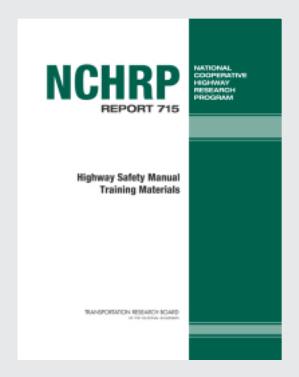

Highway Safety Manual Training Materials

DETAILS

18 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-21388-2 | DOI 10.17226/22784

CONTRIBUTORS

Dixon, Karen K.; Xie, Fei; Kopper, Neil; Zhou, Yanfen; Schalkwyk, Ida van; Neuman, Tim; Xu, Wei; Sreenivasan, Athreya; Perez-Bravo, Dante; Sutherland, Larry; Gowan, Brelend; Herbel, Susan; McGovern, Colleen; and Keller, Kathleen

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 715

Highway Safety Manual Training Materials

Karen K. Dixon
Fei Xie
Neil Kopper
Yanfen Zhou
OREGON STATE UNIVERSITY
Corvallis, OR

Ida van Schalkwyk
Tim Neuman
Wei Xu
Athreya Sreenivasan
Dante Perez-Bravo
CH2M HILL
Chicago, IL

Larry Sutherland
PARSONS BRINCKERHOFF
Columbus, OH

Brelend Gowan
Davis, CA

Susan Herbel
Colleen McGovern
CAMBRIDGE SYSTEMATICS
Bethesda, MD
and
Fort Lauderdale, FL

Kathleen Keller
AMERICAN COURSEWARE
Lake Mary, FL

Subscriber Categories
Education and Training • Safety and Human Factors

Research sponsored by the American Association of State Highway and Transportation Officials
in cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2012
www.TRB.org

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Academies was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NCHRP REPORT 715

Project 17-38
ISSN 0077-5614
ISBN 978-0-309-21388-2
Library of Congress Control Number 2012931500

COPYRIGHT INFORMATION

NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

The Transportation Research Board of the National Academies, the National Research Council, and the sponsors of the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

Published reports of the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at:

http://www.national-academies.org/trb/bookstore

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

COOPERATIVE RESEARCH PROGRAMS

CRP STAFF FOR NCHRP REPORT 715

Christopher W. Jenks, *Director, Cooperative Research Programs*
Crawford F. Jencks, *Deputy Director, Cooperative Research Programs*
Charles W. Niessner, *Senior Program Officer* (retired)
Andrea Harrell, *Senior Program Assistant*
Eileen P. Delaney, *Director of Publications*
Kami Cabral, *Editor*

NCHRP PROJECT 17-38 PANEL
Field of Traffic—Area of Safety

Kohinoor Kar, *Arizona DOT, Phoenix, AZ* (Chair)
W. Martin Bretherton, Jr., *HNTB Corp., Atlanta, GA*
Terry Butler, *University of Central Missouri, Warrensburg, MO*
Patrick Hasson, *Federal Highway Administration, Olympia Fields, IL*
David L. Piper, *Illinois DOT, Springfield, IL*
Richard Raub, *Raub Associates, Portland, OR*
Jay L. Smith, *Missouri DOT, Lee's Summit, MO*
Xiaoduan Sun, *University of Louisiana—Lafayette*
Judith Williams, *Federal Motor Carrier Safety Administration, Arlington, VA*
Eugene M. Wilson, *Wilson & Associates, Sun City West, AZ*
Thomas Elliott, *FHWA Liaison*
Esther Strawder, *FHWA Liaison*
Richard Pain, *TRB Liaison*

FOREWORD

By Charles W. Niessner
Staff Officer
Transportation Research Board

This report provides the training materials to aid in implementing the AASHTO *Highway Safety Manual* (HSM). The training materials provide a broad overview of the HSM format and procedures. The enclosed CD-ROM (*CRP-CD-106*) includes presentation slides with speaker notes, participant handouts, interactive sample problems, smart spreadsheets, and similar supporting documents. Since the target audience for this training is transportation professionals who are not required to have a vast knowledge of safety assessment procedures, the collection of training material includes basic introductory information as well as specific content for advanced procedures where appropriate. The report also briefly addresses the preferred expertise of the candidate instructors so as to enhance the learning experience for all involved parties.

The report will be of particular interest to safety practitioners responsible for developing and managing highway safety improvement programs.

The recent release of the AASHTO *Highway Safety Manual* (HSM) introduced a science-based safety assessment approach that can be used to help transportation professionals identify how to best enhance safety for their managed facilities. The purpose of the HSM is to provide the best information and tools to facilitate roadway planning, design, operations, and maintenance decisions based on explicit consideration of their safety consequences.

The emphasis of the HSM is on the development of quantitative tools addressing two-lane highways, rural multilane highways, and urban and suburban arterials. In addition, the HSM presents a summary of knowledge on the safety effects of various roadway designs and operations in a form that users can readily apply. It also describes effective techniques for safety management of a roadway system and presents state-of-the-art approaches to evaluation of the safety effectiveness of implemented projects.

Under NCHRP Project 17-38, "Highway Safety Manual Implementation and Training Materials," researchers at the Oregon State University developed training materials to aid in implementing the HSM. A common concern about the implementation of new procedures focused on safety is the potential for how these techniques and their presentation of results may be perceived. The report briefly summarizes how instruction and documentation should use clear and concise language and how instructors should be cognizant of the way specific terms associated with safety can be perceived in the litigation context. Often, phrases and terms used to conveniently describe transportation scenarios may have taken on connotations and implications far beyond their intended meaning. The report highlights example phrases that can be perceived incorrectly and also encourages instructors to impress upon their audience the need to express themselves in an objective, rather than subjective, manner.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Highway Safety Manual Training Materials

The recent release of the AASHTO *Highway Safety Manual* (HSM) introduced a science-based safety assessment approach that can be used to help transportation professionals identify how to best enhance safety for their managed facilities. A key aspect for the success of the HSM is wide dissemination and comprehensive understanding of the techniques introduced in this important document. NCHRP initiated this outreach and training project prior to the publication of the HSM that included briefing activities as well as training materials with pilot workshops. The training materials developed for this project (NCHRP Project 17-38) are reviewed in this report; the companion CD-ROM (*CRP-CD-106*) includes electronic training files.

The training materials summarized in this report are intended as a broad overview of the HSM format and procedures. They are not intended to comprehensively cover all facets of the various procedures included in the HSM, but rather to introduce workshop participants to the general content and methods that encompass the materials. Twelve informational modules address the HSM structure and content and include information ranging from HSM development and safety fundamentals to network screening, safety effectiveness evaluation methods, crash prediction procedures, and candidate crash modification factors.

In addition to presentation slides with speaker notes, the training materials also include participant handouts, interactive sample problems, smart spreadsheets, and similar supporting documents. Since the target audience for this training is transportation professionals who are not required to have a vast knowledge of safety assessment procedures, the collection of training material includes basic introductory information as well as specific content for advanced procedures where appropriate. The report also briefly addresses the preferred expertise of the candidate instructors to enhance the learning experience for all involved parties.

A common concern about the implementation of new procedures focused on safety is the potential for how these techniques and their presentation of results may be perceived. This report summarizes how instruction and documentation should use clear and concise language and how instructors should be cognizant of the way specific terms associated with safety can be perceived in the litigation context. Often, phrases and terms used to conveniently describe transportation scenarios may have taken on connotations and implications far beyond their intended meaning. This report highlights example phrases that can be perceived incorrectly and also encourages instructors to impress upon their audience the need to express themselves in an objective, rather than subjective, manner.

CHAPTER 1

Introduction

The use of scientifically based safety procedures by a transportation agency can help support strategic and effective identification of optimal enhancement projects that have the greatest likelihood for reducing crashes. Similarly, transportation professionals responsible for the design, construction, and operation of new roadways can assess alternative strategies that explicitly consider the safety of the proposed facility. In 2010, the American Association of State Highway and Transportation Officials (AASHTO) published the first edition of the *Highway Safety Manual* (HSM) so that this growing body of scientific literature could be readily available to transportation professionals. "Road safety management is in transition. The transition is from action based on experience, intuition, judgment (*sic*), and tradition, to action based on empirical evidence, science, and technology . . ." (Hauer 2005). Many in the road safety professional community lack knowledge of more effective methods currently available to guide safety investments. Some agencies may solely use antiquated procedures that, on occasion, provide questionable results and can lead to a poor use of scarce resources. Transportation safety is maturing as a science with more promising scientific methods and tools that can be applied to reduce the deaths and injuries occurring on our roads. The HSM provides an initial step toward a culture where the safety of the traveling public can and should be directly considered when assessing potential roadway projects.

The introduction and ultimate "institutionalization" of the new HSM is arguably the most significant advancement in the highway engineering industry in many years. The purpose of the HSM is to provide the best information and tools to facilitate roadway planning, design, operation, and maintenance decisions based on explicit consideration of their safety consequences. The HSM, as envisioned by those who created it, will forever alter project development and decision making by *directly* incorporating science-based, proven measures of traffic safety in all aspects of highway and traffic engineering design and operations.

AASHTO, the Federal Highway Administration (FHWA), and many professionals invested years of effort and millions in research funds to arrive at the first edition of the HSM. Now that the HSM is available, it is imperative that those who represent its intended audience—transportation professionals involved in all aspects of project decision making—be familiar with its scope, content, and appropriate use. An initial step in the successful HSM transfer of knowledge to the transportation community is the development of training material designed to introduce the HSM content and application to those not yet familiar with the evolving safety assessment techniques.

This report introduces the overview HSM training, provides a brief review about the goals and scope of the training, reviews training logistics including trainer and target audience qualifications, and describes the content and structure of the course materials. Included with this report is a CD-ROM (*CRP-CD-106*) that contains electronic copies of the HSM training materials. Appendix A provides an overview of the contents of the CD-ROM.

The training summarized in this report was performed as part of a larger National Cooperative Highway Research Program (NCHRP) project that included two key components:

1. Development of an overview presentation and briefing of various AASHTO and other safety committees and
2. Creation of training materials for the HSM.

The briefing activities as identified in the first item occurred prior to the release of the HSM in 2010 and were targeted toward informing state officials about the HSM content and application. Ultimately, the project team incorporated the generic presentation used for the briefings into the overview presentation known as Module 1 in the training materials.

Though this project included both tasks, this report primarily focuses on the resulting training materials. Appendix B of this report includes an overview of the briefings performed as part of the Task 1 effort.

CHAPTER 2

Background

The HSM introduces and promotes the use of science-based safety analysis procedures that can help ensure that the planning, design, operation, construction, and maintenance of transportation facilities can explicitly consider safety when an agency is deciding how to establish funding allocations. Ideally, complete elimination of all crashes (particularly serious and fatal injury crashes) is optimal; however, any safety improvement that would result in a reduction in crashes should be known and considered. Methods included in the HSM enable an agency to better understand how safety implications can be estimated and how this knowledge can then be integrated into the decision process.

Volume 1 of the HSM includes tools that can be used by an agency to create safety management programs. This volume of the HSM includes historically identified safety assessment methods, but also introduces ways to improve assessment performance using additional methods that eliminate known analysis deficiencies such as natural variations in crash data and how these variations can inadvertently introduce biased recommendations. The use of the safety management procedures in Volume 1 of the HSM can help an agency avoid spending valuable resources, in the name of safety, on initiatives that may not ultimately result in the anticipated reduction in crashes. The screening techniques included in Volume 1 can also help agencies assess systemic policy initiatives.

Volume 2 of the HSM introduces predictive methods to estimate crash frequency and severity for rural two-lane roads, rural multilane highways, and urban and suburban arterials. These predictive methods can be used, for example, to assist transportation professionals with weighing project-specific improvement options. Knowledge of the anticipated safety implications for a candidate countermeasure or improvement strategy can assist decision makers in selecting optimal roadway improvement alternatives.

The HSM also includes a catalog of crash modification factors/functions in Volume 3. These factors can help an agency better understand the direct impact of a single countermeasure on crash reductions.

The target audience of the HSM is practitioners at the state, county, metropolitan planning organization (MPO), or local level (AASHTO 2010b). Any training efforts, therefore, should include content for this expected user group.

Objective and Scope

An initial step toward effectively integrating the HSM into transportation decision making is to provide tools that can help agencies implement the procedures presented in this important manual. This report provides a summary of the overview training materials developed for the HSM. In addition, Appendix B documents the HSM briefing efforts critical to the early stages of this effort.

The activities that led up to the development of the HSM training included the following tasks:

- Develop learning objectives and course outline,
- Recommend the length and delivery method for the course and how it will meet the needs of the various audiences,
- Develop one full module for panel review,
- Present a draft version of the full training to the project panel and other invited guests,
- Conduct several pilot trainings to refine the material,
- Develop companion training materials including an instructor manual, and
- Propose training activities and implementation issues that can extend beyond this project.

The following summary generally reviews the training course that evolved from these various tasks.

Overview Training Course

The NCHRP Project 17-38 panel instructed the project team to develop a high-level overview training course that would generally introduce workshop participants to the content and intended application of the material included in the HSM. As

a first step toward accomplishing this effort, the team identified 12 training modules for the HSM content and developed learning objectives for each module. These learning objectives were intended to inform workshop participants about a variety of potential HSM implementation questions. Since candidate users of the HSM may have various levels of experience, the training modules also targeted introductory safety assessment issues. The resulting training modules generally addressed HSM content, but were also intended to help professionals using the new safety techniques understand how the HSM could be integrated into their daily transportation professional activities. For instance, some of the items included in the training were intended to help transportation professionals understand the role of the HSM as it applies to the following applications that were a target of numerous questions during the briefing activities:

- How do we reconcile the HSM findings with what we already "know" about highway safety?
- What is the role of the HSM when compared with the AASHTO Green Book? AASHTO Roadside Design Guide? The Manual on Uniform Traffic Control Devices (MUTCD)?
- How can you apply HSM models and approaches to locations with limited or lack of data?
- Should an agency be concerned about the possibility of tort liability exposure if it chooses to use the HSM?

The duration of the training can vary based on the audience, the level of expertise, and the depth of knowledge the workshop participants need for safety analysis. In addition, several safety courses currently exist and others are under development. The HSM overview training was developed to complement these companion efforts. In general, the duration of the training should last from 2 to 3 days, but agencies can select individual modules that could be customized for shorter training activities.

The developers of the HSM created a manual that could be used by all transportation professionals and does not require a mandatory safety background. As a result, the training modules are targeted toward the individual who is just learning about safety analysis and how the HSM can support this effort. If an agency, however, prefers to provide focused training for safety experts or other personnel, it can expand the focus for some of the analytical modules while minimizing the attention on the fundamental modules. Table 1 identifies the 12 instruction modules as well as which target workshop participants would most directly benefit from each specific module. The Introduction (Module 1) and the Overall HSM Summary (Module 12) should be included in all training workshops.

Future Training Activities and Implementation Issues

The ultimate widespread use of the HSM depends on integration of the document into the transportation community activities. Central to this goal is dissemination via means of training activities and outreach efforts well beyond the conclusion of this project. Currently, the FHWA maintains a list of courses and workshops offered by multiple agencies in the United States (see http://safety.fhwa.dot.gov/training/). In

Table 1. HSM training modules and associated target workshop participants.

Module Number	Module Description	Personnel Expertise of Workshop Participants					
		General Knowledge	Planning	Design or Operations	Safety	Maintenance or Construction	Executives or Managers
Module 1	Introduction to the HSM	✓	✓	✓	✓	✓	✓
Module 2	Fundamentals	✓	✓	✓		✓	
Module 3	Overview—Crash Modification Factors	✓	✓	✓	✓	✓	
Module 4	HSM Predictive Method Process	✓		✓	✓	✓	
Module 5	HSM Calibration Procedure	✓			✓		
Module 6	Overview of HSM Part B	✓	✓		✓		
Module 7	Network Screening	✓	✓		✓		
Module 8	Human Factors	✓	✓	✓	✓		
Module 9	Diagnosis and Countermeasure Selection	✓	✓	✓	✓	✓	
Module 10	Economic Appraisal and Project Prioritization	✓	✓		✓	✓	✓
Module 11	Safety Effectiveness Evaluation	✓	✓	✓	✓		
Module 12	Overall HSM Summary	✓	✓	✓	✓	✓	✓

addition, several state agencies provide safety-specific training courses. The training material included with this report will be used to directly develop an FHWA training course, but any agency can also use the material to enhance local training or to offer training as needed. Since the 2010 publication date, several HSM training workshops have been offered at national conferences or regional professional society meetings.

In addition to formal on-site training, the FHWA is developing a web-based training program for the HSM. The FHWA is also focusing on implementation issues and is currently sponsoring several projects, including helping to develop a practitioner's guide for the HSM.

There are also several resources currently available for HSM users. AASHTO supports a website located at http://www.highwaysafetymanual.org that provides the most recent information about the HSM, including a user discussion forum, fact sheets, video files of training webinars, supporting documents, and technical support information. In addition, the TRB Safety Performance Committee located at http://safetyperformance.org contains supplemental HSM information, including a Part C Quick Reference Guide, as well as supplemental resources for use with the HSM. Collectively, there are several efforts ongoing to help facilitate the training and implementation of the HSM.

CHAPTER 3

Target Audience and Instructors

The HSM overview training materials described in this report have been designed for a specific target audience and with the assumption that the instructors have a basic skill set that will enable effective introduction of the material covered. The target audience member is assumed to be any transportation professional and does not require a mandatory safety background. This broad audience, therefore, includes a variety of practitioners from the state, county, MPO, and local level. With this diverse audience, basic instruction of the HSM techniques is essential, but the instructors must also have a depth of knowledge about the HSM procedures and the science-based research used for this document so they can respond correctly to key computational and statistical questions, if required.

As a result, it is generally recommended that a minimum of two instructors participate in the workshop. At least one of the recommended instructors should have enough statistical knowledge to be able to clearly explain the role of key concepts, including regression to the mean and Empirical Bayes (EB). Since many of the workshop participants may have a basic understanding of historic safety procedures, the instructors should also be knowledgeable about the history and background of the HSM, why enhanced procedures are needed, and when the use of older, less reliable techniques is not appropriate.

Since the individuals responsible for the development of the HSM include a wide variety of transportation professionals affiliated with state agencies, AASHTO, FHWA, universities, consultants, and special user groups, the instructors should be aware of the history and evolution of the HSM and how it developed to the current level. The workshop would be further enhanced if the instructors are active participants helping to develop future editions of the HSM, so that they can address perceived gaps in the manual, respond to questions specific to evolving content, and serve as feedback conduits to the ongoing HSM development.

Ideally, an instructor team should include one member with specific safety management or project development experience so as to demonstrate the value of the HSM procedures and their application to specific, identified needs. An instructor with a strong linkage to the safety community will be able to direct workshop participants to best practices demonstrated by other transportation professionals.

Finally, clear and concise language is always critical when teaching a workshop; however, the instruction of a safety workshop also requires sensitivity to the use of terminology that can be potentially misinterpreted. The instructors should be cognizant of how specific terms associated with safety can be perceived in the litigation context and how they have taken on connotations and implications far beyond their original meaning. The instructors should minimize the use of terms such as “hazardous locations,” “high crash site,” or “safety problem.” Phrases such as “anticipated crash reduction” or “sites with potential for improvement” can convey the same general meaning without unnecessarily implicating litigation-related connotations and their associated risk. The instructors also need to impress upon their audience the need to express themselves in an objective, rather than subjective, manner. Terms such as “safer,” “less safe,” “preferable,” “best” and “worse” are mere statements of opinion. Factual descriptions in terms of expected number of crashes allow the user to conclude whether a facility is “safer” or not. Likewise, the standard error or similar goodness of fit metric will inform the user of a methodology’s reliability and allow the user to determine if it is “preferable” or the “best” one to use.

CHAPTER 4

Description of the Course Materials

The HSM overview training materials include presentation files, instructor and participant guides, sample problems, smart spreadsheets, and ancillary files to facilitate training activities. These training materials are based on the 12 modules depicted in Table 1. These 12 modules collectively introduce the audience to the HSM basic content including methodology, processes, and recommended applications. Each module can be customized to accommodate individual presentation preferences and styles. The presentation files also include embedded instructor notes to assist the presenter with intended content for the individual slides.

Following several pilot training efforts, the NCHRP Project 17-38 team determined that the optimal instruction sequence may not always align with the order of the material as presented in the HSM. In some cases a module represents multiple chapters. The introduction of crash modification factors (CMFs), as an example, is presented in the HSM as part of the predictive models in Volume 2 and as a library in Volume 3. For the training, early instruction of CMFs is critical to the analysis procedures and so this content was moved forward in the training sequence. The following summarizes the 12 modules and their HSM associated content.

Module 1—Introduction to the Highway Safety Manual

The intent of Module 1 is to introduce the participants to the workshop structure and purpose. To do this, the Module 1 presentation reviews the purpose and scope of the HSM and how the procedures contained in the manual apply to planning, design, operations, construction, and maintenance initiatives. The source information included in Module 1 originated from the HSM briefing presentation and material included in Chapter 1 (Introduction and Overview) of the HSM.

At the conclusion of this module, participants will be able to

- Define the purpose of the HSM;
- Recognize the target audience: safety specialists, design and traffic engineers, and transportation planners;
- Diagram the HSM structure and chapter content;
- Relate the advantages of implementing the HSM for each target audience;
- Describe the relevance of advanced road safety knowledge to HSM implementation;
- Relate activities and projects relative to the HSM; and
- Identify how to integrate the HSM into project development.

Module 2—HSM Fundamentals and Terms

The fundamentals presentation introduces workshop participants to essential safety information that is needed to establish a basic foundation of terminology and methods needed prior to a more detailed introduction of the various HSM safety procedures. Module 2 content is based on the HSM Chapter 3 (Fundamentals) and supplemented by example scenarios. In addition to the presentation, a summary of HSM Workshop Acronyms is available in the front section of the participant guide (a similar list is included in the instructor guide).

At the conclusion of this module, participants will have fundamental background that will enable them to

- Recognize HSM safety measurement by crashes;
- Describe data needs for the HSM;
- Describe the evolution of crash estimation methods;
- Recognize predictive methods in Volume 2, Part C of the HSM; and
- Identify benefits and limitations in the evaluation of safety effectiveness.

Module 3—Crash Modification Factors

The use of CMFs (single values) or functions (equations) is the focus of Module 3. The HSM includes CMFs as part of self-contained safety predictive methods (in Volume 2) as well as a library of CMF types, base conditions, and applications in the HSM Volume 3. Source material for this module,

therefore, originated from Chapters 10, 11, and 12 (predictive methods) as well as Chapters 13, 14, 15, 16, and 17 of the HSM. In addition to the presentation, six sample problems (Sample Problems 3-1 through 3-6) are available so that participants can see sample calculations that incorporate the use of CMFs.

At the conclusion of this module, participants will

- Be familiar with crash modification factors and functions; and
- Recognize Volume 3, Part D, as a resource for CMFs relative to
  - Roadway segments;
  - Intersections;
  - Interchanges; and
  - Special facilities, geometric situation, and road networks.

Module 4—Predictive Methods

The HSM includes predictive methods for rural two-lane roads, rural multilane highways, and urban and suburban arterials. Module 4 introduces the common predictive method analysis procedure required for applying the predictive methods. These methods are reliable and repeatable quantitative assessment procedures that are scientifically based and can help confirm that resources are distributed in a manner that effectively enhances safety. This Module 4 presentation introduces the predictive methods, provides an example application for rural two-lane roads, and introduces an exercise example for comparing two design options to existing conditions. A rural two-lane intersection in-class exercise and two additional sample problems (Sample Problems 4-1 and 4-2) are available for participants to begin applying the predictive methods to potential applications. The intent of the in-class exercise is for participants to manually work one simple application. The predictive methods combine safety performance functions, CMFs, and calibration factors to estimate the predicted number of crashes. Since this procedure can require multiple calculations, the training material also includes smart spreadsheets for the three road types. These spreadsheets are formatted to resemble the HSM worksheets included in Chapters 10, 11, and 12. The in-class exercise and the two sample problems are also provided as completed sample problem spreadsheets so users can see specific calculations. In many of the pilot training workshops, the participants requested that interactive computer lab exercises be included in Module 4. The worksheets and sample problems are constructed so that this expanded module content can be incorporated in more detailed training if the workshop participants' expertise deems this appropriate.

At the conclusion of this module, participants will be able to

- Explain the predictive method and the analysis process;
- Identify required data for basic and supplemental analysis;
- Define the predictive method, application, and limitations;
- Compare the differences among predictive methods based on characteristics of roadway types; and
- Demonstrate the predictive method.

Module 5—Calibration and Predictive Method Specialized Procedures

The HSM predictive procedures can be used for relative comparison purposes or they can be customized for local variations unique to a jurisdiction through the use of calibration. Example influences that can make local predictions different than the HSM values include differences in crash reporting thresholds or procedures, unique weather or terrain conditions, and high levels of animal-involved crashes. A jurisdiction may elect to develop regional safety performance functions in lieu of calibration. The appendix for Volume 2 of the HSM introduces the general procedure required to develop local calibration factors. The appendix also recommends that default crash distribution tables included in the HSM predictive chapters be customized for local crash distributions. The values from these tables primarily affect the way CMFs are applied to specific crash types. The Volume 2 appendix also introduces the Empirical Bayes (EB) procedure that can be used to calculate expected crashes at a specific location using the predicted crashes (that represent an average crash for a type of facility) in conjunction with historic (observed) crash information unique to the site of interest. A simplified example is also provided to demonstrate the calibration procedure (Sample Problem 5-1).

At the conclusion of this module, participants will be able to

- Describe how to calibrate predictive methods;
- Describe the guidance of the HSM on the creation of jurisdiction-specific safety performance functions (SPFs);
- Recognize how to replace default crash statistics with local values; and
- Identify suitable EB Method applications.

Module 6—Roadway Safety Management Process Overview

The roadway safety management process is reviewed in Chapters 4 through 9 of the HSM. The associated modules can be taught collectively or an instructor may elect to teach only a portion of these modules. As a result, Module 6 provides a **very brief** overview of the structure of the Volume 1 (Part B) content for the HSM.

At the conclusion of this module, participants will be able to

- Recognize the purpose of Volume 1 (Part B);
- Describe the Volume 1 (Part B) structure;
- Cite an overview of the six step Roadway Safety Management process;

- Describe how to use Volume 1 (Part B); and
- State the benefits of using the Roadway Safety Management process.

Module 7—Network Screening

The Module 7 presentation introduces the concept of network screening. It provides an outline of the network screening process and various reference populations, performance measures (strengths and limitations), and available screening methods. The HSM introduces a variety of analysis methods that can be used for this purpose. This module presents a list of the methods in a tabular format in the order of greater reliability. Module 7 introduces a case study that provides an application of the safety management process. This example is introduced with the Case Study 7-1 sample calculations. The details of this case study are continued and expanded in the subsequent modules. The source information for this module is HSM Chapter 4 (Network Screening).

At the conclusion of this module, participants will be able to

- Recognize the network screening process;
- Establish reference populations;
- Select performance measures;
- Select appropriate screening methods; and
- Screen and evaluate results.

Module 8—Human Factors

Network screening helps us understand **where** crashes occur or are likely to occur. Understanding human factors helps us identify **why** those crashes are occurring, that is, what human factors are contributing to the crashes. Chapter 2 of the HSM specifically introduces the role of human factors in road safety, discusses the driving task model, introduces driver characteristics and limitations, highlights the role of positive guidance, and reviews impacts of road design on the driver. Module 8 begins the process of diagnosis (e.g., identifying contributing crash factors) and focuses on human factors. Though human factors are not explicitly a part of the HSM roadway safety management process, the placement of this module immediately before diagnosis and countermeasure selection is strategic to ensure that human factors issues are recognized during the diagnosis process. The presentation for human factors includes an awareness test video that can be used to introduce the concept of sustained inattentional blindness for dynamic events.

At the conclusion of this module, participants will be able to

- Describe human factors and their role in road safety;
- Recognize the impact of road design on the driver; and
- Describe how human factors are integrated within the HSM.

Module 9—Diagnosis and Countermeasure Selection

The presentation for Module 9 introduces methods for diagnosing problems and their potential contributing crash factors and then demonstrates how to select appropriate countermeasure or solutions. This module is based on HSM Chapter 5 (Diagnosis) and Chapter 6 (Select Countermeasures). The case study previously introduced with Module 7 is extended into Case Study 9-1 to address a specific location (Intersection 2 from the previous case study). A companion spreadsheet for evaluations over a 30-year period is provided on the accompanying CD-ROM.

At the conclusion of this module, participants will be able to

- Describe the diagnosis process;
- Recognize the importance of crash and supporting data;
- Recognize how field conditions influence diagnosis;
- Identify contributing factors; and
- Select potential countermeasures.

Module 10—Economic Appraisal and Prioritization

Module 10 introduces a sample of the economic appraisal procedures introduced in the HSM Chapter 7 (Economic Appraisal) and then demonstrates how to prioritize safety enhancement projects using these procedures as introduced in Chapter 8 (Prioritize Projects). These ranked and prioritized outcomes can be used to select specific countermeasure treatments as well as prioritize various candidate improvement projects. The safety management case study introduced in Module 7 is then applied to Case Study 10-1 where candidate countermeasures are assessed for three specific intersections including Intersection 2 from Module 9. Three companion spreadsheets (one for each of the three intersections) are provided on the accompanying CD-ROM and demonstrate how an economic appraisal and prioritization could be applied to each location.

At the conclusion of the module, participants will be able to

- Describe an overview of project benefits and costs;
- Define economic evaluation methods for individual sites;
- Recognize non-monetary considerations;
- Identify three prioritization methods; and
- Describe applications of economic appraisal and prioritization methods.

Module 11—Safety Effectiveness Evaluation

The final step of the roadway safety management process is a safety effectiveness evaluation. This analysis procedure is included in Module 11 and represents HSM Chapter 9 (Safety

Effectiveness Evaluation). This step in the process occurs after selected projects have been implemented. It is critical to verify that the projects have had the intended impact on safety so that decisions related to these safety expenditures can be refined for future analysis. The case study integrated through the previous roadway safety management modules (Modules 7, 9, and 10) concludes with Case Study 11-1 where historic (observed) crash data is used to supplement the predictive procedure and assess the performance of a safety enhancement project. This sample problem is supplemented by a companion spreadsheet that shows the individual calculations for the case study. In addition to Case Study 11-1, the training material also includes a second EB example (see Sample Problem 11-2).

At the conclusion of this module, participants will be able to

- Describe evaluation methods;
- Recognize the importance of safety evaluations;
- Describe evaluation study designs;
- Identify benefits and limitations of evaluation study designs;
- Identify appropriate methods to use based on available data; and
- Describe an example safety evaluation application.

Module 12—HSM Summary and Review

The concluding presentation is Module 12. The goal of this module is to end the workshop with an overview of what was covered and a review of the key learning outcomes presented in the workshop. Items such as how an agency can move forward and the appropriate next steps are topics for discussion included with this presentation. This module also reviews the project development process and how the HSM can and should be integrated at each phase of this process.

CHAPTER 5

Summary

The goal of the HSM training workshop is to inform the transportation safety community about the growing body of scientific literature that is relevant to the safety discipline and facilitate the use of the HSM. The content of the training modules provides an overview of how these developing analytical tools can be used to enhance safety decisions. The documentation that is used, developed, compiled, or collected for analysis conducted in connection with the HSM may be protected under federal law (23 USC 409). The HSM is neither intended to be, nor does it establish, a legal standard of care for users or professionals as to the information it contains. No standard of conduct or duty toward the public is created or imposed by the publication and use or nonuse of the HSM.

Workshop Format

The workshop content outlined in this report was intended to be used for a 2- to 3-day workshop. The 12 instructional modules support lecture, guided discussion, questions, and interactive exercise learning techniques. Since interactive problems are included and encouraged, the maximum class size should be approximately 30 to 35 participants. The content that is included on the CD-ROM and summarized in Appendix A includes ancillary files such as evaluation forms, attendance forms, an example agenda, and a name tent. In addition, the content includes an instructor guide, participant guide, electronic presentation files, and spreadsheets developed to help enhance user understanding.

Ideally, the most effective training would be customized to the particular agency. Many agencies have one or more individuals who are proactive safety advocates. If the instructors can identify one of these individuals and encourage his or her participation in the workshop, this contribution will substantially enhance the learning experience as the safety advocate can provide specific implementation information unique to the agency.

During the workshop, instruction will be enhanced if copies of the HSM are readily available so that participants can actively refer to the manual. Similarly, if the instructor can create an opportunity for participants to work example problems manually as well as with a computer, this will further the learning experience.

Key Technical Messages

At the conclusion of the workshop, the attendees should be provided an opportunity to reflect on the content of the HSM and how information provided in the manual can directly apply to their daily transportation safety assessment activities.

Though the training sessions are likely to be tailored to individual audience needs, it is important that the training convey several key technical messages. These messages are summarized as follows:

- Crash rate should no longer be used as a primary metric of safety.
- In many instances, the total number of crashes can be reduced, but the focus should be on the reduction of serious injury or fatal crashes where possible.
- The terms “predicted” and “expected” crashes have specific meanings and should not be used interchangeably.
- CMFs should be used only when their base conditions are applicable to the candidate analysis scenario.
- Information acquired to perform safety assessments is legally protected.
- The HSM provides safety analysis tools and is not a required document or standard.

References

AASHTO. *Highway Safety Manual,* 1st Edition, Volumes 1, 2, and 3, American Association of State Highway and Transportation Officials, Washington, D.C. (2010a) 972 pp.

AASHTO. *An Introduction to the Highway Safety Manual,* American Association of State Highway and Transportation Officials, Washington, D.C. (2010b) 14 pp.

Cambridge Systematics, Inc. *NCHRP Report 667: Model Curriculum for Highway Safety Core Competencies,* Transportation Research Board of the National Academies, Washington, D.C. (2010) 19 pp.

Hauer, Ezra. The Road Ahead. *ASCE Journal of Transportation Engineering,* Vol. 131, No. 5 (May 2005) pp. 333–339.

APPENDIX A

CRP-CD-106 Content

1. Ancillary Files Folder
   a. Name Tent (PowerPoint file)
   b. Example Agenda (Word file)
   c. Evaluation Form (Word file)
   d. Workshop Attendance Form (Word file)
2. Instructor Guide Folder
   a. Instructor Guide with Sample Problems (pdf file)
   b. Instructor Guide Word Files Folder (includes administration document and individual module instructor guide files in Word file format)
3. Instructor Presentations Folder (includes PowerPoint files for Modules 1 through 12 plus a video file for the Awareness Test)
4. Participant Guide Folder
   a. Participant Guide with Sample Problems (pdf file)
   b. Participant Guide Word Files Folder (includes agenda, acronyms, and learning objectives and individual module participant guide files in Word file format)
5. Sample Problems Folder
   a. Sample Problem Spreadsheets
      i. Module 4—Predictive Methods
         1. Rural multilane Design Exception Case Study, Sample Problem 4-1 (Excel file)
         2. Rural 2-lane Intersection In-Class Exercise (Excel file)
         3. Practical Work Problem for Urban Intersections, Sample Problem 4-2 (Excel file)
      ii. Module 9—Diagnosis and Countermeasure, Case Study 9-1
         1. Intersection 2, 30-year Total (Excel file)
      iii. Module 10—Economic Appraisal and Prioritization, Case Study 10-1
         1. Intersection 1, 30-year Total (Excel file)
         2. Intersection 2, 30-year Total (Excel file)
         3. Intersection 10, 30-year Total (Excel file)
      iv. Module 11—Safety Effectiveness Evaluation, Case Study 11-1
         1. EB Example (Excel file)
   b. Sample Problem Work Files
      i. Module 3 CMF Problems
      ii. Module 4 Exercise Rural 2-Lane
      iii. Module 4 Predictive Methods, Sample Problems 4-1 and 4-2
      iv. Module 5 Calibration Example
      v. Module 7 Network Screening Problems
      vi. Module 9 Diagnosis and Countermeasure Selection Case Study
      vii. Module 10 Economic Appraisal and Prioritization Problem
      viii. Module 11 Safety Effectiveness Evaluation Case Study
   c. Smart Spreadsheets Folder
      i. HSM Predictive Rural Multilane (Excel file)
      ii. HSM Predictive Urban and Suburban (Excel file)
      iii. HSM Rural Two-lane Roads (Excel file)

APPENDIX B

Summary of HSM Briefing Activities

As part of the initial efforts to help the HSM balloting process, the NCHRP Project 17-38 team completed a series of briefing-related tasks. The following summarizes each task:

1. Developed content outlines for briefing AASHTO committees on the HSM. Following a webinar meeting with the NCHRP Project 17-38 panel, the project team refined the materials in preparation for briefings with the various key AASHTO committees.
2. Recommended the length(s) and delivery method(s) for the briefings to best meet the needs of the various audiences.
3. Developed the HSM briefing materials for the AASHTO committees. In addition to a handout, the briefing materials included a presentation with speaker notes.
4. Presented a briefing to the NCHRP Project 17-38 panel, key AASHTO members, and others identified by NCHRP.
5. Planned for and conducted several briefings for key AASHTO committees as directed by NCHRP. The briefings were directed to the following AASHTO committees:
   - AASHTO Subcommittee on Highway Traffic Safety,
   - AASHTO Subcommittee on Traffic Engineering,
   - TRB/AASHTO Roadside Safety joint meeting,
   - AASHTO Subcommittee on Design, and
   - AASHTO Subcommittee on Safety Management.
6. Developed a "generic" presentation with speaker notes suitable for briefings to a variety of organizations such as American Public Works Association (APWA), Institute of Transportation Engineers (ITE), Association of Metropolitan Planning Organizations/National Association of Regional Councils (AMPO/NARC), National Association of County Engineers (NACE), and Local Technical Assistance Program (LTAP). This presentation was used for several regional and national briefings and the content has now been incorporated into the Module 1 presentation of the training material.

APPENDIX C

Example Forms

The training materials are accompanied by several ancillary files including an example agenda (see Figure 1), a 2-page evaluation form (see Figure 2 and Figure 3), and a workshop attendance form (see Figure 4).

DAY 1			
8:00 am		Registration	30 minutes
8:30	Module 1	Introduction to the HSM	45 minutes
9:15	Module 2	Fundamentals	30 minutes
10:00		Break	15 minutes
10:15	Module 2	Fundamentals (Continued)	45 minutes
11:00	Module 3	Overview—Crash Modification Factors	60 minutes
12:00 pm		Lunch	60 minutes
1:00	Module 4	HSM Predictive Method Process	80 minutes
2:20		Break	35 minutes
2:35	Module 4B	HSM Predictive Method Process Overview of Spreadsheet Tool and Example Application	75 minutes
3:50		Break	10 minutes
4:00	Module 5	HSM Calibration Procedure	60 minutes
5:00		Adjourn Day 1	
DAY 2			
8:00 am	Module 6	Overview of HSM Part B	35 minutes
8:35	Module 7	Network Screening	40 minutes
9:50		Break	15 minutes
10:05	Module 9	Diagnosis and Countermeasure Selection	40 minutes
11:30		Lunch	60 minutes
12:30 pm	Module 11	Safety Effectiveness Evaluation	60 minutes
1:30		Break	15 minutes
1:45	Module 11	Safety Effectiveness Evaluation (Continued)	60 minutes
2:45	Module 12	Overall HSM Summary	15 minutes
3:30		Adjourn	

Figure 1. HSM Example Workshop Agenda

HSM Workshop – Date: *Feedback Form*

1. The presenters clearly stated the learning outcomes.

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

If you disagree or strongly disagree: please provide your suggestions:- _____

_____

_____

2. The level of content presented met my expectations.

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

If you disagree or strongly disagree: please provide your suggestions:- _____

_____

_____

3. The content was clear and easy to follow.

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

If you disagree or strongly disagree: please provide your suggestions:- _____

_____

_____

4. The course adequately addressed my expectations.

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

If you disagree or strongly disagree: please provide your suggestions:- _____

_____

_____

5. In my day to day responsibilities I am already using the more advanced tools described in the HSM. (Note: this will provide us with background information to interpret your response to the next question).

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

_____

_____

Page 1 of 2

Figure 2. Example Workshop Evaluation Form (Page 1)

6. I will likely change my thinking and/or actions as a result of this workshop.

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

If you disagree or strongly disagree: please provide your suggestions:- _____

7. The sample problems and handouts supported mastering the learning outcomes:

☐Strongly Agree ☐Agree ☐Neither agree/disagree ☐Disagree ☐Strongly Disagree

If you disagree or strongly disagree: please provide your suggestions:- _____

8. The level of detail in the workshop was:

☐Too technical ☐Just right ☐Not technical enough

If you disagree or strongly disagree: please provide your suggestions:- _____

9. What did you like most about the workshop?

10. What did you like least about the workshop?

11. Any other suggestions or comments?

Figure 3. Example Workshop Evaluation Form (Page 2)

HSM Highway Safety Manual

Highway Safety Manual Workshop Attendance

Name	Agency	Title	Email	Day 1	Day 2

NCHRP 17-38 HSM Workshop
Attendance Form

Figure 4. Example Workshop Attendance Form

APPENDIX D

Acronyms and Abbreviations

Acronym or Abbreviation	Description
AASHTO	American Association of State Highway and Transportation Officials
CMF	Crash Modification Factor/Function
EB	Empirical Bayes
FHWA	Federal Highway Administration
HSM	Highway Safety Manual
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
SPF	Safety Performance Function

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation