred during the day. This could be a conspicuity issue within the railroad environment, because it isn't seen with fatal motor vehicle crashes.

Research Needs Subsequently Identified that Address Above Issues:

- D-7 Safety Measures for Highway-Rail Grade Crossings with Special Needs
- D-13 Train Operating Practices at and in the Vicinity of Crossings
- HF-25 Warning Time Trade-offs
- CIP-6 Proper Warning Time with Credibility
- D-1 Data Requirements for Highway-Rail Grade Crossings
- D-2 Data Integration Working Group
- D-3 Grade Crossing Inventory
- D-4 Exposure Measures
- D-5 Performance Measures

3.2 ANALYSIS OF ALL RESEARCH NEEDS IDENTIFIED

This section of the report presents, by title, all formal research needs identified by all topical area groups. The topical area groups synthesized a total of ninety-two formal research needs. These needs are summarized in Table 3-1 in order of their presentation during the first day of the workshop.

Table 3-1. Distribution of All Research Needs Identified

RN #	TOPICAL AREA
10	Driver (public) Education
8	Enforcement
38	Human Factors
21	Crossing Improvement (engineering) Programs
15	Data

All research needs identified are presented in the next four tables by category of urgency:

- Table 3-2 High Urgency
- Table 3-3 Medium Urgency
- Table 3-4 Low Urgency
- Table 3-5 Unidentified Urgency

All research needs are identified by research need number and title only.

There are a few points that should be made about the following tables. First, it should be noted that the high urgency research needs were initially categorized as such by the topical area group that developed the needs. However, HF-18 and DE-4A through DE-4D, two of the high urgency needs, were not categorized as such until the entire delegation met in a plenary session on the third day of the workshop.

Second, the number of high urgency needs identified in each topical group varies, in part, depending on the level of consolidation of the research need. For example, the research need E-2, *Training and Model Enforcement Policies*, encompasses a broad range of target training audiences as well as encompassing two enforcement ideas, i.e., training and legislative issues. The same is true for the two Data needs found in the high urgency list. Therefore, the number of

research needs in these areas are less than those of Crossing Improvement (engineering) Programs, Driver (public) Education, and Human Factors.

Third, the medium urgency list includes research needs from all topical area groups, however, the remainder of all Data research needs identified can be found in this category. This could be an indication that the participants felt Data is critical to accident reduction research. As a general rule, all of the groups tended not to categorize research needs by low urgency. The last category, "unidentified urgency," consists solely from the Crossing Improvement (engineering) Program group. This may simply reflect that this group did not have enough time to rank all needs by urgency.

Table 3-2. High Urgency Research Needs Identified

RN #	TITLE
DE-1	Determining Target Audiences
DE-2	Survey of Current and Completed Research
DE-3A	Survey of Existing Programs
DE-3B	Funding Sources
DE-4 A-D	Educational Effectiveness Evaluations
E-1	Training and Model Policies
E-2	Photo Enforcement
HF-1	Effects of Sight Distance on Driver Behavior
HF-2	Effectiveness of Low-Cost Countermeasures for Passive Crossings
HF-4	Unique Advance Warning Signs for Active and Passive Crossings
HF-6	Causal Analysis of Accidents Involving Grade Crossings
HF-9	Vehicle Activated Strobe
HF-10	Applicability of Highway Traffic Control Devices at Railroad Grade Crossings
HF-11	Interim Improvements at Grade Crossings
HF-12	Rail Car Conspicuity
HF-14A	Train Horns
HF-14B	Wayside Horns
HF-15	Factors Affecting Credibility of Grade Crossing Warning Devices
HF-18	Train Gap Acceptance
HF-22	Institutional Issues: Technology Transfer
HF-23	Driver Perception of Risk
HF-25	Warning Time Trade-offs
HF-28	In-Train Warning Devices
HF-29	Post Train Accident Effects
HF-37	ITS and its Relationship to Driver and Rail Operators Information
CIP-1	Highway Traffic Control Engineering Technology Transfer
CIP-2	Highway Median Barriers
CIP-3	Four Quadrant Gate Systems
CIP-4	Standard Crossbuck Applications
CIP-5	Low-Cost Alternatives to Conventional Warning Devices
CIP-6	Proper Warning Time with Credibility
CIP-7	Intelligent Highway-Rail Intersection
CIP-8	Proposed National Warrants for the Selection of Warning Devices
CIP-9	Off - Track Train Detection
CIP-21	Advance Warning Messages
D-1	Data Requirements for H-R Grade Crossing Safety
D-2	Data Integration Working Group
D-3	Grade Crossing Inventory
D-4	Exposure Measures

Table 3-3. Medium Urgency Research Needs Identified

RN #	TITLE
DE-5	Sensitivity of Education to Age and Approach
DE-6	High Speed Rail
E-3	Increase Fines and Penalty Assessment
E-4	911 Versus Railroad Telephone Number
E-5	Law Enforcement
E-7	Altering Bad Driving Habits
HF-7	In-Vehicle Warning Devices
HF-8	Effects of Crossing Closures
HF-13	Assessment of Vehicle Occupant-Kinematics, etc.
HF-16	Study Driver "Information Gathering" Processes at Crossings
HF-17	Driver Behavior: Understanding Responsibilities
HF-19	Nature of Driver Error
HF-20	Driver Familiarity - Implications for Grade Crossing Safety
HF-21	Driver Behavior
HF-24	Social Factors in Crossing Behavior
HF-26	More Effective Crossing Gates
HF-27	Train Warning Device Malfunctions
HF-30	ADA Accessibility of Crossings
HF-31	Truck Driver Needs and Behavior
HF-32	Emergency Vehicle Response
HF-33	Effects of Demographic Variables on Driver Behavior
HF-34	Dual Clearance Time for Autos, HAZMAT and Long Trucks
CIP-10	Quantitative Risk Assessment
CIP-11	Audible Warning at Crossings
CIP-16	Sight Distance Evaluation
CIP-17	Innovative Low-Cost Grade Separation
CIP-19	Low-Cost Intrusion Barriers
D-5	Performance Measures
D-6	Sight Distance Analysis
D-7	Safety Measures for H-R Grade Crossings with Special Needs
D-8	Cost and Benefits of Highway-Rail Safety Improvements
D-9	Foreign Experience with Warning Devices
D-10	Expert System
D-11	RR Accident Investigations Team
D-12	"Lessons Learned" Analysis
D-13	Train Operating Practices at and in the Vicinity of Crossings
D-14	Maintenance & Crossing Improvement Concerns of Shortline RRs
D-15	RR Whistle Operational Practices

Table 3-4. Low Urgency Research Needs Identified

RN #	TITLE
E-6	Financial Issues
E-8	Enforcement Interaction
HF-3	Driver Acceptance of High Speed Rail Crossing Barriers
HF-5	Human Factor Issues Surrounding the Use of Mobile Barriers
HF-35	Bicycles - Different from Motorists
HF-36	Privacy Intrusion - ITS
CIP-20	Humpback Crossing

Table 3-5. Unknown Urgency Research Needs Identified

RN #	TITLE
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements
CIP-13	Signal Status Monitoring
CIP-14	Light Rail/Commuter Rail Pedestrian Gates
CIP-15	ADA Compliance for Pedestrian Crossings
CIP-18	Video Monitoring/Detection System

3.3 PRIORITIZATION OF HIGH URGENCY RESEARCH NEEDS

After a productive day of identifying ninety-two formalized research needs, the entire delegation met at the Volpe Center Auditorium on Thursday to hear presentations by the Chairperson of each topical area group. This section provides a summary of the Chairperson presentations of the high urgency needs and any discussion by the delegation about these needs.

3.3.1 Chairperson Presentations

The first speaker was Tom Simpson from RPI/OLI representing the Driver (public) Education Group. As the group brainstormed, it was discovered that they weren't just discussing driver education but education in general as applied to grade crossing safety. Therefore, this group and the ideas presented here should be categorized as Public Education. All of the items identified were considered high priority, but some of the later issues required earlier issues to be resolved first and therefore were classified as less urgent.

The first topic of discussion was educational audiences. It is unclear which part of the educational community to target and whether the message should change for different communities. Determining target audiences is essential in order to get more "bang for our buck." This area needs to be researched. A way to do this may be to learn about other public information programs that are further along in the delivery of their message than the grade crossing community (e.g., Mothers Against Drunk Driving, etc.).

Funding was another issue that was cited as needing investigation. No private funds go to Operation Lifesaver from the insurance industry. Testing of the current public education program is also needed. For example, testing of the actual effectiveness of Operation Lifesaver needs to begin to determine which portions of the program work versus those that don't (e.g., brochure/literature campaigns).

1. Driver Education Issues

The driver education process itself needs to be investigated. This education is only given when drivers first learn to drive. Perhaps some sort of training program should be instituted that could be retaken throughout one's life. The driver education industry also needs to be researched to determine if a consistent message is being provided, particularly in the case of private driving schools' curriculum. A public education program needs to be developed for the peculiar aspects of high speed rail. These trains are moving much faster, and may not be seen when warning devices are being applied.

Question: In terms of driving fatalities, there are fifteen states which produce 75% of the fatalities and about 70% of the accidents and 70% of the injuries. Why doesn't Operation Lifesaver or some national organization focus on those fifteen states in terms of driver education?

Answer: One shortcoming with Operation Lifesaver is that there is one national program and 49 autonomous state programs. Operation Lifesaver programs, therefore, stop at the state line. Perhaps regional, targeted Operation Lifesaver programs would work better.

The second speaker was Linda Meadow from Los Angeles County MTA representing the Enforcement Group. This group identified two highly urgent areas:

1. Photo Enforcement

The use of photo enforcement has proven very effective in reducing violations and accidents. Although it is presently used in Los Angeles and many railroads are considering using it, there are several areas of research that must be addressed before the technology can be made available for widespread use. One area that needs to be addressed is legislation. Currently, most states don't have legislation regarding photo enforcement. Because of this, the laws are not clear and many times judges need to be convinced during an individual case that this is a good or legal process. California's Rail Transit Enforcement Act clarifies photo enforcement and perhaps should be used as a model for other states.

Guidelines and standards are also needed to ensure that photo enforcement is used optimally. Since photo enforcement would be applied differently at different intersections, standards are needed (e.g., how to determine where to place cameras, put detection loops, identify a violator, etc.). Another issue is how to detect violations with photo enforcement at rural grade crossings. Research in this area needs to be conducted.

Research into mobile or portable enforcement is also needed. Since there are different problem areas, spot enforcement may be necessary. Digital cameras are another area that need investigation. Los Angeles has started looking into this technology. These cameras are one way

of transmitting data very quickly and enable the driver's statistics to be checked, as well as the means to analyze violator characteristics and statistics.

2. Training and Model Policies

Because law enforcement personnel are involved in so many other problems (e.g., burglaries, assaults, homicides) grade crossings are of lower priority. There are several reasons for this. One of them is that, in many cases, law enforcement personnel do not know what laws apply at the crossings. It is imperative to provide procedures and policies regarding enforcement of grade crossing and trespassing laws. It would be helpful to develop a model enforcement training program that looks at all of the multi-agencies involved and trains the field officers and executives.

Question: Did the enforcement group discuss such items as informational newsletters? This is essential because judges and lawyers look for precedent.

Answer: It wasn't directly addressed, but that could definitely fit under the training section. It's a good idea.

Comment: NHTSA has had some experience with radar enforcement and speed limits with mixed success. This work may warrant review since it has run the gamut of issues (e.g., legal, vendor, operational, etc.).

The third speaker was Bob Winans from FHWA representing the Human Factors Group. The top issues that this group identified as needing high urgency investigation were as follows:

- Effectiveness of different improvement types - markings, illumination, signs, pavement marking, textural pavements, etc.
- Factors affecting the credibility of warning devices.
- Driver attitudes and reactions towards stop and yield signs and highway traffic signals.
- Safety performance of locomotive engineers with post traumatic stress syndrome. In this case, the testing of the effectiveness of intervention programs is necessary.
- The need for unique advanced warning signs to distinguish between active and passive crossings.
- ITS architecture for grade crossing safety.
- Accident analysis with specific emphasis on near misses and non-train accidents.
- Active warning trade-offs of safety.
- Credibility for high speed and other trains.
- Conspicuity of trains.
- The effect of site distance on driver behavior.
- Wayside horns.
- Institutional issues.
- Interim improvements at crossings.
- Train horns.
- Within train warning devices.
- Driver response to passive signs.

An explanation of institutional barriers as they occurred during an FHWA research program investigation of four quadrant gate systems was then given by Steve Richards, Director, Transportation Center, University of Tennessee. Steve described the four quadrant study that was conducted a few years ago to provide an illustration of the current institutional barriers that hinder research. There was consensus that in addition to needing research, the institutional constraints and barriers which have prevented implementation of past research results and - in the broader sense - innovation in general must be addressed. There is an area that's funded by Federal dollars and regulated under Federal standards but the highways are typically under state and local control and responsibility. Addressing these issues on the front end is important so that when research is conducted these problems don't occur.

These are the areas that need to be addressed:

- An internal or external assessment to research this issue.
- Establish a framework for implementing research into practice.
- Regulations or administrative waivers to facilitate research.
- A system of incentives or disincentives to make it profitable for the highway agencies or railroads to do something.
- A standing multi-interest task force that would champion research ideas and move it through the bureaucracy on the front end.

The fourth speaker was Chuck Taylor from the Association of American Railroads representing the Crossing Improvement (engineering) Program Group. This group classified the following ten issues as high urgency research needs:

1. Highway traffic control engineering technology transfer

This refers to the application of traditional highway traffic control engineering to the highway-rail intersection. The selection and specification of highway traffic control devices and strategies at highway-rail intersections are frequently considered separately from the traditional practices of highway traffic control engineering. This can result in confusion with both motorists and law enforcement personnel. The objective of this research would be to assess the similarities of highway-rail intersections with highway-highway intersections. Also, it would aid in determining if the messages being conveyed to motorists at railroad intersections are consistent with their comprehension of their behavioral response. This research need addresses whether more traditional highway-highway type intersection control strategies, such as stop signs, yield signs or the redefinition of traditional highway-rail signage, should be used as regulatory versus warning devices. It would then need to be determined if this will improve the consistency of compliance, education, and enforcement. The role that highway capacity issues should play in traffic device selection at highway rail intersections needs to be determined.

2. Highway median barriers

The problem with this area is that highway agencies have resisted the use of barriers at crossings due to added maintenance costs and obstructions. The objective here would be to compare the costs/benefits of median barriers and assess alternate designs.

3. Four quadrant gates

The objective here would be to analyze failure mode options of 4 quadrant gates to assess whether exit gates should fail up or down. Recommendations should be investigated and made of the control logic and definition of vehicle detection system inputs and outputs and exit system inputs and outputs. It would also be helpful to monitor the pilot installations in Connecticut, North Carolina, Wyoming, and California where they are currently using 4 quadrant gates.

4. Standard crossbuck applications

The problem here is the misunderstanding and misinterpretation of the expected responses to crossbucks at active and passive crossings. The objective would include the evaluation of the use of standard crossbucks alone or in combination with a standard sign at passive locations. Other objectives would be to evaluate the use of standard signs in place of crossbucks at passive locations, to evaluate the use of alternative signs to crossbucks at passive locations, and the use of current or modified crossbucks at active locations.

5. Low-cost alternatives to conventional warning devices

Research objectives for this item would include the examination of low-cost systems which could be used at low density crossings. There would also be an important addition to the traditional research statements - to take a look at the benefits and costs and perform a risk analysis of systems that are designed to be reliable, but not necessarily fail-safe.

6. Proper warning time with credibility

This issue would identify the role of time in the loss of credibility, allowing the determination of the time needed by various vehicles to pass the crossing and also evaluate existing systems at various levels of warning (e.g., flashing versus solid, colors to send different signals to different vehicles, etc.).

7. Intelligent highway rail intersection

The objective here would be to make sure that as the ITS and ATCS systems come forward that the architecture for those systems takes proper account of the highway-rail intersections. A handbook needs to be developed on the application of these systems to the highway-rail intersection.

8. To develop national warrants for the selection of warning devices at vehicular and pedestrian grade crossings

The objective would be to evaluate existing warrants and the criteria used for them, and the policies and procedures used for warning devices, to try to make the process more consistent.

9. Advanced warning messages

In this case, the research objective would be to develop new advanced warning signs to tell motorists what to expect at the crossings they're approaching. These items would include such things as message signs, rumble strips, train direction, etc.

10. The investigation of off-track train detection systems

This would supplement existing FRA and AAR work. It would serve to identify cost-effective off-track presence detection systems, beginning with functional/performance specifications and prototypes. The big issue is that combinations of new lightweight railroad rolling stock and such things as rail lubrication and changes in rail and wheel profiles have resulted in false deactivations of railway warning devices while trains are in the crossing. With increased use of lightweight materials, this problem is only expected to worsen.

Question: Regarding humpback crossings, there is data available from West Virginia University in this area. They're in the process of getting the sign approved. This issue, therefore, may need to be revised since the matter has been addressed.

Answer: The issue here wasn't so much the issue of signage for the intersection at humpback crossing but more the lack of standards for vehicle design construction. An intersection can only be designed if it is known what type of vehicles the crossing will see. The focus was to develop criteria for vehicle design so that it is known what type of vehicles will traverse the crossings.

The fifth speaker was Brian Bowman from the Transportation Research Board representing the Data Group. This group determined five high priority research areas:

- Noting that data is collected and maintained by a lot of different sources (e.g., states, Federal, FHWA, NHTSA) for railroad grade crossings, a clearinghouse needs to be established to coordinate activities. If data collection efforts, data requirements, etc., are coordinated the system will be much more efficient.
- There is a need to establish a data integration working group. A team of multi-modal specialists should be developed that is aware of Federal and state railroad and highway needs and issues. This will reduce duplication of data collection efforts, thereby meeting internal and external customer needs.
- The third issue is related to crossing inventory. This inventory was initially established during the 1970s. There are gross inaccuracies in it (e.g., estimates that were never updated) as well as missing items. Assistance needs to be provided to the states to update this inventory.
- This item concerned research that looked at ADTs, train volume, train speed, occupancy time, day of week, and time of day to help develop an accurate estimate of exposure to help normalize the accident experience and improve the accident prediction formulas.
- The last issue dealt with railroad whistle operating processes. There is a need to determine the real railroad operating practices related to whistle blowing when trains are approaching a crossing, and also train speed. The impact of the whistle practice within the cab of trucks and within the passenger cars when they're environmentally isolated needs to be determined.

Question: When reading over the project statements, it wasn't clearly stated that non-train accidents were included. Over the past few years it was found that non-train accidents at the intersection may be two to three times the number of "train involved." Did the Data group specifically talk about this issue? Is this addressed by any of the group's project statements?

Answer: This issue was addressed; I'm (Brian Bowman) surprised it wasn't kept in the research statements. I will make sure it is put back in.

Question: Was there any discussion in the Data group on how to measure site distance? It is a pretty elusive item with changing variables.

Answer: Yes, the group discussed this issue. There are many data requirements, like site distance, which were folded into the first category. Many of these issues need to be made uniform from state to state.

Question: It can be dangerous to generalize about the status of the inventory. Parts of it are out-of-date, however others are current. Is the group's statement a request for research or a request for additional resources?

Answer: It is a hybrid of the two. It's research in that there are items that, through use of the inventory, would enhance the inventory by including items that aren't there now. And it's also a request for resources in that in all the states I've (Brian Bowman) worked, it has been the failure of the states to maintain and make the changes required within that inventory.

Question: If this inventory varies from state to state, would it be possible to rank the states on the basis of one to ten so that researchers would know how reliable this information is in a particular state?

Answer: This information is available. The FRA Office of Safety is able to identify by state or railroad how much updating is being performed.

Question: Some of the other groups discussed site distance requirements at railroad crossings as well. Has any research been done that shows how important site distance is in prioritizing crossings for safety improvements?

Answer: In terms of determining the research that's been done in the past, there are a number of bibliographies available. For example, in the TRB Bibliography 57 there is a lot of information. This annotated bibliography covers research at grade crossings from 1941 to 1976. Another bibliography, TRB Bibliography number 58, covers research from 1976 to 1979. It's an update of the first one. There's also a list of research projects published by the FRA and FHWA. This can be obtained by contacting Bruce George or the FHWA Office of Engineering or Office of Research and Development. There is also a highway safety publications catalog produced by TransSafety, Inc. This document contains a lot of information on grade crossing research. Lastly, there is the TRB Transportation Research Information Service. Agencies that are sponsors of TRB can have access to a wide spectrum of research.

3.3.2 General Discussion

The groups were asked to rank all of the research needs identified. Before doing this, however, a number of concerns were cited by the delegates.

There was considerable concern within the groups that they had dismissed investigation of certain issues, thinking that they were being dealt with by other groups. At the same time, there were concerns that some issues were treated by more than one group in slightly varied categories. This issue came up repeatedly with regard to the Human Factors and Crossing Improvement

(engineering) Program groups. Furthermore, others felt that they didn't have the knowledge or ability to rank each other's identified research needs, saying it was too much information to digest so quickly.

The workshop coordinator then noted that although these concerns were valid, the objective of this meeting was to take a first step in getting the intermodal community together to talk about grade crossing issues. In the near future, the FRA and the Steering Committee that organized the workshop will discuss and determine how many additional activities may be needed to promote further dialogue and exchange of information and issues among the groups.

In reference to the general consensus that many of the Human Factors and Crossing Improvement (engineering) Program research needs were related, it was noted that there are likely interrelationships among all of these groups. Initially, the groups were separated into five topical areas and now they need to be integrated.

After discussions, it was decided that a few more issues would be added to the high urgency list. These included:

- The subject of gap acceptance. This involves the issue of how close in advance of a train a motor vehicle driver is willing to cross the tracks. Although initially some participants felt that this issue was included in CIP 6 (Proper Warning Time With Credibility), they did want the "softer side" addressed as well.
- The issue of non-train accidents. It was decided that the data items that dealt with this were not specific enough, and it will be included in the data research need that was identified concerning accident analysis.
- The need to evaluate the effectiveness of public information programs in terms of driver's education was mentioned. Four interrelated research needs were consolidated as one and approved by the delegation as a high urgency need.
- Lastly, it was noted that an issue was raised in the CIP group that didn't make the list but is important. This was the notion of a Washington-led task force to coordinate grade crossing safety needs with the ITS community.

On this last point, it was noted that recently FRA researchers met with Christine Johnson of the ITS Joint Program Office and members of her staff. They discussed various crossing issues and high speed rail issues and their place in the ITS program. An FRA commitment was made that discussions will occur on a quarterly basis with contact in the interim. Additionally, Claire Orth, who at the time was the acting head of the Research and Development Office at FRA, is a member of the ITS Program Office Steering Committee and provides a needed liaison.

3.4 ANALYSIS OF HIGH URGENCY RESEARCH NEEDS

The following section displays results of analyses conducted on the high urgency research needs identified. Of the ninety-two established research needs, the workshop delegates identified thirty-nine to be of high urgency for the enhancement of grade crossing safety. Table 3-6 shows the distribution of the highly urgent research needs by topical area.

Table 3-6. Distribution of Highly Urgent Research Needs

HIGHLY URGENT NEEDS	TOPICAL AREA
8	Driver (public) Education
2	Enforcement
18	Human Factors
10	Crossing Improvement (engineering) Programs
4	Data

The priority ranking results should be considered preliminary. Only forty-five prioritization opinion surveys were received for analysis, reflecting the views of only 60% of the workshop delegates. A second prioritization opinion survey may therefore need to be administered to substantiate the preliminary results.

Another point that should be emphasized is that five of the research needs identified (HF-18, DE-4A through DE-4D) were not ranked highly urgent until the plenary session on Thursday, April 13th. Therefore, they were not included on the formally printed opinion survey form of urgent needs to be prioritized. Each delegate was requested to write-in these research needs on their ballot. When these five needs were prioritized, the four education research needs were requested to be considered as one. As a result, the response rate for these five needs was far less than all the other needs prioritized, as shown in Table 3-7.

Table 3-7. Research Need Response Rates

PRIORITY NEED	TITLE	RESPONSE RATE
#39, 40, 41 & 42	Educational Effectiveness Evaluations	51%
#37	Train Gap Acceptance	60%
	Average of All Other Needs	90%

Analyses have been completed on the high urgency preliminary results as well as “all other urgency” research needs identified. Figure 3-1 summarizes the analyses conducted on the high urgency research needs. The next section discusses the results of these analyses.

ANALYSES PERFORMED
Sort by Priority Ranking of Weighted Scores
Sort by Cost Factor
Sort by HSR Applicability
Sort by Research Type (supplemental or new)

Figure 3-1. Analyses Performed on High Urgency Research Needs Identified

3.4.1 Priority Ranking by Weighted Scores

The delegation remaining by the last day of the workshop, i.e., approximately 60% of the total delegates, received a blank prioritization opinion survey. After completion of the presentations and discussions of the high urgency research needs, the delegates were asked to write-in research needs HF-18 and DE-4A through DE-4D (as one) on the survey form. The delegates were then

asked to rank the thirty-nine high urgency needs with a numerical score ranging from one to five, one being the highest and five the lowest. Another constraint added to the process was each delegate could have no more than ten number ones on the survey form.

The prioritization opinion surveys were analyzed by the Volpe Center. All responding delegates met the constraint outlined above. The prioritized research needs were weighted by numerical score to determine a rank. Each number one was assigned five points and each number five was assigned one point for the weighting process. The high urgency research needs were sorted by the weighted scores and subsequently ranked as shown in column two of Table 3-8.

Table 3-8. High Urgency Research Needs Ranked by Weighted Scores

RN #	RANK	TITLE	SCORES
CIP-1	1	Highway Traffic Control Engineering Technology Transfer	199
CIP-5	2	Low-Cost Alternatives To Conventional Warning Devices	165
CIP-6	3	Proper Warning Time with Credibility	163
D-1	4	Data Requirements for H-R Grade Crossing Safety	163
HF-15	5	Factors Affecting Credibility of Grade Crossing Warning Devices	163
CIP-3	6	Four Quadrant Gate Systems	160
HF-2	7	Effectiveness of Low-Cost Countermeasures for Passive Crossings	158
HF-1	8	Effects of Sight Distance on Driver Behavior	157
E-2	9	Photo Enforcement	156
HF-10	10	Applicability of Highway Traffic Control Devices at Railroad Grade Crossings	155
CIP-7	11	Intelligent Highway-Rail Intersection	153
D-3	12	Grade Crossing Inventory	149
CIP-2	13	Highway Median Barriers	147
CIP-21	14	Advanced Warning Messages	147
DE-1	15	Determining Target Audiences	147
E-1	16	Training and Model Policies	147
HF-4	17	Unique Advance Warning Signs for Active and Passive Crossings	147
HF-6	18	Causal Analysis of Accidents Involving Grade Crossings	144
CIP-4	19	Standard Crossbuck Applications	142
CIP-8	20	Proposed National Warrants for the Selection of Warning Devices	134
HF-22	21	Institutional Issues: Technology Transfer	131
HF-23	22	Driver Perception of Risk	131
HF-25	23	Warning Time Trade-Offs	131
HF-14A	24	Train Horns	129
D-4	25	Exposure Measures	128
D-2	26	Data Integration Working Group	126
CIP-9	27	Off - Track Train Detection	125
HF-37	28	ITS and its Relationship to Driver and Rail Operators Information	125
HF-14B	29	Wayside Horns	124
DE-2	30	Survey of Current & Completed Research	107
HF-12	31	Rail Car Conspicuity	106
DE-3A	32	Survey of Existing Programs	104
HF-11	33	Interim Improvements at Grade Crossings	91
HF-28	34	In-Train Warning Devices	88
DE-3B	35	Funding Sources	84
HF-29	36	Post Train Accident Effects	84
HF-18	37	Train Gap Acceptance	84
HF-9	38	Vehicle Activated Strobe	81
DE-4 A-D	39	Educational Effectiveness Evaluations	68

3.4.2 Sort By Cost Factor

The high urgency research needs are sorted by cost in the following four tables. The research needs within each table are grouped by topical area, if applicable. Also shown in the tables are the rankings for each research need based on Table 3-8.

Table 3-9. High Urgency Research Needs -- Low Cost

RN #	RANK	TITLE	COST
DE-1	15	Determining Target Audiences	L
DE-2	30	Survey of Current & Completed Research	L
DE-3B	35	Funding Sources	L
HF-28	34	In-Train Warning Devices	L
CIP-4	19	Standard Crossbuck Applications	L
D-4	25	Exposure Measures	L

Table 3-10. High Urgency Research Needs -- Medium Cost

RN #	RANK	TITLE	COST
DE-3A	32	Survey of Existing Programs	M
DE-4A-D	39	Educational Effectiveness Evaluations	M
E-1	16	Training and Model Policies	M
HF-15	5	Factors Affecting Credibility of Grade Crossing Warning Devices	M
HF-1	8	Effects of Sight Distance on Driver Behavior	M
HF-4	17	Unique Advance Warning Signs for Active and Passive Crossings	M
HF-6	18	Causal Analysis of Accidents Involving Grade Crossings	M
HF-23	22	Driver Perception of Risk	M
HF-25	23	Warning Time Trade-Offs	M
HF-14A	24	Train Horns	M
HF-37	28	ITS and its Relationship to Driver and Rail Operators Information	M
HF-14B	29	Wayside Horns	M
HF-12	31	Rail Car Conspicuity	M
HF-11	33	Interim Improvements at Grade Crossings	M
HF-29	36	Post Train Accident Effects	M
HF-18	37	Train Gap Acceptance	M
HF-9	38	Vehicle Activated Strobe	M
CIP-5	2	Low-Cost Alternatives to Conventional Warning Devices	M
CIP-3	6	Four Quadrant Gate Systems	M
CIP-7	11	Intelligent Highway-Rail Intersection	M
CIP-21	14	Advanced Warning Messages	M
CIP-8	20	Proposed National Warrants for the Selection of Warning Devices	M
CIP-9	27	Off - Track Train Detection	M

Table 3-11. High Urgency Research Needs -- High Cost

RN #	RANK	TITLE	COST
HF-2	7	Effectiveness of Low-Cost Countermeasures for Passive Crossings	H
HF-22	21	Institutional Issues: Technology Transfer	H
CIP-6	3	Proper Warning Time with Credibility	H
D-3	12	Grade Crossing Inventory	H
D-2	26	Data Integration Working Group	H

Table 3-12. High Urgency Research Needs -- Unidentified Cost

RN #	RANK	TITLE
E-2	9	Photo Enforcement
HF-10	10	Applicability of Highway Traffic Control Devices at Railroad Grade Crossings
CIP-1	1	Highway Traffic Control Engineering Technology Transfer
CIP-2	13	Highway Median Barriers
D-1	4	Data Requirements for H-R Grade Crossing Safety

The Driver (public) Education topical area is predominant (50%) in the low-cost subcategory. The Human Factors topical area dominates with 61% of the medium-cost range. The high-cost range illustrates the key issue that only approximately 13% of the high urgency research needs identified were subcategorized by this cost range. This suggests that cost-effective research can be conducted without large expenditures of public funds and promotes the realistic aim of the FRA: to achieve its goal of reducing grade crossing accidents by 50% in ten years.

As shown in Table 3-12, 13% of high urgency needs were not identified by a cost subcategory. This strengthens the need for further review of these preliminary results.

3.4.3 Sort By High Speed Rail Applicability

The applicability of research needs to high speed rail was requested as a suggested input in the *comment* section of the research need form. As a result, it may have had an affect on the distribution of results as shown in the following three tables. The research needs within each table are grouped by topical area, if applicable. Also shown in the tables are the rankings for each research need based on Table 3-8.

Table 3-13. High Urgency Research Needs -- Not Applicable To HSR

RN #	RANK	TITLE	HSR
CIP-5	2	Low-Cost Alternatives To Conventional Warning Devices	N
CIP-6	3	Proper Warning Time with Credibility	N

Table 3-14. High Urgency Research Needs -- Applicable to HSR

RN #	RANK	TITLE	HSR
DE-1	15	Determining Target Audiences	Y
DE-2	30	Survey of Current & Completed Research	Y
DE-4 A-D	39	Educational Effectiveness Evaluations	Y
HF-15	5	Factors Affecting Credibility of Grade Crossing Warning Devices	Y
HF-6	18	Causal Analysis of Accidents Involving Grade Crossings	Y
HF-22	21	Institutional Issues: Technology Transfer	Y
HF-25	23	Warning Time Trade-Offs	Y
HF-14A	24	Train Horns	Y
HF-37	28	ITS and its Relationship to Driver and Rail Operators Information	Y
HF-14B	29	Wayside Horns	Y
HF-12	31	Rail Car Conspicuity	Y
HF-11	33	Interim Improvements at Grade Crossings	Y
HF-28	34	In-Train Warning Devices	Y
HF-29	36	Post Train Accident Effects	Y
HF-18	37	Train Gap Acceptance	Y
CIP-1	1	Highway Traffic Control Engineering Technology Transfer	Y
CIP-3	6	Four Quadrant Gate Systems	Y
CIP-7	11	Intelligent Highway-Rail Intersection	Y
CIP-21	14	Advanced Warning Messages	Y
D-1	4	Data Requirements for H-R Grade Crossing Safety	Y
D-3	12	Grade Crossing Inventory	Y
D-4	25	Exposure Measures	Y
E-1	16	Training and Model Policies	Y

Table 3-15. High Urgency Research Needs -- Unspecified for HSR

RN #	RANK	TITLE
DE-3A	32	Survey of Existing Educational Programs
DE-3B	35	Educational Funding Sources
E-2	9	Photo Enforcement
HF-2	7	Effectiveness of Low-Cost Countermeasures for Passive Crossings
HF-1	8	Effects of Sight Distance on Driver Behavior
HF-10	10	Applicability of Highway Traffic Control Devices at Railroad Grade Crossings
HF-4	17	Unique Advance Warning Signs for Active and Passive Crossings
HF-23	22	Driver Perception of Risk
HF-9	38	Vehicle Activated Strobe
CIP-2	13	Highway Median Barriers
CIP-4	19	Standard Crossbuck Applications
CIP-8	20	Proposed National Warrants for the Selection of Warning Devices
CIP-9	27	Off - Track Train Detection
D-2	26	Data Integration Working Group

In review of the titles in Table 3-15, it is evident that some of the unassigned research needs could have been specified as applicable to HSR. For example, *Off-Track Train Detection* (CIP-9) and *Highway Median Barriers* (CIP-2) are currently being researched by the FRA for HSR applications.

Finally, it was suggested that groups provide *ease of implementability* of the research. Only one topical area, Driver (public) Education, commented on this suggestion. Although the results are not tabulated, three out of five high urgency needs were classified as easy to implement.

3.4.4 Sort By Research Type (Supplemental or New Initiative)

The type of research for the highly urgent research needs is shown in the following three tables. The participants were asked to note whether the specific research need was supplemental to research being done or whether it was a new research initiative. Some of the research needs identified, however, were supplemental with new aspects. Therefore they were asked to denote those as supplemental/new. The research needs within each table are grouped by topical area, if applicable. Also shown in the tables are the rankings for each research need based on the weighted score discussed in the previous subsection.

Table 3-16. High Urgency Research Needs -- Supplemental Research Activity

RN #	RANK	TITLE	TYPE
DE-2	30	Survey of Current & Completed Research	SUP
E-2	9	Photo Enforcement	SUP
E-1	16	Training and Model Policies	SUP
HF-25	23	Warning Time Trade-Offs	SUP
HF-14A	24	Train Horns	SUP
HF-14B	29	Wayside Horns	SUP
HF-12	31	Rail Car Conspicuity	SUP
HF-28	34	In-Train Warning Devices	SUP
CIP-5	2	Low-Cost Alternatives to Conventional Warning Devices	SUP
CIP-2	13	Highway Median Barriers	SUP
CIP-4	19	Standard Crossbuck Applications	SUP
CIP-8	20	Proposed National Warrants for the Selection of Warning Devices	SUP/NEW
CIP-9	27	Off - Track Train Detection	SUP
D-1	4	Data Requirements for H-R Grade Crossing Safety	SUP/NEW
D-3	12	Grade Crossing Inventory	SUP/NEW
D-4	25	Exposure Measures	SUP/NEW

Table 3-17. High Urgency Research Needs -- New Research Activity

RN #	RANK	TITLE	TYPE
DE-1	15	Determining Target Audiences	NEW
DE-3A	32	Survey of Existing Programs	NEW
DE-3B	35	Funding Sources	NEW
DE-4 A-D	39	Educational Effectiveness Evaluations	NEW
HF-15	5	Factors Affecting Credibility of Grade Crossing Warning Devices	NEW
HF-2	7	Effectiveness of Low-Cost Countermeasures for Passive Crossings	NEW
HF-1	8	Effects of Sight Distance on Driver Behavior	NEW
HF-4	17	Unique Advance Warning Signs for Active and Passive Crossings	NEW
HF-6	18	Causal Analysis of Accidents Involving Grade Crossings	NEW
HF-22	21	Institutional Issues: Technology Transfer	NEW
HF-23	22	Driver Perception of Risk	NEW
HF-37	28	ITS and its Relationship to Driver and Rail Operators Information	NEW
HF-11	33	Interim Improvements at Grade Crossings	NEW
HF-29	36	Post Train Accident Effects	NEW
HF-18	37	Train Gap Acceptance	NEW
HF-9	38	Vehicle Activated Strobe	NEW
CIP-1	1	Highway Traffic Control Engineering Technology Transfer	NEW
CIP-6	3	Proper Warning Time with Credibility	NEW
CIP-3	6	Data Requirements for R-H Grade Crossing Safety	NEW
CIP-7	11	Intelligent Highway-Rail Intersection	NEW
CIP-21	14	Advanced Warning Messages	NEW
D-2	26	Data Integration Working Group	NEW

Table 3-18. High Urgency Research Needs -- Unidentified Research Activity

RN #	RANK	TITLE
HF-10	10	Applicability of Highway Traffic Control Devices at Railroad Grade Crossings

The three Data issues shown in Table 3-16 were categorized as both supplemental and new because this topical area is considered to be a relatively new initiative to the FRA highway-rail grade crossing safety area. There may, however, be other research activities underway in modes other than FRA.

As can be seen from Table 3-17, the new research initiatives are dominated by the Human Factors area. This suggests that the Human Factors area of research should be targeted in the future to improve highway-rail grade crossing safety. There was only one research need that was unspecified as to research type, *Applicability of Highway Traffic Control Devices at Railroad Grade Crossings* (HF-10), but this may have been an oversight by the group.

3.5 ANALYSIS OF ALL OTHER RESEARCH NEEDS IDENTIFIED

Analyses have been completed on all other needs identified in addition to the high urgency needs discussed in the previous section. Figure 3-2 summarizes the analyses conducted on “all other urgency” research needs.

ANALYSES PERFORMED
Sort by Topical Area with Cost, HSR Applicability and Research Type
Sort by Cost Factor
Sort by HSR Applicability
Sort by Research Type (supplemental or new)

Figure 3-2. Analyses Performed on All Other Needs

3.5.1 Sort by Topical Area with Cost, HSR Applicability and Research Type

The following tables summarize “all other urgency” research needs established by the delegation. These needs are first shown by topical area designation. Further analyses are shown by information on cost, high speed rail applicability and research activity type necessary.

Table 3-19. All Other Urgency Categories - Driver (public) Education

RN #	TITLE	COST	HSR	RESEARCH TYPE
DE-5	Sensitivity of Education to Age and Approach	M	Y	NEW
DE-6	High Speed Rail	L	Y	SUP

Table 3-20. All Other Urgency Categories - Enforcement

RN #	TITLE	COST	HSR	RESEARCH TYPE
E-3	Increase Fines and Penalty Assessment	L	Y	SUP
E-4	911 Versus Railroad Telephone Number	L	Y	NEW
E-5	Law Enforcement	M		NEW
E-6	Financial Issues			NEW
E-7	Altering Bad Driving Habits	L	Y	SUP
E-8	Enforcement Interaction	L		NEW

Table 3-21. All Other Urgency Categories -- Human Factors

RN #	TITLE	COST	HSR	RESEARCH TYPE
HF-3	Driver Acceptance of High Speed Rail Crossing Barriers	H	Y	NEW
HF-5	Human Factor Issues Surrounding the Use of Mobile Barriers	M	Y	SUP
HF-7	In-Vehicle Warning Devices	M	Y	SUP
HF-8	Effects of Crossing Closures	L	Y	NEW
HF-13	Assessment of Vehicle Occupant-Kinematics, etc.	M	Y	NEW
HF-16	Study Driver "Information Gathering" Processes at Crossings	M		NEW
HF-17	Driver Behavior: Understanding Responsibilities	M		NEW
HF-19	Nature of Driver Error	M	Y	NEW
HF-20	Driver Familiarity - Implications for Grade Crossing Safety	L	Y	NEW
HF-21	Driver Behavior	M		NEW
HF-24	Social Factors in Crossing Behavior	M		NEW
HF-26	More Effective Crossing Gates	M	Y	SUP
HF-27	Train Warning Device Malfunctions	M	Y	NEW
HF-30	ADA Accessibility of Crossings	M		
HF-31	Truck Driver Needs and Behavior	L		NEW
HF-32	Emergency Vehicle Response	L	Y	NEW
HF-33	Effects of Demographic Variables on Driver Behavior	M		NEW
HF-34	Dual Clearance Time for Autos, HAZMAT and Long Trucks	M	Y	NEW
HF-35	Bicycles - Different from Motorists	L		NEW
HF-36	Privacy Intrusion - ITS	L		NEW

**Table 3-22. All Other Urgency Categories --
Crossing Improvement (engineering) Programs**

RN #	TITLE	COST	HSR	RESEARCH TYPE
CIP-10	Quantitative Risk Assessment	L	Y	SUP
CIP-11	Audible Warning at Crossings	M		SUP
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements	L	Y	NEW
CIP-13	Signal Status Monitoring	L		NEW
CIP-14	Light Rail/Commuter Rail Pedestrian Gates			SUP
CIP-15	ADA Compliance for Pedestrian Crossings	M		NEW
CIP-16	Sight Distance Evaluation	M		NEW
CIP-17	Innovative Low-Cost Grade Separation	H	Y	SUP
CIP-18	Video Monitoring/Detection System	H	Y	SUP
CIP-19	Low-Cost Intrusion Barriers	H	Y	SUP
CIP-20	Humpback Crossing			NEW

Table 3-23. All Other Urgency Categories -- Data

RN #	TITLE	COST	HSR	RESEARCH TYPE
D-5	Performance Measures	L		SUP
D-6	Sight Distance Analysis	M		NEW
D-7	Safety Measures for H-R Grade Crossings with Special Needs	L	Y	NEW
D-8	Cost and Benefits of Highway-Rail Safety Improvements	M		
D-9	Foreign Experience with Warning Devices			SUP
D-10	Expert System			SUP
D-11	RR Accident Investigations Team	M		NEW
D-12	"Lessons Learned" Analysis	L		SUP/NEW
D-13	Train Operating Practices at and in the Vicinity of Crossings	L		NEW
D-14	Maintenance & Crossing Improvement Concerns of Shortline RRs	L		NEW
D-15	RR Whistle Operational Practices	M		SUP

3.5.2 Sort By Cost Factor

“All other urgency” research needs are sorted by cost in Tables 3-24 through 3-27. The research needs within each table are grouped by topical area, if applicable.

Table 3-24. All Other Urgency Categories -- Low Cost

RN #	TITLE	COST*
DE-6	High Speed Rail	L
E-3	Increase Fines and Penalty Assessment	L
E-4	911 Versus Railroad Telephone Number	L
E-7	Altering Bad Driving Habits	L
E-8	Enforcement Interaction	L
HF-8	Effects of Crossing Closures	L
HF-20	Driver Familiarity - Implications for Grade Crossing Safety	L
HF-31	Truck Driver Needs and Behavior	L
HF-32	Emergency Vehicle Response	L
HF-35	Bicycles - Different from Motorists	L
HF-36	Privacy Intrusion - ITS	L
CIP-10	Quantitative Risk Assessment	L
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements	L
CIP-13	Signal Status Monitoring	L
D-5	Performance Measures	L
D-7	Safety Measures for H-R Grade Crossings with Special Needs	L
D-12	"Lessons Learned" Analysis	L
D-13	Train Operating Practices at and in the Vicinity of Crossings	L
D-14	Maintenance & CIP Concerns of Shortline RRs	L

* -- LOW COST IS < \$100,000

There is an even distribution of topical areas in the low-cost subcategory. The Human Factors topical area dominates with 60% of the medium-cost range. These results also indicate that 82% of "all other urgency" research needs that have been identified are within the low- to medium-cost ranges. This finding supports the results of the high urgency needs analysis of cost factors.

The high-cost range illustrates that only about 8% of "all other urgency" research needs identified were subcategorized by this cost range. Research in the area of barrier systems and grade separations dominates the research needs found in the high-cost range subcategory.

As shown in Table 3-27, 10% of "all other urgency" needs were not identified by a cost subcategory. This strengthens the need for further review of these preliminary results.

Table 3-25. All Other Urgency Categories -- Medium Cost

RN #	TITLE	COST*
DE-5	Sensitivity of Education to Age and Approach	M
E-5	Law Enforcement	M
HF-5	Human Factor Issues Surrounding the Use of Mobile Barriers	M
HF-7	In-Vehicle Warning Devices	M
HF-13	Assessment of Vehicle Occupant-Kinematics, etc.	M
HF-16	Study Driver "Information Gathering" Processes at Crossings	M
HF-17	Driver Behavior: Understanding Responsibilities	M
HF-19	Nature of Driver Error	M
HF-21	Driver Behavior	M
HF-24	Social Factors in Crossing Behavior	M
HF-26	More Effective Crossing Gates	M
HF-27	Train Warning Device Malfunctions	M
HF-30	ADA Accessibility of Crossings	M
HF-33	Effects of Demographic Variables on Driver Behavior	M
HF-34	Dual Clearance Time for Autos, HAZMAT and Long Trucks	M
CIP-11	Audible Warning at Crossings	M
CIP-15	ADA Compliance for Pedestrian Crossings	M
CIP-16	Sight Distance Evaluation	M
D-6	Sight Distance Analysis	M
D-8	Cost and Benefits of Highway-Rail Safety Improvements	M
D-11	RR Accident Investigations Team	M
D-15	RR Whistle Operational Practices	M

* -- MODERATE COST IS \$100,000 TO \$500,000

Table 3-26. All Other Urgency Categories -- High Cost

RN #	TITLE	COST*
HF-3	Driver Acceptance of High Speed Rail Crossing Barriers	H
CIP-17	Innovative Low-Cost Grade Separation	H
CIP-19	Low-Cost Intrusion Barriers	H
CIP-18	Video Monitoring/Detection System	H

* -- HIGH COST IS > \$500,000

Table 3-27. All Other Urgency Categories -- Unidentified Cost

RN #	TITLE
E-6	Financial Issues
CIP-14	Light Rail/Commuter Rail Pedestrian Gates
CIP-20	Humpback Crossing
D-9	Foreign Experience with Warning Devices
D-10	Expert System

3.5.3 Sort By High Speed Rail Applicability

The applicability of research needs to high speed rail development was requested as a suggested input for the comment section of the research need form. This may have resulted in the large number of needs that were not specified as applicable to HSR as shown in the following two tables. The research needs within each table are grouped by topical area, if applicable.

Table 3-28. All Other Urgency Categories -- Applicable to HSR

RN #	TITLE	HSR*
DE-5	Sensitivity of Education to Age and Approach	Y
DE-6	High Speed Rail	Y
E-3	Increase Fines and Penalty Assessment	Y
E-4	911 Versus Railroad Telephone Number	Y
E-7	Altering Bad Driving Habits	Y
HF-3	Driver Acceptance of High Speed Rail Crossing Barriers	Y
HF-5	Human Factor Issues Surrounding the Use of Mobile Barriers	Y
HF-7	In-Vehicle Warning Devices	Y
HF-8	Effects of Crossing Closures	Y
HF-13	Assessment of Vehicle Occupant-Kinematics, etc.	Y
HF-19	Nature of Driver Error	Y
HF-20	Driver Familiarity - Implications for Grade Crossing Safety	Y
HF-26	More Effective Crossing Gates	Y
HF-27	Train Warning Device Malfunctions	Y
HF-32	Emergency Vehicle Response	Y
HF-34	Dual Clearance Time for Autos, HAZMAT and Long Trucks	Y
CIP-10	Quantitative Risk Assessment	Y
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements	Y
CIP-17	Innovative Low-Cost Grade Separation	Y
CIP-18	Video Monitoring/Detection System	Y
CIP-19	Low-Cost Intrusion Barriers	Y
D-7	Safety Measures for H-R Grade Crossings with Special Needs	Y

* -- Y = YES

Table 3-29. All Other Urgency Categories -- Unspecified Applicability to HSR

RN #	TITLE
E-5	Law Enforcement
E-6	Financial Issues
HF-16	Study Driver "Information Gathering" Processes at Crossings
HF-17	Driver Behavior: Understanding Responsibilities
HF-21	Driver Behavior
HF-24	Social Factors in Crossing Behavior
HF-30	ADA Accessibility of Crossings
HF-31	Truck Driver Needs and Behavior
HF-33	Effects of Demographic Variables on Driver Behavior
HF-35	Bicycles - Different from Motorists
HF-36	Privacy Intrusion - ITS
CIP-11	Audible Warning at Crossings
CIP-13	Signal Status Monitoring
CIP-14	Light Rail/Commuter Rail Pedestrian Gates
CIP-15	ADA Compliance for Pedestrian Crossings
CIP-16	Sight Distance Evaluation
CIP-20	Humpback Crossing
D-5	Performance Measures
D-6	Sight Distance Analysis
D-8	Cost and Benefits of Highway-Rail Safety Improvements
D-9	Foreign Experience with Warning Devices
E-8	Enforcement Interaction
D-10	Expert System
D-11	RR Accident Investigations Team
D-12	"Lessons Learned" Analysis
D-13	Train Operating Practices at and in the Vicinity of Crossings
D-14	Maintenance & CIP Concerns of Shortline RRs
D-15	RR Whistle Operational Practices

The Human Factors area comprised 50% of the research needs in Table 3-28. From review of the titles in Table 3-29 it is evident that some of the unassigned research needs could have been specified as applicable to high speed rail. For example, research need number D-9, *Foreign Experience with Warning Devices*, would be a prime candidate since most passenger trains in Europe and Japan are high speed rail.

3.5.4 Sort By Research Type (Supplemental or New Initiative)

The type of research, in terms of supplemental or new initiative, for “all other urgency” research needs identified is shown in the following three tables. The research needs within each table are grouped by topical area, if applicable.

Table 3-30. All Other Urgency Categories - New Research Activity

RN #	TITLE	RESEARCH TYPE*
DE-5	Sensitivity of Education to Age and Approach	NEW
E-4	911 Versus Railroad Telephone Number	NEW
E-5	Law Enforcement	NEW
E-6	Financial Issues	NEW
E-8	Enforcement Interaction	NEW
HF-3	Driver Acceptance of High Speed Rail Crossing Barriers	NEW
HF-8	Effects of Crossing Closures	NEW
HF-13	Assessment of Vehicle Occupant-Kinematics, etc.	NEW
HF-16	Study Driver "Information Gathering" Processes at Xings	NEW
HF-17	Driver Behavior: Understanding Responsibilities	NEW
HF-19	Nature of Driver Error	NEW
HF-20	Driver Familiarity - Implications for Grade Xing Safety	NEW
HF-21	Driver Behavior	NEW
HF-24	Social Factors in Crossing Behavior	NEW
HF-27	Train Warning Device Malfunctions	NEW
HF-31	Truck Driver Needs and Behavior	NEW
HF-32	Emergency Vehicle Response	NEW
HF-33	Effects of Demographic Variables on Driver Behavior	NEW
HF-34	Dual Clearance Time for Autos, HAZMAT and Long Trucks	NEW
HF-35	Bicycles - Different from Motorists	NEW
HF-36	Privacy Intrusion - ITS	NEW
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements	NEW
CIP-13	Signal Status Monitoring	NEW
CIP-15	ADA Compliance for Pedestrian Crossings	NEW
CIP-16	Sight Distance Evaluation	NEW
CIP-20	Humpback Crossing	NEW
D-6	Sight Distance Analysis	NEW
D-7	Safety Measures for H-R Grade Crossings with Special Needs	NEW
D-11	RR Accident Investigations Team	NEW
D-13	Train Operating Practices at and in the Vicinity of Crossings	NEW
D-14	Maintenance & CIP Concerns of Shortline RRs	NEW

* -- NEW = NEW RESEARCH ACTIVITY

Table 3-31. All Other Urgency Categories - Supplemental Research Activity

RN #	TITLE	RESEARCH TYPE
DE-6	High Speed Rail	SUP*
E-3	Increase Fines and Penalty Assessment	SUP
E-7	Altering Bad Driving Habits	SUP
HF-5	Human Factor Issues Surrounding the Use of Mobile Barriers	SUP
HF-7	In-Vehicle Warning Devices	SUP
HF-26	More Effective Crossing Gates	SUP
CIP-10	Quantitative Risk Assessment	SUP
CIP-11	Audible Warning at Crossings	SUP
CIP-14	Light Rail/Commuter Rail Pedestrian Gates	SUP
CIP-17	Innovative Low-Cost Grade Separation	SUP
CIP-18	Video Monitoring/Detection System	SUP
CIP-19	Low-Cost Intrusion Barriers	SUP
D-5	Performance Measures	SUP
D-9	Foreign Experience with Warning Devices	SUP
D-10	Expert System	SUP
D-12	"Lessons Learned" Analysis	SUP/NEW**
D-15	RR Whistle Operational Practices	SUP

* -- SUP = SUPPLEMENTAL RESEARCH ACTIVITY

**--SUP/NEW = SUPPLEMENTAL AND NEW RESEARCH ACTIVITY

Table 3-32. All Other Urgency Categories -- Unidentified Research Activity

RN #	TITLE
D-8	Cost and Benefits of Highway-Rail Safety Improvements
HF-30	ADA Accessibility of Crossings

As can be seen from Table 3-30, the new research initiatives are dominated by the Human Factors area with 52% of the research needs. This indicates that this area should be targeted in the future to enhance safety at highway-rail grade crossings. Two research needs were unspecified as to research type but this may have been an oversight by the groups.

3.6 GENERAL DISCUSSION

A summary of the observations for the thirty-nine (39) high urgency needs is given below:

- Seventy-four percent (74%) of the high urgency research needs are within the low- to medium-cost range.
- Most high urgency research needs identified are applicable to HSR.
- New research initiatives consist of 56% of the high urgency needs and are dominated by the Human Factors topical area.

In addition, fifty (50) other urgency research needs were analyzed and the results are as follows:

- Eighty-two percent (82%) of “all other urgency” research needs fall in the low- to medium-cost range.
- Most “all other urgency” research needs are applicable to HSR.
- Human Factors dominates the new research needs within the “all other urgency” research needs identified.

Furthermore, an analysis of all ninety-two (92) research needs identified indicates that a number of the areas overlap significantly and/or could be assigned to common areas of research. This suggested an overall structure for an integrated research program with two general themes, (1) Crossing Improvement (engineering) Programs and (2) Enforcement and Education, under which subcategories of common areas of research could be assigned. This general structure is described in Figure 3-3.

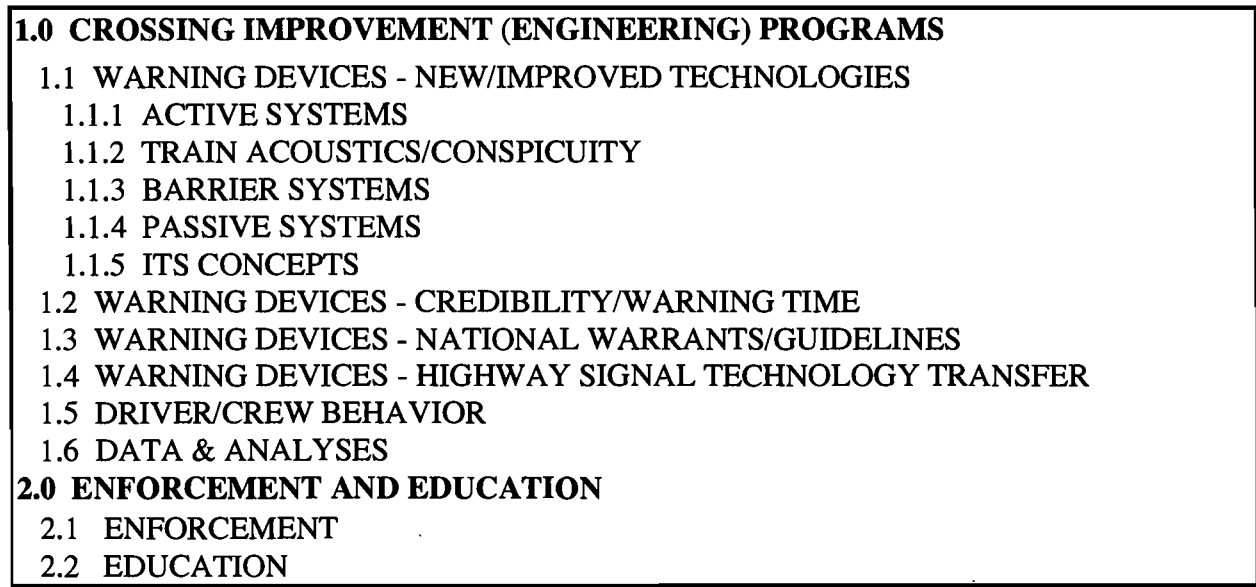
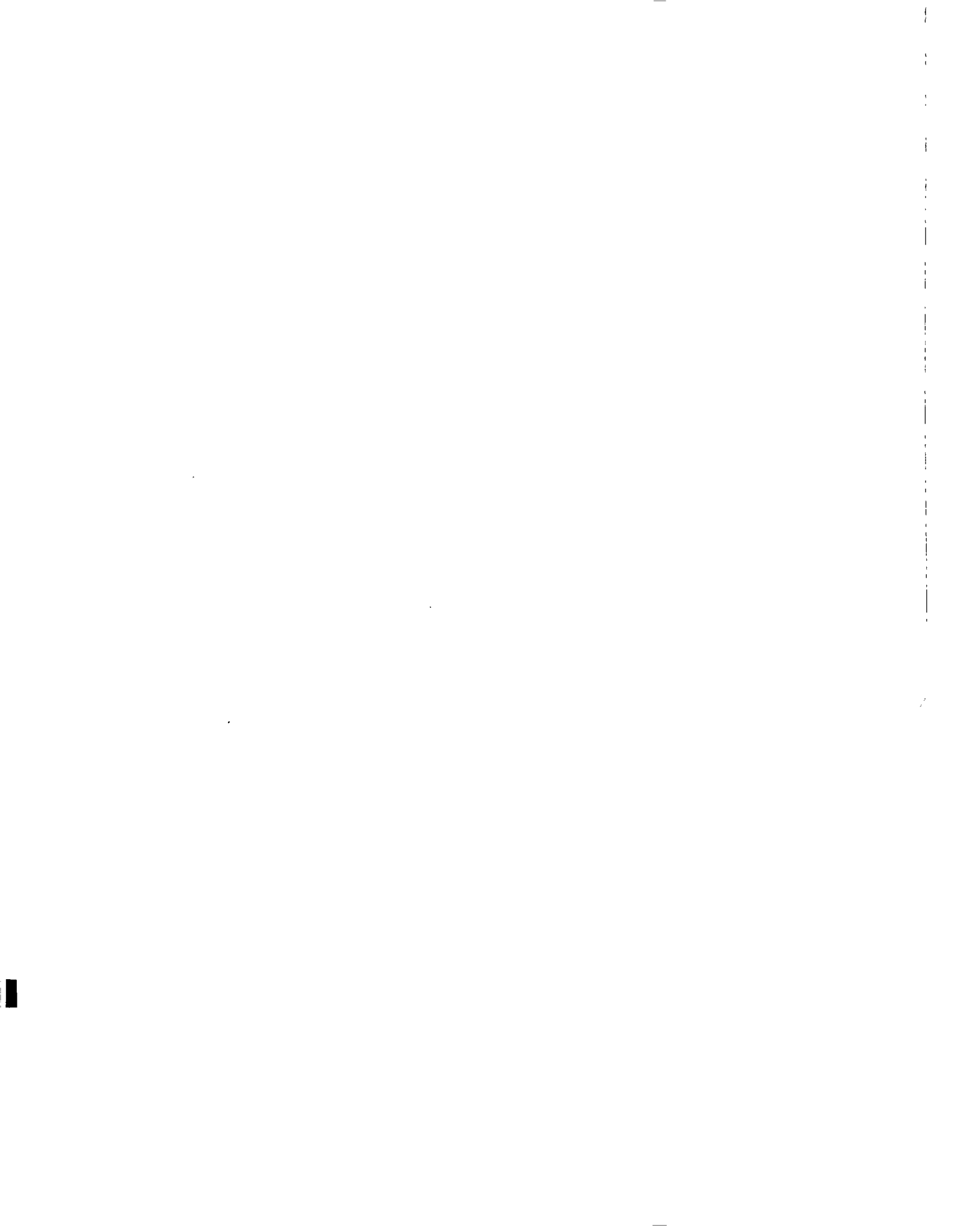


Figure 3-3. General Structure of an Integrated Research Program



4. OBSERVATIONS

The objective of the Rail-Highway Grade Crossing Safety Action Plan, released June 13, 1994, is to achieve at least a 50% reduction in accidents and fatalities at grade crossings over the next ten years. The following section summarizes observations based on the analysis of the results of the workshop and presents a proposed integrated research program to support the above goal.

4.1 HIGH URGENCY NEED OBSERVATIONS

Thirty-nine (39) of the research needs identified were specified by the workshop delegates as being of high urgency to promote safety at highway-rail grade crossings in the future. The following analyses summarize the preliminary results and offer observations reviewing the factors of cost, HSR applicability and research type.

4.1.1 Cost Factors

All highly urgent needs have been sorted by cost and results of the analysis are shown below. Seventy-four percent (74%) of all research needs identified were within the low- to medium-cost range, suggesting that cost-effective research can be conducted without large expenditures of public funds. The Driver (public) Education research needs predominate (50%) in the low-cost subcategory. The Human Factors needs hold 61% of the medium-cost range. The high-cost range includes only about 13% of the high urgency research needs identified, a key finding, as shown in Table 4-1.

Table 4-1. High Urgency Needs -- by Cost

COST	PERCENTAGE OF HIGH URGENCY NEEDS
LOW = <\$1000,000	18%
MEDIUM = \$100,000 TO \$500,000	56%
HIGH = >\$500,000	13%
UNIDENTIFIED	13%

These results indicate that most of the research needs identified may cost-effectively promote achievement of the FRA's goal of reducing grade crossing accidents by 50%.

4.1.2 High Speed Rail Applicability

The highly urgent needs that were identified to be applicable to HSR are shown in Table 4-2 by percentage. The following results show approximately 60% of the these needs were specified as applicable. Although a large percentage of research needs in this category were unspecified, a review of the these needs indicates that most are applicable. For example, Research Need # HF-23, *Driver Perception of Risk*, was unspecified, but the FRA guidelines for HSR have established a necessity for treatments to minimize the driver's risk-taking behavior.

Table 4-2. High Urgency Needs -- by HSR Applicability

HIGH SPEED RAIL APPLICABILITY	PERCENTAGE OF HIGH URGENCY NEEDS
YES	60%
NO	4%
UNIDENTIFIED	36%

4.1.3 Research Type (Supplemental or New)

The workshop participants were asked to note whether the specific research need was supplemental to research being done or whether it was a new research initiative. Some of the research needs identified, however, were supplemental with new aspects. Therefore they were asked to denote those as supplemental/new.

The supplemental (including supplemental/new) research needs consist of 41% of the high urgency research needs and all topical areas appear. The new research initiatives consist of 56% of the high urgency needs and are dominated by the Human Factors area. This indicates that this research area should be targeted in the future to improve highway-rail grade crossing safety. There was only one research need that was unspecified as to research type but this may have been an oversight by the group.

Table 4-3. High Urgency Needs -- by Research Type

RESEARCH ACTIVITY TYPE	PERCENTAGE OF HIGH URGENCY NEEDS
SUPPLEMENTAL	41%
NEW	56%
UNIDENTIFIED	4%

4.2 ALL OTHER URGENCY RESEARCH NEED OBSERVATIONS

An analysis was conducted on “all other urgency” research needs identified as one group to include medium, low and unidentified urgency needs. These needs were not prioritized but were analyzed based on factors of cost, HSR applicability and type of research as indicated in the following sections. The trends indicated are based on the information received on the research needs forms supplied by each topical area group. These trends have not been reviewed by all of the Steering Committee or delegates in attendance at the workshop.

4.2.1 Cost Factors

In reviewing Table 4-4, results indicate that 82% of the “all other urgency” research needs that have been identified are within the low- to medium-cost range. The Human Factors topical area consists of 61% of the medium-cost subcategory. This supports the findings stated above in the high urgency category - most needs fall within the low- to medium-cost range.

Table 4-4. All Other Urgency Needs -- by Cost

COST	PERCENTAGE OF ALL OTHER URGENCY NEEDS
LOW = <\$1000,000	38%
MEDIUM = \$100,000 TO \$500,000	44%
HIGH = >\$500,000	8%
UNIDENTIFIED	10%

4.2.2 High Speed Rail Applicability

“All other urgency” research needs that were identified to be applicable to high speed rail are shown below by percentage. As can be seen, the majority of research needs were unspecified as to applicability to high speed rail. However, a review of the research needs in the “all other urgency” category shows that most are actually applicable to HSR. For example, Research Need # D-9, *Foreign Experience with Warning Devices*, would be a prime candidate for high speed rail applications. The results of this analysis support the observations identified within the high urgency category of research needs.

Table 4-5. All Other Urgency Needs -- by HSR Applicability

HIGH SPEED RAIL APPLICABILITY	PERCENTAGE OF ALL OTHER URGENCY NEEDS
YES	44%
NO	0%
UNSPECIFIED	56%

4.2.3 Research Type (Supplemental or New)

The supplemental (including supplemental/new) research needs are shown below by percentage. The Human Factors topical area constitutes 52% of the new research initiatives. This result once again supports the observations within the high urgency category of research needs identified.

Table 4-6. All Other Urgency Needs -- by Research Type

RESEARCH ACTIVITY TYPE	PERCENTAGE OF ALL OTHER URGENCY NEEDS
SUPPLEMENTAL	34%
NEW	62%
UNIDENTIFIED	4%

4.3 INTERRELATED RESEARCH NEEDS

An analysis of all ninety-two (92) research needs identified indicates that a number of the areas overlap significantly and/or could be assigned to common areas of research. This general structure is described in Section 3.6 - *General Observations*. Using the general structure described in Figure 3-3 as a basis, an integrated research program was developed by selecting individual or combined research needs and assigning them to the areas of research in the general structure. This integrated program is described in Table 4-7. The table indicates the specific research needs that comprise each area of research by their reference code and the status of the research in terms of type, i.e., new or supplemental to other ongoing research. The table also shows the applicable section of the U.S. DOT Action Plan for Rail-Highway Grade Crossing Safety that addresses related research.

Table 4-7. Integrated Research Program for Crossing Safety

REFERENCE BY RN #	RESEARCH AREA	STATUS	REFERENCE BY ACTION PLAN #
ACTIVE SYSTEMS			
CIP - 5/HF-26	More Effective and Low-Cost Warning Devices	Sup	VD1/G3/I1/Q4
CIP-21/HF-4/HF-9	Advanced Warnings	New	
CIP - 9	Off - Track Train Detection	Sup	VE2G6
D-9/DE-6	High Speed Rail Studies	Sup	G8
TRAIN ACOUSTICS/CONSPICUITY			
HF-14A/HF-14B/CIP-11/D-15	Acoustic Warning Devices	Sup	G4/VD-2/J
HF-12	Rail Car Conspicuity	Sup	G2/VD4/G1/I2
BARRIER SYSTEMS			
CIP-3/CIP-2/CIP-19/HF-5	Barrier System Research	Sup	A2/A3/IVC
CIP-17	Innovative Low-Cost Grade Separation	Sup	A3
PASSIVE SYSTEMS			
CIP-4/HF-2	Effective Signs and Countermeasures for Passive Crossings	Sup	G5/IIC
ITS CONCEPTS			
CIP - 7/HF-7/HF-37	ITS Applications to Crossing Safety	Sup	A4
CIP-18	Video Monitoring/Detect (priority unknown)	Sup	VE1
WARNING DEVICES - CREDIBILITY/WARNING TIME			
CIP - 6/HF-15/HF-23/HF-25/HF-18	Warning Device Credibility and Warning Time	New	
WARNING DEVICES - NATIONAL WARRANTS/GUIDELINES			
CIP - 8	Proposed National Warrants for the Selection of Warning Devices	Sup	IID
CIP-12	Identification of Institutional Impediments to Grade Crossing Improvements	Sup	IF
HF-11	Interim Improvements at Grade Crossings	New	
WARNING DEVICES - HIGHWAY SIGNAL TECHNOLOGY TRANSFER			
CIP - 1/HF-10/HF-22	Highway Traffic Control Devices at Crossings	New	

Table 4-7. Integrated Research Program for Crossing Safety (cont.)

REFERENCE BY RN #	RESEARCH AREA	STATUS	REFERENCE BY ACTION PLAN #
<i>DRIVER/CREW BEHAVIOR</i>			
HF-1	Effects of Sight Distance on Driver Behavior	New	
HF-28	In-Train Warning Devices	New	
HF-29	Post Train Accident Effects	New	
<i>DATA & ANALYSES</i>			
D-1 to D-4	Improved Grade Crossing Data Resources	Sup	VI
HF-6	Causal Analysis of Accidents Involving Grade Crossings	New	
CIP-10	Quantitative Risk Assessment	Sup	G8
<i>ENFORCEMENT</i>			
E-1	Training and Model Policies	Sup	L2
E-2	Photo Enforcement	Sup	G7/C1
E-3	Increase Fines and Penalty Assessment	Sup	C1
E-4	911 Versus Railroad Telephone Number	Sup	VF/M
<i>EDUCATION</i>			
DE-1 to DE-4D	Comprehensive Education Program	Sup	III/F/VB/G8

4.4 GENERAL OBSERVATIONS

The consensus of the workshop delegates is that the workshop was a very good first step in developing an intermodal approach to highway-rail grade crossing safety research and that the process should continue.

Further examinations of the preliminary research needs identified at the workshop and other current research programs will continue. However, significant results of the current analyses on all research needs identified include the following:

- Seventy-seven percent (77%) of all research needs identified were within the low- to medium-cost range, suggesting that cost-effective research can be conducted without large expenditures of public funds.
- Most research needs identified are applicable to HSR.
- The Human Factors topical area provided 43% of all needs identified and dominates (60%) of the new research initiatives. Therefore, this topical area should receive increased emphasis in the future.

Most research needs identified at the workshop address safety issues at grade crossings on proposed high speed rail corridors. The results of these research endeavors could aid the railroads and states in making determinations as to warning device applications and treatments which could be used to promote safety. In conclusion, the workshop, conducted in response to the U.S. DOT Action Plan, has identified research needs which may cost-effectively promote the

achievement of the plan's primary goal - the reduction of highway-rail grade crossing accidents
by 50 % in the next ten years.

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1. INTRODUCTION

2. IDENTIFIED RESEARCH NEEDS

2.2 DRIVER (PUBLIC) EDUCATION

2.3 ENFORCEMENT

2.4 HUMAN FACTORS

2.5 CROSSING IMPROVEMENT (ENGINEERING) PROGRAMS

2.6 DATA

3. DISCUSSION AND ANALYSIS OF IDENTIFIED RESEARCH NEEDS

4. OBSERVATIONS