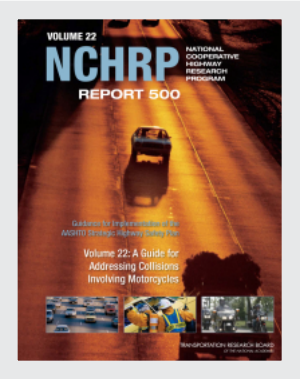


A Guide for Addressing Collisions Involving Motorcycles (2008)

DETAILS

165 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-11759-3 | DOI 10.17226/14204

CONTRIBUTORS

SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2008. *A Guide for Addressing Collisions Involving Motorcycles*. Washington, DC: The National Academies Press. https://doi.org/10.17226/14204.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 500

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Volume 22: A Guide for Addressing Collisions Involving Motorcycles

Ingrid Potts
MIDWEST RESEARCH INSTITUTE
Kansas City, MO

Stephen Garets
TEAM OREGON MOTORCYCLE SAFETY PROGRAM
Corvallis, OR

Terry Smith
DYNAMIC RESEARCH, INC
Torrance, CA

Ronald Pfefer
Zikhron Yaacov, Israel

Timothy R. Neuman
Kevin L. Slack
Kelly K. Hardy
CH2M HILL
Chantilly, VA

James Nichols
Vienna, VA

Subject Areas
Safety and Human Performance

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.
2008
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 500, VOLUME 22

Project 17-18(3)
ISSN 0077-5614
ISBN: 978-0-309-11759-3
Library of Congress Control Number 2008904443

COPYRIGHT PERMISSION

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. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

The Transportation Research Board of the National Academies, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in 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 this 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 the 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 500, VOLUME 22

Christopher W. Jenks, *Director, Cooperative Research Programs*
Crawford F. Jencks, *Deputy Director, Cooperative Research Programs*
Charles W. Niessner, *Senior Program Officer*
Eileen P. Delaney, *Director of Publications*
Natassja Linzau, *Editor*
Natalie Barnes, *Editor*

NCHRP PROJECT 17-18(3) PANEL
Field of Traffic—Area of Safety

Thomas E. Bryer, *Science Applications International Corporation, Camp Hill, PA* (Chair)
Jasvinderjit "Jesse" Bhullar, *California DOT*
Linda A. Cosgrove, *National Highway Traffic Safety Administration*
Troy Costales, *Oregon DOT*
Leanna Depue, *Missouri DOT*
L. Keith Golden, *Georgia DOT*
Barbara Harsha, *Governors Highway Safety Association, Washington, DC*
Bruce Ibarguen, *Maine DOT*
Marlene Markison, *National Highway Traffic Safety Administration*
Margaret "Meg" Moore, *Texas DOT*
Kathryn R. Swanson, *Minnesota Department of Public Safety, St. Paul, MN*
Rudy Umbs, *FHWA*
Thomas M. Welch, *Iowa DOT*
Ray Krammes, *FHWA Liaison*
Ken Kobetsky, *AASHTO Liaison*
Richard Pain, *TRB Liaison*

FOREWORD

By Charles W. Niessner
Staff Officer
Transportation Research Board

The American Association of State Highway and Transportation Officials (AASHTO) has adopted a national highway safety goal of halving fatalities over the next 2 decades—or reducing the number of fatalities by 1,000 per year. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This twenty-second volume of *NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan* provides strategies that can be employed to reduce crashes involving motorcycles. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

In 1998, AASHTO approved its Strategic Highway Safety Plan, which was developed by the AASHTO Standing Committee for Highway Traffic Safety with the assistance of the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Transportation Research Board Committee on Transportation Safety Management. The plan includes strategies in 22 key emphasis areas that affect highway safety. Each of the 22 emphasis areas includes strategies and an outline of what is needed to implement each strategy.

NCHRP Project 17-18(3) is developing a series of guides to assist state and local agencies in reducing injuries and fatalities in targeted areas. The guides correspond to the emphasis areas outlined in the AASHTO Strategic Highway Safety Plan. Each guide includes a brief introduction, a general description of the problem, the strategies/countermeasures to address the problem, and a model implementation process.

This is the twenty-second volume of *NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan*, a series in which relevant information is assembled into single concise volumes, each pertaining to specific types of highway crashes (e.g., run-off-the-road, head-on) or contributing factors (e.g., aggressive driving). An expanded version of each volume with additional reference material and links to other information sources is available on the AASHTO Web site at http://safety.transportation.org. Future volumes of the report will be published and linked to the Web site as they are completed.

While each volume includes countermeasures for dealing with particular crash emphasis areas, *NCHRP Report 501: Integrated Management Process to Reduce Highway Injuries and Fatalities Statewide* provides an overall framework for coordinating a safety program. The integrated management process comprises the necessary steps for advancing from crash data to integrated action plans. The process includes methodologies to aid the practitioner in problem identification, resource optimization, and performance measurements. Together, the management process and the guides provide a comprehensive set of tools for managing a coordinated highway safety program.

CONTENTS

ACKNOWLEDGMENTS

This volume of *NCHRP Report 500* was developed under NCHRP Project 17-18(3), the product of which is a series of implementation guides addressing the emphasis areas of AASHTO's Strategic Highway Safety Plan. The project was managed by CH2M HILL, and the co-principal investigators were Kevin Slack of CH2M HILL and Ron Pfefer. Timothy Neuman of CH2M HILL served as the overall project director for the team. Kelly Hardy, also of CH2M HILL, served as a technical specialist on the development of the guides. James Nichols provided additional expertise as the guides evolved.

The project team was organized around the specialized technical content contained in each guide and the overall team included nationally recognized experts from many organizations. The following team of experts, selected based on their knowledge of this emphasis area, served as lead authors for the motorcycle guide:

- Ingrid Potts
  Midwest Research Institute
- Stephen Garets
  TEAM OREGON Motorcycle Safety Program
- Terry Smith
  Dynamic Research, Inc

Development of the volumes of *NCHRP Report 500* utilized the resources and expertise of many professionals from around the country and overseas. Through research, workshops, and actual demonstration of the guides by agencies, the resulting documents represent best practices in each emphasis area. The project team is grateful to the following list of people and their agencies for supporting the project by providing material, participating in workshops and meetings, and providing input and comments during the development of the motorcycle guide:

American Motorcyclist Association
Patrick Holz

Connecticut Department of Transportation
Raymond Gaulin

Dynamic Research Institute
Terry Smith

Florida Department of Transportation
Angela Evans

Florida Rider Training Program
Louie Kyler

Federal Highway Administration
Erin Kenley
Heidi Liske

Harley Davidson Inc.
Eric Lundquist

Iowa Department of Transportation
Tom Welch

Maryland Motor Vehicle Administration
Jack Joyce

Missouri Motorcycle Safety Program
Neil Meyers

Montana Department of Transportation
Mark Baum

Motorcycle Riders Foundation
Steve Zimmer

Motorcycle Safety Foundation
Kathy Vankleeck
Sherry Williams

National Association of State Motorcycle Administrators
Ron Shepard

National Highway Traffic Safety Association
Diane Wigle

Texas Transportation Institute
Paul Carlson

Vanryan Banks, Inc.
David Banks

Virginia Department of Transportation
Raymond Khoury

SECTION I

Summary

Introduction

The American Association of State Highway and Transportation Officials' (AASHTO's) Strategic Highway Safety Plan includes 22 key emphasis areas that affect highway safety. Each of the emphasis areas includes strategies and an outline of what is needed to implement each strategy. A series of guides is being developed, including this guide on motorcycle safety, to assist state and local agencies in reducing injuries and fatalities in targeted emphasis areas. The guides correspond to the emphasis areas outlined in the AASHTO Strategic Highway Safety Plan.

One of the plan's hallmarks is to comprehensively approach safety problems. The range of strategies available in the guides will ultimately cover various aspects of the road user, the highway, the vehicle, the environment, and the management system. The guides strongly encourage the user to develop a program to tackle a particular emphasis area from each perspective in a coordinated manner. To facilitate this, the electronic form of the material uses hypertext links to enable seamless integration of various approaches to a given problem. Several guides have already been developed for other emphasis areas, so the integration between guides should be very useful.

AASHTO's overall goal is to move away from *independent* activities of engineers, law enforcement, educators, judges, and other highway safety specialists and to move toward *coordinated* efforts. The implementation process outlined in the series of guides promotes the formation of working groups and alliances that represent all of the elements of the safety system. In so doing, they can use their combined expertise to reach the bottom-line goal of targeted reduction of crashes and fatalities associated with a particular emphasis area.

Goal 11 in the Strategic Highway Safety Plan is to improve motorcycle safety and increase motorcycle awareness; that is, the awareness by highway agencies of the unique characteristics of motorcycles and their needs on the roadway. This guide includes strategies intended to reduce the number and severity of motorcycle crashes. Strategies include not only operation of the motorcycle, but also ways of improving both the traveled way and roadside to be more 'motorcycle–friendly.'

This volume addresses many topics covered in other emphasis areas, but will approach each one solely from the viewpoint of how each affects motorcycle users.

A key resource for guidance on improving motorcycle safety and awareness is the *National Agenda for Motorcycle Safety* (NAMS), published by the National Highway Traffic Safety Administration (NHTSA, 2000) and available on the Internet at http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/00-NHT-212-motorcycle/toc.html. NAMS represents a significant effort by many stakeholders in motorcycle safety and provides recommendations to improve motorcycle safety. The recommendations provided by NAMS served as a resource and a starting point for the development of this guide. The reader is encouraged to compare and compile information from the *National Agenda for Motorcycle*

Safety to use along with this guide in tackling the motorcycle safety needs most pertinent to their roadway system or area of responsibility.

Since the mid-1990's, motorcycle use in the United States for commuting and recreational purposes has been on the rise, with motorcycle registrations having increased 61 percent between 1996 and 2005 (NHTSA, 2006b). As the number of motorcyclists increases, it is important that the safety issues associated with this mode of travel be addressed. These issues include improved motorcycle crash reporting, personal protective equipment, proper motorcycle rider training, and roadway environment characteristics that pose a unique problem to motorcyclists.

Motorcycles themselves present a unique mode of transport relative to other motor vehicles. The lack of a protected vehicle compartment means that motorcycle riders and passengers are much more vulnerable to injury in crash situations. Furthermore, the task of operating a motorcycle is much more demanding than operating a passenger vehicle. Riders must focus on coordinating speed and body lean, and managing traction and control, while navigating various surfaces, curves and conditions.

While there are risks associated with riding motorcycles, this guide demonstrates how to minimize some of these risks by addressing specific objectives with detailed strategies designed to approach motorcycle safety from a variety of perspectives.

Objectives of the Emphasis Area

The objectives for improving motorcycle safety and increasing the awareness of the unique characteristics of motorcycles include:

- Incorporate motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices
- Reduce the number of motorcycle crashes due to rider impairment
- Reduce the number of motorcycle crashes due to unlicensed or untrained motorcycle riders
- Increase the visibility of motorcyclists
- Reduce the severity of motorcycle crashes
- Increase motorcycle rider safety awareness
- Increase safety enhancements for motorcyclists
- Improve motorcycle safety research, data and analysis

Explanation of Objectives

Considering the needs of motorcyclists during the planning and construction of roadways can reduce the likelihood of motorcycle crashes. Creating a motorcycle-friendly environment goes beyond providing a gentle alignment of traffic lanes, but also entails such things as keeping the roadway free of foreign debris, providing a safe roadside free of objects or obstacles to motorcyclists, maintaining safe roadway surfaces during maintenance projects,

and providing sufficient warning devices to motorcyclists prior to encountering potentially dangerous zones.

As with all types of motor vehicle traffic, alcohol use by motorcycle operators continues to be a problem. Research shows that alcohol-related fatalities among motorcyclists are higher than in any other motor vehicle group. A NHTSA study in 2003 indicated that 30 percent of all fatally injured motorcycle operators were riding while under the influence of alcohol (NHTSA, 2004). Strategies that effectively reduce the incidence of motorcycle rider impairment should greatly reduce the number of motorcycle fatalities.

A preemptive strategy to reduce the number of motorcycle crashes is to ensure proper training and licensing of motorcyclists before they reach the roadways. Even though all 50 states require separate license endorsements to operate a motorcycle and 47 states sponsor rider education courses (with 18 of those states having mandatory training programs), it was estimated that during the mid-1990's, 20 percent of the motorcycle population was either unlicensed or improperly licensed. Even more alarming was that more than 40 percent of motorcyclists involved in fatal crashes were improperly licensed (TRB, 1994).

A common complaint of many motorcyclists is that other vehicle drivers often do not see them and, as a result, violate the motorcyclists' right-of-way. The Hurt Study, *Motorcycle Accident Cause Factors and Identification of Countermeasures* (Hurt et al., 1981), found that riders who wore camouflage or other hard-to-see apparel were over-represented in right-of-way crashes, suggesting that conspicuity plays an important role in crash avoidance. The predominant color of motorcycle apparel is black: black leather jackets, black gloves and boots, and black helmets. The problem with black garments is that they are inconspicuous in the day and, in the absence of any retro-reflective material, invisible at night or in low-light conditions. Motorcyclists can immediately and inexpensively improve conspicuity, and thus their safety, by wearing retro-reflective material on their clothes and helmets.

A study by Sosin and Sacks (1992) found more than 50 percent of all motorcycle-related fatalities were mainly attributed to head injuries. This study—along with many others—has indicated that helmets are the single most important piece of protective equipment that a motorcyclist has at his or her disposal. The National Highway Traffic Safety Administration (NHTSA) estimates that from 1986 through 1996 more than 7,900 motorcyclist fatalities have been prevented by motorcycle helmet use, with an estimated health cost savings of more than $10 billion. *Increasing the usage of effective, FMVSS 218 compliant helmets is universally accepted as a key motorcycle safety goal.*

Implementing such a strategy on a widespread basis has proven challenging. Initial efforts to promote effective helmet usage involved outreach to the motorcycle riding community. NHTSA discovered the benefit of collaborating with a diverse stakeholder community when it launched the *National Agenda for Motorcycle Safety* (NAMS). Developing the framework for NAMS involved participation from experts in industry, research, training, and rider communities, as well as health care, media, insurance and law enforcement. The result was a collaborative document that gained broad-based support. However, consensus on the most effective means of achieving widespread helmet usage was not and has not been reached. To date the only proven approaches to increasing helmet usage and saving lives—legislation and enforcement of mandated helmet usage—have not been supported by most people in the motorcycle-riding community. New developments are rapidly being integrated into transportation systems and, too often, these new Intelligent Transportation Systems (ITS)

have not considered motorcycles as a user of the transportation infrastructure. For example, traffic signal systems frequently include the use of sensors embedded in the pavement to detect the presence of a left-turning vehicle. The sensors, however, are often unable to detect the presence of a motorcycle, thus causing the motorcycle rider to wait until another vehicle enters the left-turn lane, or violate traffic code and make an unauthorized left turn. Motorcycles should be included in the development and implementation of ITS.

The last objective deals with motorcycle crash data. In order to properly understand the particular safety problems related to motorcycle use, there must be an improvement in motorcycle traffic research and motorcycle crash data analysis. Historically, roadway safety studies have often neglected to include motorcyclists as an individual roadway user group and develop motorcycle-specific safety strategies that may be outside of the general motor vehicle safety umbrella.

Strategies designed to fulfill these objectives are presented in Exhibit I-1.

Target of the Objectives

The objectives contained in this guide are intended to target a variety of issues and a broad audience. Because motorcycle safety cannot be pinpointed on one controlling factor, neither can the responsibility of providing this safety fall upon the shoulders of one group of

EXHIBIT I-1
Emphasis Area Objectives and Strategies

Objectives	Strategies
11.1 A Incorporate motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices	11.1 A1 Provide full paved shoulders to accommodate roadside motorcycle recovery and breakdowns
	11.1 A2 Consider motorcycles in the selection of roadside barriers
	11.1 A3 Identify pavement markings, surface materials, and other treatments that reduce traction for motorcycles and treat or replace with high-traction material
	11.1 A4 Maintain the roadway to minimize surface irregularities and discontinuities
	11.1 A5 Maintain roadway surfaces in work zones to facilitate safe passage of motorcycles
	11.1 A6 Reduce roadway debris – such as gravel, shorn treads, snow and ice control treatments (sand/salt), and that resulting from uncovered loads – from the roadway and roadside
	11.1 A7 Provide advance warning signs to alert motorcyclists of reduced traction and irregular roadway surfaces
	11.1 A8 Incorporate motorcycle safety considerations into routine roadway inspections
	11.1 A9 Provide a mechanism for notifying highway agencies of roadway conditions that present a potential problem to motorcyclists

EXHIBIT I-1 (Continued)
Emphasis Area Objectives and Strategies

Objectives	Strategies
11.1 B Reduce the number of motorcycle crashes due to rider impairment	11.1 B1 Increase motorcyclist awareness of the risks of impaired motorcycle operation
	11.1 B2 Expand existing impairment prevention programs to include motorcycle riders and specific motorcycle events
	11.1 B3 Target law enforcement to specific motorcycle rider impairment behaviors that have been shown to contribute to crashes
11.1 C Reduce the number of motorcycle crashes due to unlicensed or untrained motorcycle riders	11.1 C1 Increase awareness of the causes of crashes due to unlicensed or untrained motorcycle riders
	11.1 C2 Ensure that licensing and rider training programs adequately teach and measure skills and behaviors required for crash avoidance
	11.1 C3 Identify and remove barriers to obtaining a motorcycle endorsement
11.1 D Increase the visibility of motorcyclists	11.1 D1 Increase the awareness of the benefit of high-visibility clothing
	11.1 D2 Identify and promote rider visibility-enhancement methods and technology
11.1 E Reduce the severity of motorcycle crashes	11.1 E1 Increase the use of FMVSS 218 compliant helmets
	11.1 E2 Increase the use of protective clothing
11.1 F Increase motorcycle rider safety awareness	11.1 F1 Form strategic alliances with motorcycle user community to foster and promote motorcycle safety
	11.1 F2 Increase awareness of the consequences of aggressive riding, riding while fatigued or impaired, unsafe riding, and poor traffic strategies
	11.1 F3 Educate operators of other vehicles to be more conscious of the presence of motorcyclists
11.1 G Increase safety enhancements for motorcyclists	11.1 G1 Include motorcycles in the research, development and deployment of ITS
11.1 H Improve motorcycle safety research, data and analysis	11.1 H1 Develop and implement standardized data gathering and reporting for motorcycle crashes
	11.1 H2 Include motorcycle attributes in vehicle exposure data collection programs
	11.1 H3 Develop a set of analysis tools for motorcycle crashes

professionals. It is thus appropriate that this guide provide objectives that are far-reaching and that encompass many areas of expertise.

Meaningful progress toward accomplishing the above objectives will be achieved only with the cooperation and involvement of all stakeholders—licensing agencies, motorcycle riders, roadway designers, law enforcement, and legislators—with all stakeholders taking responsibility for implementing those strategies within their area of responsibility. By working together, everyone will work towards the objective of this effort, which is to reduce the number of motorcycle injuries and fatalities.

SECTION II

Introduction

The American Association of State Highway and Transportation Officials' (AASHTO's) Strategic Highway Safety Plan includes 22 key emphasis areas that affect highway safety. Each of the emphasis areas includes strategies and an outline of what is needed to implement each strategy. A series of guides is being developed, including this guide on motorcycle safety, to assist state and local agencies in reducing injuries and fatalities in targeted emphasis areas. The guides correspond to the emphasis areas outlined in the AASHTO Strategic Highway Safety Plan.

One of the plan's hallmarks is to comprehensively approach safety problems. The range of strategies available in the guides will ultimately cover various aspects of the road user, the highway, the vehicle, the environment, and the management system. The guides strongly encourage the user to develop a program to tackle a particular emphasis area from each perspective in a coordinated manner. To facilitate this, the electronic form of the material uses hypertext links to enable seamless integration of various approaches to a given problem. Several guides have already been developed for other emphasis areas, so the integration between guides should be very useful.

AASHTO's overall goal is to move away from *independent* activities of engineers, law enforcement, educators, judges, and other highway safety specialists and to move toward *coordinated* efforts. The implementation process outlined in the series of guides promotes the formation of working groups and alliances that represent all of the elements of the safety system. In so doing, they can use their combined expertise to reach the bottom-line goal of targeted reduction of crashes and fatalities associated with a particular emphasis area.

Goal 11 in the AASHTO Strategic Highway Safety Plan is to improve motorcycle safety and increase motorcycle awareness; that is, the awareness by highway agencies of the unique characteristics of motorcycles and their needs on the roadway. This guide includes strategies intended to reduce the number and severity of motorcycle crashes. Strategies include not only operation of the motorcycle, but ways of improving both the traveled way and roadside to be more 'motorcycle–friendly.'

This volume addresses many topics covered in other emphasis areas, but will approach each one solely from the viewpoint of how each affects motorcycle users.

A key resource for guidance on improving motorcycle safety and awareness is the *National Agenda for Motorcycle Safety* (NAMS), published by the National Highway Traffic Safety Administration (NHTSA, 2000, http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/00-NHT-212-motorcycle/toc.html). NAMS represents a significant effort by many stakeholders in motorcycle safety and provides recommendations to improve motorcycle safety. The recommendations provided by NAMS served as a resource and a starting point for the development of this guide. The reader is encouraged to compare and compile information from the *National Agenda for Motorcycle Safety* to use along with this guide in tackling the motorcycle safety needs most pertinent to their roadway system or area of responsibility.

Since the mid-1990's, motorcycle use in the United States for commuting and recreational purposes has been on the rise, with motorcycle registrations having increased 61 percent between 1996 and 2005 (NHTSA, 2006b). As the number of motorcyclists increases, it is important that the safety issues associated with this mode of travel be addressed. These issues include the need for improved motorcycle crash reporting, personal protective equipment, proper motorcycle rider training, and roadway environment characteristics that pose a unique problem to motorcyclists.

Motorcycles themselves present a unique mode of transport relative to other motor vehicles. The lack of a protected vehicle compartment means that motorcycle riders and passengers are much more vulnerable to injury in crash situations. Furthermore, the task of operating a motorcycle is much more demanding than operating a passenger vehicle. Riders must focus on coordinating speed and body lean, and managing traction and control, while navigating various surfaces, curves and conditions.

While there are risks associated with riding motorcycles, this guide demonstrates how to minimize some of these risks by addressing specific objectives with detailed strategies designed to approach motorcycle safety from a variety of perspectives.

SECTION III

Type of Problem Being Addressed

General Description of the Problem

As motorcycle use increases, providing a safe environment for motorcyclists continues to challenge transportation professionals. Motorcycle ownership has increased dramatically over the last several years and statistical trends have shown a steady increase in motorcycle fatalities. Motorcycles represent approximately 2 percent of all registered vehicles in the United States, but are responsible for only about 0.4 percent of all vehicle miles traveled. In 2006, motorcycles accounted for over 11 percent of all traffic fatalities (FARS, 2006). Exhibit III-1 presents the long-term trend in motorcyclist fatalities, showing a significant increase since 1997.

Exhibit III-2 shows that the annual increase in motorcycle fatalities has been significant not only in numbers, but in percentage change (except for 2002), and as a proportion of all fatalities in the USA. Motorcyclist injuries, however, have not grown in the same fashion. From 1996 to 2006, while fatalities grew 122 percent, injuries grew 60 percent. While the rate of growth for fatalities continues to be steady, that for injuries may be slowing.

When taking into account exposure, however, the increase in fatalities appears to be less pronounced (see Exhibit III-3).

Recent trends show that the number of registered motorcycles in the United States continues to rise along with the number of miles being driven by motorcyclists. Given this trend, unless the issues related to motorcycle safety are addressed directly, fatalities and serious rider injuries stand to increase proportionally.

Single-Vehicle Crashes

Research has shown that as much as 50 percent of all motorcycle crashes are single-vehicle crashes (FARS, 2006). This research has shown that the following factors contribute to the risk of being involved in a fatal single-vehicle motorcycle crash:

- Motorcycle rider over the age of 40
- On a rural road or an undivided road
- High BAC level
- On a curve
- Contacting a fixed object off of the roadway
- At night
- Not wearing an FMVSS 218 compliant helmet
- Not holding a valid or proper license

EXHIBIT III-1
Motorcyclists Killed 1989–2006
Source: Shankar, 2004; FARS, 2006

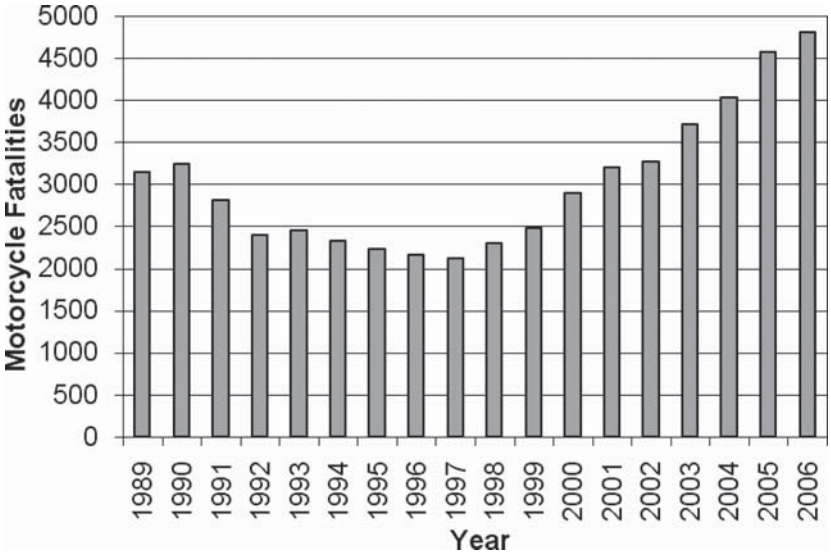
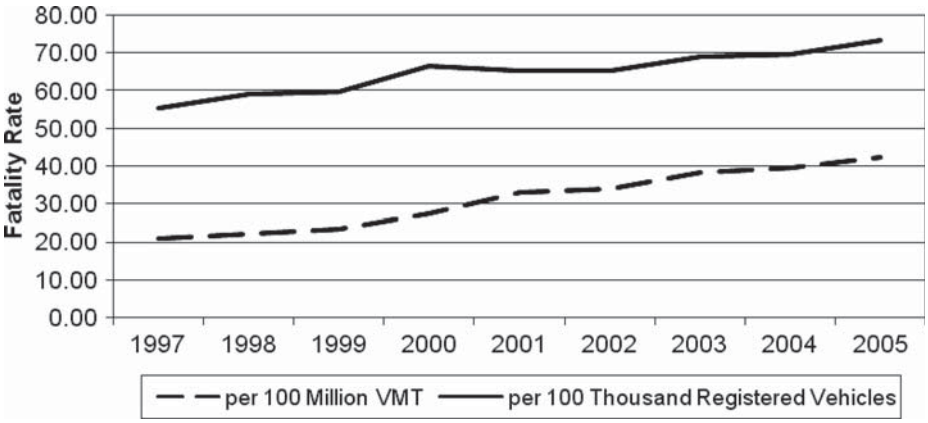


EXHIBIT III-2
Motorcycle Fatality and Injury Trends
Source: Adapted from Shankar, 2004; FARS, 2006

Fatalities and Injuries	Year									
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Total Killed	42,013	41,501	41,717	41,945	42,196	43,005	42,884	42,836	43,510	42,642
Change	—	–512	+216	+228	+251	+809	–121	–48	+674	–868
Motorcyclists Killed	2,116	2,294	2,483	2,897	3,197	3,270	3,714	4,028	4,576	4,810
Change	—	+178	+189	+414	+300	+73	+444	+312	+548	+234
Percent Change	—	8.4	8.2	16.7	9.4	2.3	13.6	8.5	13.6	5.1
Percent of All Fatalities	5.0	5.5	6.0	6.9	7.6	7.6	8.7	9.4	10.5	11.3
Motorcyclists Injured	53,000	49,000	50,000	58,000	60,000	65,000	67,000	76,000	87,000	88,000

EXHIBIT III-3
Motorcycle Fatality Rates
Source: Adapted from Shankar, 2004; FARS, 2006



While it is often assumed that excessive speed is a factor in the causation of single-vehicle crashes, research has suggested that loss of traction due to the road surface condition is also a contributing factor in crashes (de Rome et al., 2002).

Multiple-Vehicle Crashes

In 2006, 50 percent of all fatal motorcycle crashes were the result of a motorcycle crash with another vehicle (FARS, 2006). Most of these crashes occurred on major roadways (as opposed to freeways and minor roads) and most of them occurred between noon and midnight (NHTSA, 2004). There were also a large number of cases involving alcohol.

In 1981, an in-depth motorcycle crash study conducted in Los Angeles found that 75 percent of all crashes, both fatal and non-fatal, involved a collision with another vehicle, most often at an intersection. Failure to yield the right of way was the most frequently reported cause of a motorcycle-vehicle collision in that study (Hurt et al., 1981). More recent data has suggested that inattention and unsafe speed are also major causes of motorcycle-vehicle crashes. There is also recent research that suggests that motorcycle conspicuity is a contributing factor in motorcycle-automobile collisions (Wells et al., 2004).

Specific Attributes of the Problem

Exhibit III-4 illustrates the distribution of helmet use in fatal crashes. Numerous studies have been completed over recent years to quantify the safety effectiveness and value of using a helmet. For example, one study showed that helmeted riders were less likely to have sustained traumatic

EXHIBIT III-4
Helmet Use Distribution of Motorcycle Fatalities in 2006
Source: FARS, 2006

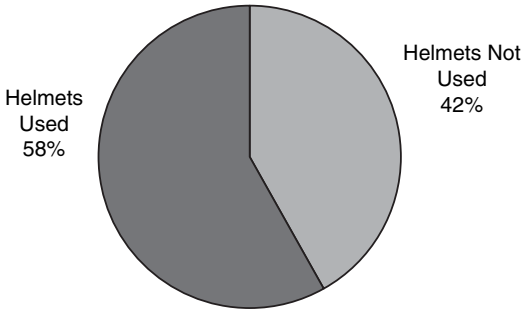
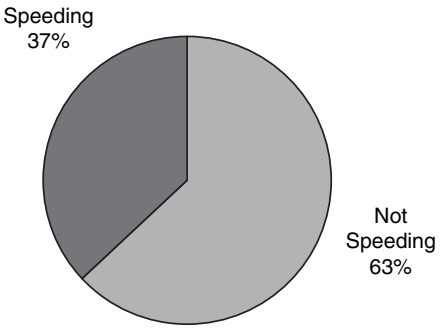


EXHIBIT III-5
Distribution of Motorcycle Fatalities in 2004 in which Speeding Was Cited As a Factor
Source: NHTSA, 2006b



brain injury across a variety of crash-related factors including crash type, speed limit, highway type and alcohol involvement (Bigelow, 2001). Another study found that riders not wearing helmets were found to be three times more likely to have head injuries requiring either EMS transport or hospitalization or resulting in death than motorcyclists who were helmeted (Finison, 2001).

Speeding is one of the factors that increases the odds of a motorcyclist being at fault in a collision (Kim, 2001). Exhibit III-5 shows that speed is a contributing factor in fatal crashes 37 percent of the time, which is about twice the rate for drivers of passenger cars or light trucks (NHTSA, 2006b).

Alcohol involvement among motorcycle riders is higher than all other vehicle types (passenger cars, SUVs, vans, and pickups [NHTSA, 2005]). The operation of a motorcycle combined with alcohol can lead to deadly consequences for motorcycle riders and passengers. In fact, riding a motorcycle while under the influence of alcohol is a leading cause of fatal crashes involving motorcycles. Exhibit III-6 illustrates the distribution of blood alcohol level in fatal crashes.

Licensing programs are necessary to measure the readiness of riders to ride safely on the road. Many riders, however, avoid the licensing process and ride illegally. In 2006, one in four motorcycle operators (24 percent) involved in fatal crashes was operating the vehicle with an invalid license, as illustrated in Exhibit III-7. This compares with only 13 percent of drivers of passenger vehicles involved in fatal crashes without a valid license (FARS, 2006). Typically, riders who are operating a motorcycle with an invalid license are actually operating a vehicle "out of class," meaning that the rider has an automobile license but the

EXHIBIT III-6
Alcohol Level Distribution of Motorcycle Fatalities in 2006
Source: FARS, 2006

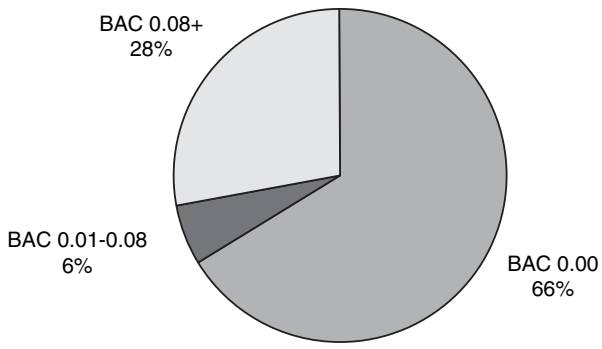
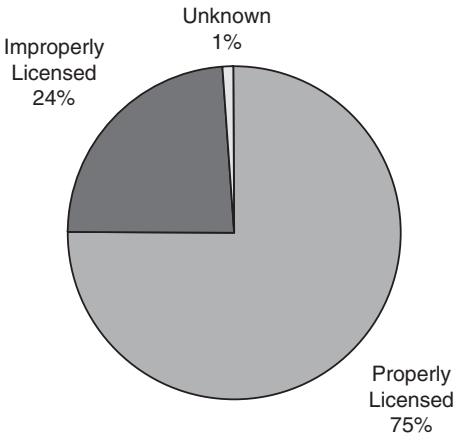


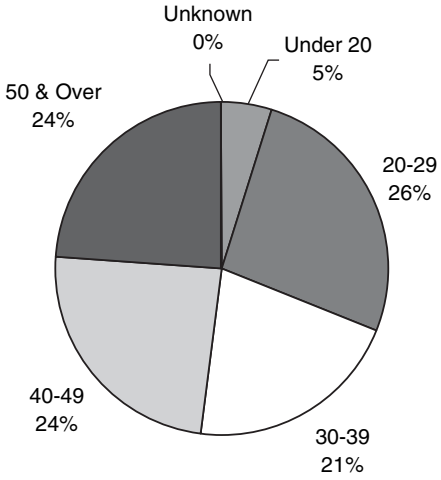
EXHIBIT III-7
Distribution of Motorcycle Fatalities in 2006 by Proper Licensing of Rider
Source: FARS, 2006



license is not lawfully endorsed for motorcycle operation.

An interesting trend in motorcycle safety is the changing distribution of motorcycle fatalities by age group. Exhibit III-8 presents the age distribution of motorcycle fatalities in 2006. While the exhibit does not demonstrate any trends over recent years, older motorcyclists have become proportionately more involved in fatal crashes. In fact, the number of fatalities in the over-40 age group has been steadily increasing since 1992. This could be due to a combination of the aging of the younger population of users, or it could be due to an increase in new motorcyclists among the older population.

EXHIBIT III-8
Age Distribution of Motorcycle Fatalities in 2006
Source: FARS, 2006



SECTION IV

Index of Strategies by Implementation Timeframe and Relative Cost

Exhibit IV-1 provides a classification of strategies according to the expected timeframe and relative cost for this emphasis area. In several cases, the implementation time will depend on such factors as the agency's procedures, the length of roadway involved, the need for additional ROW, the degree to which multiple-agency cooperation is needed, and whether or not legislation is required. The range of costs may also vary for some of these strategies because of many of the same factors. Placement in the table below is meant to reflect the most common expected application of the strategy.

EXHIBIT IV-1
Classification of Strategies According to Expected Timeframe and Relative Cost

		Relative Cost to Implement and Operate			
Timeframe for Implementation	**Strategy**	**Low**	**Moderate**	**Moderate to High**	**High**
Short (less than 1 year)	11.1 A4 Maintain the roadway to minimize surface irregularities and discontinuities	✓			
	11.1 A5 Maintain roadway surfaces in work zones to facilitate safe passage of motorcycles	✓			
	11.1 A6 Reduce roadway debris – such as gravel, shorn treads, snow and ice control treatments (sand/salt), and that resulting from uncovered loads – from the roadway and roadside			✓	
	11.1 B1 Increase motorcyclist awareness of the risks of impaired motorcycle operation	✓			
	11.1 B2 Expand existing impairment prevention programs to include motorcycle riders and specific motorcycle events	✓			
	11.1 B3 Target law enforcement to specific motorcycle rider impairment behaviors that have been shown to contribute to crashes	✓			
	11.1 C1 Increase awareness of the causes of crashes due to unlicensed or untrained motorcycle riders	✓			
	11.1 D1 Increase the awareness of the benefit of high-visibility clothing	✓			
	11.1 D2 Identify and promote rider visibility-enhancement methods and technology	✓			

EXHIBIT IV-1 (Continued)
Classification of Strategies According to Expected Timeframe and Relative Cost

Timeframe for Implementation	Strategy	Relative Cost to Implement and Operate			
		Low	Moderate	Moderate to High	High
	11.1 E2 Increase the use of protective clothing	✓			
	11.1 F1 Form strategic alliances with the motorcycle user community to foster and promote motorcycle safety		✓		
	11.1 F2 Increase awareness of the consequences of aggressive riding, riding while fatigued or impaired, unsafe riding, and poor traffic strategies		✓		
Medium (1-2 years)	11.1 A2 Consider motorcycles in the selection of roadside barriers			✓	
	11.1 A7 Provide advance warning signs to alert motorcyclists of reduced traction and irregular roadway surfaces			✓	
	11.1 A9 Provide a mechanism for notifying highway agencies of roadway conditions that present a potential problem to motorcyclists		✓		
	11.1 C2 Ensure that licensing and rider training programs adequately teach and measure skills and behaviors required for crash avoidance	✓			
	11.1 C3 Identify and remove barriers to obtaining a motorcycle endorsement	✓			
	11.1 E1 Increase the use of FMVSS 218 compliant helmets		✓		
	11.1 F3 Educate operators of other vehicles to be more conscious of the presence of motorcyclists	✓			
	11.1 G1 Include motorcycles in the research, development, and deployment of ITS			✓	
	11.1 H2 Include motorcycle attributes in vehicle exposure data collection programs			✓	
	11.1 H3 Develop a set of analysis tools for motorcycle crashes			✓	
Long (more than 2 years)	11.1 A1 Provide full paved shoulders to accommodate roadside motorcycle recovery and breakdowns				✓
	11.1 A3 Identify pavement markings, surface materials, and other treatments that reduce traction for motorcycles and treat or replace with high-traction material			✓	
	11.1 A8 Incorporate motorcycle safety considerations into routine roadway inspections	✓			
	11.1 H1 Develop and implement standardized data gathering and reporting for motorcycle crashes		✓		

SECTION V

Description of Strategies

Objectives of the Emphasis Area

The objectives for improving motorcycle safety and increasing the awareness of the unique characteristics of motorcycles are:

- Incorporate motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices
- Reduce the number of motorcycle crashes due to rider impairment
- Reduce the number of motorcycle crashes due to unlicensed or untrained motorcycle riders
- Increase the visibility of motorcyclists
- Reduce the severity of motorcycle crashes
- Increase motorcycle rider safety awareness
- Increase safety enhancements for motorcyclists
- Improve motorcycle safety research, data and analysis

Explanation of Objectives

In order to more properly understand the particular safety problems related to motorcycle use, improvements in traffic research and data analysis are necessary. Historically, roadway safety studies have focused on passenger cars and trucks and have neglected to consider motorcyclists as an individual roadway user group. Thus, the safety issues that may be unique to motorcyclists are not well documented. Furthermore, motorcycles are often overlooked during standardized crash data gathering efforts.

Considering the needs of motorcyclists during the planning and construction of roadways can reduce the likelihood of motorcycle crashes. Creating a motorcycle-friendly environment goes beyond providing a gentle alignment, but also includes keeping the roadway free of foreign debris, providing a safe roadside free of objects or obstacles to motorcyclists, maintaining safe roadway surfaces during maintenance projects, and providing sufficient warning devices to motorcyclists prior to encountering potentially dangerous zones.

As with all types of motor vehicle traffic, alcohol use by motorcycle operators continues to be a problem. Research shows that alcohol-related fatalities among motorcyclists are proportionally higher than in any other motor vehicle group. In 2003, 30 percent of all fatally injured motorcycle operators had BAC levels of 0.08 g/dl or higher. An additional 7 percent had lower alcohol levels (BAC 0.01 to 0.07 g/dl) (NHTSA, 2004).

A preemptive measure in trying to reduce the number of motorcycle crashes is to ensure proper training and licensing of motorcyclists before they reach the roadways.

Even though all 50 states require separate driver's license endorsements to operate a motorcycle and 47 states sponsor rider education courses (with 18 of those states having universal training programs), it has been estimated that 20 percent of the motorcycle population is either unlicensed or improperly licensed. Even more alarming is that more than 40 percent of motorcyclists involved in fatal crashes are improperly licensed (TRB, 1994).

A common complaint of many motorcyclists is that passenger car drivers often do not see them and, as a result, violate the motorcyclists' right-of-way. The Hurt Study, *Motorcycle Accident Cause Factors and Identification of Countermeasures* (Hurt et al., 1981), identified that riders who wore camouflage or other hard-to-see apparel were over-represented in right-of-way crashes, suggesting that conspicuity also plays a role in crash avoidance. The predominant color of motorcycle apparel is black: black leather jackets, black gloves and boots, and black helmets. The problem with black is that it is inconspicuous in the day and, in the absence of any retro-reflective material, invisible at night or in low-light conditions. Motorcyclists can immediately and inexpensively improve conspicuity, and thus their safety, by wearing retro-reflective material on their clothes and helmets. Retro-reflective vests are especially effective at increasing visibility at night.

A study by Sosin and Sacks (1992) found more than 50 percent of all motorcycle-related fatalities were mainly attributed to head injuries. This study along with many others indicates that helmets are the single most important piece of protective equipment that a motorcyclist has at his or her disposal. NHTSA estimates that from 1986 through 1996 motorcycle helmets have prevented more than 7,900 motorcyclist fatalities and saved over $10 billion in related costs. Increasing the use of effective FMVSS 218 compliant helmets is universally accepted as a key motorcycle safety goal. Two approaches to work toward achieving an increase in the use of FMVSS 218 compliant helmets include: campaigns to promote helmet use and universal helmet laws. These approaches vary in ease of implementation and the level of rider community acceptance.

The last objective deals with the need to enhance motorcycle safety, both on the motorcycle itself and within the roadway system. Continuing research is bringing several standard motor vehicle safety features to the motorcycle industry (such as anti-lock braking systems) and with a maintained focus, technology is sure to provide additional protection through advancements. Additionally, motorcycle detection for operational and warning systems needs to be investigated and improved.

Strategies designed to fulfill these objectives are presented in Exhibit V-1. For a more detailed arrangement of strategies, according to cost and implementation time frame, see Section IV of this guide.

EXHIBIT V-1
Objectives and Strategies to Address Motorcycle Collisions

Objectives	Strategies
11.1 A Incorporate motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices	11.1 A1 Provide full paved shoulders to accommodate roadside motorcycle recovery and breakdowns (T)
	11.1 A2 Consider motorcycles in the selection of roadside barriers (E)

EXHIBIT V-1 (Continued)
Objectives and Strategies to Address Motorcycle Collisions

Objectives	Strategies
	11.1 A3 Identify pavement markings, surface materials, and other treatments that reduce traction for motorcycles and treat or replace with high-traction material (T)
	11.1 A4 Maintain the roadway to minimize surface irregularities and discontinuities (T)
	11.1 A5 Maintain roadway surfaces in work zones to facilitate safe passage of motorcycles (T)
	11.1 A6 Reduce roadway debris – such as gravel, shorn treads, snow and ice control treatments (sand/salt), and that resulting from uncovered loads – from the roadway and roadside (T)
	11.1 A7 Provide advance warning signs to alert motorcyclists of reduced traction and irregular roadway surfaces (T)
	11.1 A8 Incorporate motorcycle safety considerations into routine roadway inspections (E)
	11.1 A9 Provide a mechanism for notifying highway agencies of roadway conditions that present a potential problem to motorcyclists (E)
11.1 B Reduce the number of motorcycle crashes due to rider impairment	11.1 B1 Increase motorcyclist awareness of the risks of impaired motorcycle operation (T)
	11.1 B2 Expand existing impaired driving prevention programs to include motorcycle riders and specific motorcycle events (T)
	11.1 B3 Target law enforcement to specific motorcycle rider impairment behaviors that have been shown to contribute to crashes (T)
11.1 C Reduce the number of motorcycle crashes due to unlicensed or untrained motorcycle riders	11.1 C1 Increase awareness of the causes of crashes due to unlicensed or untrained motorcycle riders (E)
	11.1 C2 Ensure that licensing and rider training programs adequately teach and measure skills and behaviors required for crash avoidance (T)
	11.1 C3 Identify and remove barriers to obtaining a motorcycle endorsement (T)
11.1 D Increase the visibility of motorcyclists	11.1 D1 Increase the awareness of the benefit of high-visibility clothing (E)
	11.1 D2 Identify and promote rider visibility-enhancement methods and technology (T)
11.1 E Reduce the severity of motorcycle crashes	11.1 E1 Increase the use of FMVSS 218 compliant helmets (P)
	11.1 E2 Increase the use of protective clothing (T)
11.1 F Increase motorcycle rider safety awareness	11.1 F1 Form strategic alliances with motorcycle user community to foster and promote motorcycle safety (T)
	11.1 F2 Increase awareness of the consequences of aggressive riding, riding while fatigued or impaired, unsafe riding, and poor traffic strategies (T)
	11.1 F3 Educate operators of other vehicles to be more conscious of the presence of motorcyclists (T)

EXHIBIT V-1 (Continued)
Objectives and Strategies to Address Motorcycle Collisions

Objectives	Strategies
11.1 G Increase safety enhancements for motorcyclists	11.1 G1 Include motorcycles in the research, development, and deployment of ITS (E)
11.1 H Improve motorcycle safety research, data and analysis	11.1 H1 Develop and implement standardized data gathering and reporting for motorcycle crashes (N/A)
	11.1 H2 Include motorcycle attributes in vehicle exposure data collection programs (N/A)
	11.1 H3 Develop a set of analysis tools for motorcycle crashes (N/A)

Note: P = Proven, T = Tried, and E = Experimental. See further explanation below.

Classification of Strategies

The strategies in this guide were identified from a number of sources, including the literature, contact with state and local agencies throughout the United States, motorcycle organizations representatives, and federal agencies. Some of the strategies are widely used, while others are used at a state or even a local level. Some have been subjected to well-designed evaluations to prove their effectiveness, while others, including some that are widely used, have not been adequately evaluated.

Due to the varying degree to which each strategy has been used, as well as the limited knowledge about the effectiveness of most of the strategies, the reader should be prepared to exercise engineering judgment before adopting a particular strategy for implementation. To help the reader, the strategies have been classified into three types, each identified by a letter:

Proven (P): *Those strategies which have been used in one or more locations, and for which properly designed evaluations have been conducted that show it to be effective.* These strategies may be employed with a good degree of confidence, with the understanding that any application can lead to results that vary from those found in previous evaluations. The attributes of the strategies that are provided will help the user make judgments on which is the most appropriate for their particular situation(s).

Tried (T): *Those strategies that have been implemented in a number of locations, and may even be accepted as standards or standard approaches, but for which there have not been found valid evaluations.* These strategies, while frequently or even generally used, should be applied with caution; users should carefully consider the attributes cited in the guide and relate them to the specific conditions for which they are being considered. Implementation can proceed with some degree of assurance that there is not likely to be a negative impact on safety, and very likely to be a positive one. It is intended that as the experiences of implementation of these strategies continue under the AASHTO Strategic Highway Safety Plan initiative, appropriate evaluations will be conducted, so that effectiveness information can be accumulated to provide better estimating power for the user, and the strategy can be upgraded to a "proven" one.

Experimental (E): *Those strategies that are ideas that have been suggested and at least one agency has considered sufficiently promising to try them on a small scale in at least one location.* These strategies should be considered only after the others have proven not to be appropriate or feasible. Even where they are considered, their implementation should initially occur using a very controlled and limited pilot study which includes a properly designed evaluation component. Only after careful testing and evaluations show the strategy to be effective should broader implementation be considered. It is intended that as the experiences of such pilot tests are accumulated from various state and local agencies, the aggregate experience can be used to further detail the attributes of this type of strategy, so that it can be upgraded to a "proven" one.

Targeting the Objectives

The objectives contained in this guide are intended to target a variety of issues and a broad audience. Because motorcycle safety cannot be pinpointed to one controlling factor, neither can the responsibility of providing this safety fall solely upon the shoulders of the motorcyclist, or one group of professionals. It is thus appropriate that this guide provide objectives that are far-reaching and that encompass many areas of expertise.

Meaningful progress toward accomplishing the above objectives will be achieved when all stakeholders—licensing officials, roadway users, motorcycle riders, roadway designers, law enforcement, and legislators—take responsibility for implementing those strategies within their area of responsibility. Success will be measured in motorcyclists' lives saved and serious injuries that are averted on the roadways.

Related Strategies for Creating a Truly Comprehensive Approach

The strategies listed above, and described in detail below, are those largely unique to the motorcycle safety emphasis area. However, to create a truly comprehensive approach to the highway safety problems associated with this emphasis area, there are related strategies that may be included as candidates in any program planning process. These strategies can be organized into five categories:

Public Information and Education Programs (PI&E)—Highway safety programs can be effectively enhanced with a properly designed PI&E campaign. The primary objective of a PI&E campaign in highway safety is to reach an audience across an entire jurisdiction, or a significant part of it. However, it may be desired to focus a PI&E campaign on a location-specific problem. While this is a relatively untried approach, as compared to area-wide campaigns, use of roadside signs and other experimental methods may be tried on a pilot basis. Within this guide, where the application of PI&E campaigns is deemed appropriate, it is usually in support of some other strategy. In such a case, the description for that strategy will suggest the possible use of a PI&E campaign (see the attribute area for each strategy entitled, "Associated Needs for, or Relation to, Support Services").

Enforcement of Traffic Laws—Well-designed, well-operated law enforcement programs can have a significant effect on highway safety. It is well established, for instance, that an effective way to reduce crashes and their severity is to have jurisdiction-wide programs that enforce an effective law against driving under the influence (DUI), or driving without seatbelts. When that law is vigorously enforced, with well-trained officers, the frequency and severity of highway crashes can be significantly reduced. This is considered an important element in

any comprehensive highway safety program. Enforcement programs are conducted at specific locations by the nature of how they must be performed. The effect (e.g., lower speeds, greater use of seatbelts, and reduced impaired driving) may occur at or near the specific location where the enforcement is applied. Coordinating the effort with an appropriate PI&E program can often enhance this effect. However, in many cases (e.g., speeding and seatbelt usage) the impact is area-wide or jurisdiction-wide. The effect can be either positive (i.e., the desired reductions occur over a greater part of the system), or negative (i.e., the problem moves to another location as road users move to new routes where enforcement is not applied). A pilot program is useful when it is unclear how the enforcement effort may impact behavior, or where it is desired to try an innovative and untried method. Within this guide, where the application of enforcement programs is deemed appropriate, it is often in support of some other strategy. Many of those strategies may be targeted at either a whole system, or a specific location. In such cases, the description for that strategy will suggest this possibility (see the attribute area for each strategy entitled, "Associated Needs for, or Relation to, Support Services").

Strategies to Improve Emergency Medical and Trauma System Services—Treatment of injured parties at highway crashes can have a significant impact on the level of severity and length of time that an individual spends in treatment. This is especially true when it comes to timely and appropriate treatment of severely injured persons. Thus, a well-based and comprehensive emergency care program is a basic part of a highway safety infrastructure. While the types of strategies that are included here are often thought of as simply support services, they can be critical to the success of a comprehensive highway safety program. Therefore, it is beneficial for a comprehensive motorcycle safety effort to include a critical review of the emergency medical and trauma system services to determine if there are improvements that can be made, especially for programs which are focused on location-specific (e.g., corridors), or area-specific (e.g., rural areas) issues. A separate guide has been developed to address the design and implementation of emergency medical systems strategies in rural areas (http://safety.transportation.org/guides.aspx?cid=36).

Strategies Directed at Improving the Safety Management System—The management of the highway safety system is essential to success. Thus it follows that a sound organizational structure, as well as infrastructure of laws, policies, etc., should be in place to monitor, control, direct and administer a comprehensive approach to highway safety. It is important that a comprehensive program include a standardized system of crash data coding, collecting and analysis. While motorcycles are often overlooked during the collection of crash data, many states are recognizing the benefits of using existing crash data as a tool for monitoring highway safety and for the development of safety countermeasures. Until another comprehensive motorcycle crash causation study is conducted, this data can serve as a useful tool to better understand motorcycle crash causation. (Objective A of this guide specifically addresses the need to improve the coding, collection, and analysis of motorcycle crash data.) It is important that a comprehensive safety management program not be limited to one jurisdiction, such as a state DOT. Local agencies are often responsible for the majority of the road system. Furthermore, many different groups (e.g., law enforcement, data entry specialists, and data analysts) are needed in the standardization of motorcycle crash data.

Strategies That Are Detailed in Other Emphasis Area Guides—Motorcycles, while unique in many regards, are still motor vehicles and subject to many of the same issues and solutions that are discussed for other vehicles. Therefore, most of the other guides in this series have strategies that may also improve motorcycle safety. The reader is encouraged to review each of the other guides, as well.

Objective 11.1 A—Reduce the Number of Motorcycle Crashes by Incorporating Motorcycle-Friendly Roadway Design, Traffic Control, Construction, and Maintenance Policies and Practices

Strategy 11.1 A1—Provide Full Paved Shoulders to Accommodate Roadside Motorcycle Recovery and Breakdowns (T)

General Description

Shoulders are desirable for all vehicle types, but provide particular benefits to motorcyclists. For example, motorcyclists that run off the roadway or experience mechanical problems within a confined cross section (e.g., bridge, work zone) with no shoulder are especially vulnerable to traffic following in their path of travel. That is, motorcyclists do not have a vehicle to provide at least limited protection and to make them more visible to oncoming or following traffic. By widening the shoulders, or providing a shoulder where one previously did not exist, motorcyclists have a refuge area out of the traveled way to accommodate motorcycle breakdowns. They also have more recovery area to regain control of their errant motorcycle before encroaching on the roadside, thereby reducing the risk of an impact with a fixed roadside object.

While there are no reliable studies in the literature that document the safety benefits to motorcyclists of providing full paved shoulders, the relationship between shoulder width and safety has been studied extensively for motor vehicles in the rural environment. An expert panel (Harwood, 2000) recently reviewed the literature on safety for shoulder widths on rural two-lane highways for the Interactive Highway Safety Design Model (IHSDM). The panel concluded that the most credible studies of shoulder width on rural two-lane highways were those by Zegeer et al. (1981) for low-volume roads and another study by Zegeer et al. (1988) for higher-volume roads. The expert panel developed accident modification factors (AMFs) based on these past studies. AMFs are used in accident prediction algorithms to represent the safety effects of various geometric features (e.g., shoulder width, right-turn lanes, etc.). The base value of each AMF is 1.0. Any feature associated with a higher accident experience than the base condition has an AMF with a value greater than 1.0, and any feature associated with lower accident experience than the base condition has an AMF with a value less than 1.0. Another expert panel in a later research study (Harwood et al., 2003) concluded that the AMFs for rural two-lane highways are also the best available estimates for rural multilane highways.

Strategy 15.1 A8 in *NCHRP Report 500, Volume 6: A Guide for Addressing Run-Off-Road Collisions* also addresses shoulder treatments and may be referenced for further details, including a complete list of the technical attributes of this strategy. The Run-Off-Road (ROR) guide provides one set of accident modification factors for widening a paved shoulder on a two-lane rural highway and a second set of accident modification factors for various shoulder types and widths.

To achieve the desired safety improvements, highway agencies may find it helpful to consider whether their design policies for new or reconstructed roadways—including the shoulder width and type of shoulder to be used—take into consideration motorcycle safety.

A review of existing roadways, where a full paved shoulder is not provided, may be appropriate to identify locations that could be problematic for motorcyclists. Full paved shoulders may be targeted to high-crash locations. Since many highway agencies have not yet adopted an organizational motorcycle safety philosophy, highway agency personnel need to be trained to identify locations where the lack of a full paved shoulder may be problematic for motorcycles.

Information on Agencies or Organizations Currently Implementing This Strategy

The state of Iowa has conducted a study to evaluate the costs and benefits associated with paved shoulders on primary highways in the state. This study reviewed current design criteria as well as state crash data and decided upon a minimum 3-ft paved shoulder width on rural highways in the state. Visit http://www.ctre.iastate.edu/reports/pavedshoulder.pdf for more information.

Strategy 11.1 A2—Consider Motorcycles in the Selection of Roadside Barriers (E)

General Description

Historically, roadside safety barriers have been installed to protect errant motor vehicles from encroaching on fixed objects located beyond the barrier. In most cases, the installation of safety barriers has only taken into consideration the needs and concerns of passenger cars, trucks, and other motor vehicles, while the needs of motorcyclists are typically overlooked. For example, with post and rail or wire rope barriers, there is the chance that the rider could slide under the rail or wire and continue off the roadside. Other traditional roadside barriers may be too low, and do not protect motorcyclists vaulted from their vehicle. When this happens, the rider is not only subjected to possible injury from the tops of posts should he or she come in contact with them, but the rider may continue off the roadside.

FARS data for 2006 show that fatal crashes involving fixed objects constituted a little more than one-quarter of all fatal crashes. Bryden and Fortuniewicz (1986) conducted field investigations for 3,302 traffic barrier crashes in the state of New York in order to determine the barriers' performance as different types and sizes of vehicles collided with them. They found that crashes involving motorcycles were by far the most severe. Nearly 50 percent of crashes involving motorcycles resulted in either a fatality or severe injury, and in approximately 12 percent of those crashes, the motorcyclist ended up beyond the traffic barrier.

NCHRP Report 350 (Ross et al., 1993) presents procedures for conducting vehicle crash tests and in-service evaluation of roadside safety features or appurtenances. Types of devices included are: (1) longitudinal barriers (such as bridge rails, guardrails, median barriers, transitions, and terminals); (2) crash cushions; (3) breakaway or yielding supports for signs and luminaries; (4) breakaway utility poles; (5) truck-mounted attenuators; and (6) work zone traffic control devices. FHWA requires use of *NCHRP Report 350* testing protocols for all roadside safety hardware. As currently established, there are no protocols covering the performance of roadside barriers based on collisions with motorcycles.

There are three main types of barrier systems currently used in the United States:

- Concrete barriers
- W-beam guide rails and three-beam rail systems
- Wire rope safety barriers (WRSBs)

Each of these provides unique benefits and detriments to motorcyclists based on their physical properties and placement along the roadside.

Concrete barriers, such as the one illustrated in Exhibit V-2, are the most rigid barriers in use and are often found in locations where there is limited space for barrier deflection, and/or where traffic volumes are significant and the relative frequency of impacts is higher. These barrier systems are made of interlocking sections that form a continuous smooth surface that is most advantageous in collisions where impact angle is small because it prevents snagging and blunt force impacts (from posts) to the motorcyclist. Research by Sala and Astori (1998) determined that the physical nature of concrete barriers enabled sliding and redirection of the crash victim in addition to providing a significant distribution of contact forces over the surface area of the barrier. Highway agencies may want to consider installation of concrete barriers at high-crash locations or at locations with the greatest potential for motorcycle/barrier collisions. Appropriate locations for their application include sites with high motorcycle traffic volumes, high motorcycle accident rates, and locations where current roadside barriers are deemed problematic for motorcyclists.

The W-beam guide rail, as the name suggests, consists of a "W" shaped rail supported by posts incrementally spaced to provide sufficient strength to withstand collisions. Exhibit V-3 illustrates a W-beam guide rail. Because these barriers are not as rigid as their concrete counterparts, they do provide a significant amount of deflection during impacts with heavier vehicles. The most undesirable features of this design, from the motorcyclist's perspective, are the posts and the sharp edges associated with them, which are exposed both above and below the guide rail. Should a motorcyclist be ejected from the vehicle across the top of the guide rail, he or she could be severely injured by the tops of the posts. More common, however, is the possibility of a motorcyclist passing under the protective rail and then coming in contact with the lower portion of a post. In these situations, even

EXHIBIT V-2
Concrete Roadside Barrier (New Jersey Type)

EXHIBIT V-3
W-beam Guide Rail

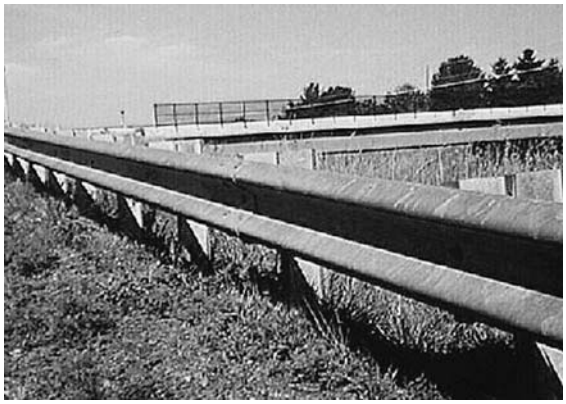


EXHIBIT V-4
Wire Rope Safety Barrier

if the angle of impact is relatively small, the impact with the post surface will be approximately perpendicular. Studies by Ouellet (1982) and Domhan (1987) have each shown that collisions with guide rail posts are often severe, if not fatal. Even if a person could travel between guide rail posts without coming in contact with them, there is often a roadside hazard (from which the guide rail is protecting the roadway user) directly beyond the guide rail.

Similar in many aspects to W-beam guide rails, WRSBs (Exhibit V-4) are generally composed of three or four lateral wire rope segments that are supported by vertical posts and tensioned by anchors at incremental spaces. These barriers are used in environments where there is ample space for deflection and they provide very little impediment to sight distance. The motorcycle safety issues associated with WRSBs are twofold. First, the supporting posts for this barrier pose the same threat to motorcyclists as the posts for the W-beam guide rails discussed above. Secondly, the greatest perceived concern for motorcyclists unique to this design is the potential to be severed by the wire rope.

This type of barrier device is much less expensive to implement than concrete or W-beam guardrail. Its widespread application on open medians of freeways has gained substantial interest in recent years and met with great success in eliminating cross-median head-on crashes involving motor vehicles. Given the relative newness of this design treatment there is a general lack of research on its performance when impacted by motorcyclists.

It is understood in the design community that the best solutions to roadside hazards are eliminating the hazard itself. Thus, preference is to remove trees, objects, etc. and flatten slopes versus placing barriers to shield vehicles from them. However, quite clearly there are many, frequent situations where roadside barriers are necessary to provide overall system safety. Given that historically the basis for roadside appurtenance design uses larger vehicles and does not directly consider motorcycle impacts, the safety effectiveness of motorcycle-friendly roadside barriers is largely unknown. Further research to quantify the safety benefits of these systems is needed.

EXHIBIT V-5
Strategy Attributes for Considering Motorcycles in the Selection of Roadside Barriers

Technical Attributes	
Target	The strategy is targeted to reduce the severity of collisions resulting from motorcyclists coming in contact with a roadside barrier. The strategy is also targeted at agencies responsible for the placement of such treatments.
Expected Effectiveness	This strategy should reduce motorcyclists' exposure to serious injury due to collisions with roadside barriers.

EXHIBIT V-5 (Continued)
Strategy Attributes for Considering Motorcycles in the Selection of Roadside Barriers

	There is no consensus on a quantitative estimate of the safety effectiveness of this strategy. The effectiveness likely depends on the number of locations where non-conforming barrier treatments were replaced, the volume and speed of motorcycle traffic at the location, and motorcycle accident patterns at the location.
Keys to Success	The key to the success of this strategy will be the existence of a policy and a set of procedures that requires the identification of high-risk locations due to poorly engineered barriers and the replacement or modification of these barriers.
Potential Difficulties	The cost of replacing or constructing roadside barriers could be significant compared to other road treatments. This may limit the number of locations in which this strategy could be introduced. Some barriers that are not conducive to motorcycle safety may still be sufficient to protect other motor vehicles; thus, replacing otherwise acceptable barriers may be difficult. Keeping sufficient maintenance on motorcycle-safe barriers after collisions have occurred may be difficult.
Appropriate Measures and Data	Key process measures include the number of locations where insufficient or dangerous roadside barriers have been replaced with motorcycle-friendly barriers, and the severity of accidents reduced by the improvement. Crash frequency and severity, by type of crash, are key safety effectiveness measures. It is especially useful to identify crashes related to collision with a roadside barrier and analyze them separately. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to barrier collisions should be analyzed separately. Motorcycle traffic volume data are needed to represent exposure.
Associated Needs	There are no particular public information and education needs to be addressed when this strategy is implemented. Communication regarding the presence of these roadway improvements to the motorcycle riding community would be beneficial but not essential.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Highway and other agencies should make sure that their design policies for new or reconstructed roadways incorporate a consideration of how potential roadside barriers will affect the motorcycle population. Highway agencies should review their barrier warrant policies and maintenance practices regarding the use of concrete, W-beam and WRSB barriers to ensure that appropriate action is being taken on routine projects. Nearly any highway agency can participate in implementing this strategy, which is applicable to rural, urban, and suburban areas. This strategy is complemented by effective stakeholder partnerships. Coordinating with a state/region motorcycle advisory group will serve to inform the motorcycle community of this effort, and will provide a conduit for information to the agency of potential problem areas.
Issues Affecting Implementation Time	This strategy can be implemented within 3 months of identifying a location with unacceptable roadside barriers.

EXHIBIT V-5 (Continued)
Strategy Attributes for Considering Motorcycles in the Selection of Roadside Barriers

Costs Involved	The costs involved in this strategy are all related to the identification of harmful locations and the engineering and installation of new roadside barriers.
Training and Other Personnel Needs	Highway agency personnel should be trained to identify high priority locations and install new treatments in a manner that will effectively improve the roadway environment. Highway agency personnel should also be made aware of the multitude of roadside barrier options that are available.
Legislative Needs	None identified.
Other Key Attributes	
Compatibility of Different Strategies	This strategy can be used in conjunction with most others for improving safety for motorcyclists.
Other Key Attributes to a Particular Strategy	None identified.

Strategy 11.1 A3—Identify Pavement Markings, Surface Materials, and Other Treatments That Reduce Traction for Motorcycles and Treat or Replace with High-Traction Material (T)

General Description

Painted roadway markings and other surface materials can be extremely slippery when wet. In fact, slick materials that interfere with traction are applied to road surfaces with increasing frequency. The *National Agenda for Motorcycle Safety* (NHTSA, 2000) made the following proposal: Take steps to remove slippery sealants and repair substances applied to road surfaces.

A motorcycle's traction can be seriously compromised by a variety of surface treatments, including:

- Bituminous rubberized asphalt sealer (used for crack repair)
- Plasticized adhesive pavement-marking tape
- Manhole covers
- Raised pavement markers

While each of these treatments is particularly slick in wet conditions, some may even be slippery in dry environments. These treatments become even more problematic for motorcyclists when they are installed in horizontal curves where a leaning motorcycle can potentially slip and crash.

Where bituminous rubberized asphalt sealers are applied to large areas, more motorcyclists can be adversely affected. Often this material is applied in widths of 12 to 24 in. As the material warms, it becomes gummy and may cause a motorcycle to slip on contact. Bridge joints that are treated with generously applied asphalt sealer can also be problematic for motorcycles.

In some conditions (i.e., wet pavement and hot temperatures), this material becomes very slippery and can cause a motorcycle traveling in a straight line to lose control and fall.

Plasticized adhesive pavement markings and large painted lines present traction problems. Usually located at an intersection, motorcyclists pass over these markings while leaning. Depending on speed and lean angle, these markings can cause a motorcyclist to lose traction and fall.

Manhole covers become extremely slippery when wet. Compounding this problem is the fact that manhole covers often blend with the roadway color and are difficult to see at night or in low-light conditions. Treating the cover with a non-slip material and edging it in contrasting color would provide greater traction and make the cover more visible.

While raised pavement markers (a.k.a. "traffic buttons") do not create a slick surface in the same way that asphalt sealers and plasticized adhesives do, they serve as potential obstacles in the roadway that can cause a motorcyclist to lose control, especially when the motorcycle operator fails to notice them.

Since there is no known design standard for traction coefficient for surface treatments and manhole covers, it is difficult to define specifically when these treatments pose a problem for motorcycles. Research is needed to create a uniform standard under which agencies can make these determinations. Also, a number of highway agencies routinely test marking materials such as paints, thermoplastics, epoxies, and temporary tapes to evaluate their retroreflectivity and durability. Routine testing of marking materials should consider including a test for the traction needed by motorcycles and reflect the compatibility of these applied materials to motorcycles in various temperatures and wet and dry conditions. For example, plasticized adhesive pavement markings may be available in a "grit" surface that provides better traction when a motorcycle crosses in a lean and/or in wet or reduced traction conditions.

Highway agencies may want to first target high-crash locations and routes with high motorcycle volumes.

EXHIBIT V-6
Strategy Attributes for Identifying Pavement Markings, Surface Materials, and Other Treatments That Reduce Traction for Motorcycles and Treating or Replacing with High-Traction Material

Technical Attributes	
Target	The strategy is targeted to reduce the frequency of collisions resulting from motorcyclists losing control while traversing pavement markings, surface treatments, manhole covers, or raised pavement markers that present an obstacle or provide inadequate surface friction. The strategy is also targeted at agencies responsible for the placement of such treatments.
Expected Effectiveness	This strategy should reduce crashes involving motorcycle loss of control due to raised pavement markers or reduced traction surface treatments. There is no consensus on a quantitative estimate of the safety effectiveness of this strategy. The effectiveness likely depends on the number of locations where raised pavement markers and reduced traction surface treatments were replaced, the volume and speed of motorcycle traffic at the location, and the available sight distance to the surface treatment or reduced traction location.

EXHIBIT V-6 (Continued)
Strategy Attributes for Identifying Pavement Markings, Surface Materials, and Other Treatments That Reduce Traction for Motorcycles and Treating or Replacing with High-Traction Material

Keys to Success	The key to the success of this strategy will be the existence of a policy and a set of procedures that requires the identification of raised and low-traction roadway markings and the replacement or modification of these markings and road surface materials.
Potential Difficulties	The cost of high-traction materials may be higher than conventional road treatments. This may limit the number of locations in which this material could be introduced. Budget constraints may also limit the use of these high-traction materials. High-traction materials may be more difficult to maintain.
Appropriate Measures and Data	Key process measures include the number of locations where raised or slick pavement markings or surface treatments have been replaced with low-profile, high-traction material and treatments, and the number of accidents eliminated by the improvement. Crash frequency and severity, by type of crash, are key safety effectiveness measures. It is especially useful to identify crashes related to reduced traction and analyze them separately. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to reduced traction should be analyzed separately. Motorcycle traffic volume data are needed to represent exposure.
Associated Needs	There are no particular public information and education needs to be addressed when this strategy is implemented. Communication regarding the presence of these roadway improvements to the motorcycle riding community would be beneficial but not essential.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Highway and other agencies should make sure that their design policies for new or reconstructed roadways incorporate provision of low-profile, high-traction pavement marking materials and surface treatments. Highway agencies should review their pavement marking policies and maintenance practices regarding use of low-profile, high-traction pavement marking materials and surface treatments to ensure that appropriate action is being taken on routine projects. Nearly any highway agency can participate in implementing this strategy, which is applicable to rural, urban, and suburban areas. This strategy is complemented by effective stakeholder partnerships. Coordinating with a state/region motorcycle advisory group will serve to inform the motorcycle community of this effort, and will provide a conduit for information to the agency of potential problem areas.
Issues Affecting Implementation Time	This strategy can be implemented within 3 months of identifying a location with raised markers and/or reduced traction.
Costs Involved	The cost of high-traction markings may be higher than conventional markings.
Training and Other Personnel Needs	Highway agency personnel should be trained to apply materials in a manner to preserve traction for motorcycles and to identify locations with reduced traction. Highway agency personnel should also be made aware of the different traction materials or pavement markings that are available.
Legislative Needs	None identified.

EXHIBIT V-6 (Continued)
Strategy Attributes for Identifying Pavement Markings, Surface Materials, and Other Treatments That Reduce Traction for Motorcycles and Treating or Replacing with High-Traction Material

Other Key Attributes	
Compatibility of Different Strategies	This strategy can be used in conjunction with most others for improving safety for motorcyclists.
Other Key Attributes to a Particular Strategy	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

The Oregon Department of Transportation contacts the TEAM OREGON Motorcycle Safety Program when a new surface treatment is applied or tested. A member of the TEAM OREGON program visits the site(s), test rides the material or application, and takes photographs. A brief report is provided from TEAM OREGON to ODOT on the suitability of the product or application to motorcycle use.

The Idaho Department of Transportation has purchased a grooving system. It is more labor intensive, but it appears to improve roadway traction.

The Montana Department of Transportation uses a 40-mm wide reservoir and underfills it, thus minimizing the spread of asphalt sealer on the road surface. Economics was the driving force behind this effort.

Strategy 11.1 A4—Maintain the Roadway to Minimize Surface Irregularities and Discontinuities (T)

General Description

General "wear-and-tear" on the roadway system—caused by adverse weather conditions, increasing traffic volumes, and heavy vehicle loads—is inevitable. However, it can deteriorate the roadway surface to such a condition that motorcyclists traverse the roadway with great difficulty. While it is not feasible for every surface irregularity to be treated immediately, it is essential that those irregularities and discontinuities that present an inherent problem to motorcycle users be identified and treated as quickly as possible. Highway agencies may want to first target high-crash locations and routes with high motorcycle volumes. In fact, the *National Agenda for Motorcycle Safety* (NHTSA, 2000) has listed "maintaining roadway surfaces" as an essential proposal.

Common surface irregularities that are especially problematic for motorcycle users include potholes, tire rutting, surface drop-offs or rises, manhole covers, deteriorating pavement and railroad grade crossings that are worn or cross the roadway at a shallow angle. Each is discussed below:

- *Potholes*—While potholes are often an inconvenience for motor vehicles, due to the jarring involved as a tire suddenly dips into an opening in the road, they are even

EXHIBIT V-7
Example of a Pothole That Would Be Problematic for Motorcyclists

more of a problem for single-track vehicles whose balance is more easily disrupted by the sudden jarring action. Motorcycle tires range in size from 10 to 18 inches in diameter, so even small holes in the road can cause a motorcyclist to lose control (see Exhibit V-7).

- *Tire Ruts*—It is not uncommon, especially on freeways, for tire ruts to be present on the roadway surface due to heavy truck traffic; however, a motorcyclist can have a particularly difficult time maneuvering in and out of the ruts without over-steering or over-correcting in the process. When a rut is filled with water from a rainstorm, the condition is amplified by the hydroplaning affect, leaving the motorcyclist to find a narrow path along the center or edge of the lane.

EXHIBIT V-8
Pavement Drop-off Due to Repaving Project

- *Surface Drop-offs*—Another type of surface irregularity, surface drop-off or rise, can be found at either end of bridges or resurfacing project locations (see Exhibit V-8). If the elevation change is too drastic, the surface irregularity can be problematic for motorcyclists.

- *Manhole Covers*—Manhole covers are especially problematic for motorcyclists when they are not placed flush with the pavement surface. That is, manhole covers that are either too high (creating a raised object in the roadway) or too low (creating a "crater" or "pothole" effect) can cause a motorcyclist to lose control. This misalignment creates a problem when the cover suddenly appears from beneath the vehicle ahead. Manhole covers that are too high are often found

in construction zones where they are first installed, or relocated, and then the final surface courses are added. Compounding this problem is the fact that manhole covers often blend with the roadway color and are difficult to see at night or in low-light conditions. Exhibit V-9 illustrates a manhole cover that is too low and blends in with the roadway color. Edging the cover in contrasting color would make the cover more visible.

- *Deteriorating Pavement*—Pavements that are poorly maintained can deteriorate and break apart, leaving a patch of broken pavement and gravel through which motorcyclists must negotiate (see Exhibit V-10). Such debris can deflect a motorcycle's wheel when it is struck, causing the rider to lose control of the motorcycle. There are certain locations where debris is a particular problem for motorcycles, such as at horizontal curves (where insufficient traction can result in running off the road or motorcycle slide-out) or locations with limited maneuvering space (such that a rider is unable to negotiate around the debris).

- *Railroad Grade Crossings*—Outdated and well-worn railroad crossings are a rugged surface that, if not carefully traversed by motorcyclists, can easily lead to a loss of balance and control. Also, railroad crossings that do not cross the roadway at right angles can be especially difficult for motorcyclists to navigate, especially with worn crossings. The jarring impact of striking the track coupled with the slick surface can result in a loss of control.

Currently there is no surface irregularity/discontinuity threshold for motorcycles. Therefore, officials have no way to quantify to what degree various surface irregularities affect motorcyclists. Further research should be conducted to develop thresholds that can be incorporated into design criteria.

Highway agencies should regularly and systematically inspect all roadway surfaces for irregularities and discontinuities that potentially pose a safety problem for motorcyclists. Patchwork may serve as a temporary solution until permanent repairs can be made. However, care should be taken that the repair work is of good quality.

EXHIBIT V-9
Manhole Cover

EXHIBIT V-10
Deteriorating Pavement and Gravel from Poor Roadway Maintenance

Where surface irregularities and discontinuities can neither be fixed nor removed, advanced warning signs should be placed upstream of the problem area. For information on advanced warning signs, see Strategy 11.1 A7.

Highway agencies may choose to develop a toll free number or Internet website where motorcycle riders could report locations where surface irregularities and discontinuities are present (See Strategy 11.1 A9). This could potentially reduce personnel costs.

EXHIBIT V-11
Strategy Attributes for Maintaining the Roadway to Minimize Surface Irregularities and Discontinuities

Technical Attributes	
Target	The strategy is targeted at motorcyclists traveling on roadways that may be facing hazards due to surface irregularities and discontinuities. The target is also the agencies responsible for design and maintenance of roads.
Expected Effectiveness	No quantitative estimates of the safety effectiveness of this strategy are available. However, providing a smoother, more continuous roadway surface would be considered an effective step towards providing a more comfortable and safe environment for motorcyclists.
Keys to Success	It will be important to create sensitivity within the responsible agencies for conditions that are dangerous for motorcyclists. A “champion” at an upper management level will be helpful to give the effort momentum and stamina. Where surface irregularity problems are a result of design policies, then changes in those policies will be needed to resolve the problem effectively before it occurs. The keys to success in the field are identifying surface irregularities and discontinuities in a timely manner and conducting a high-quality repair.
Potential Difficulties	Implementation of this strategy may be limited due to cost and personnel availability, especially where this is not seen to be a high-priority need.
Appropriate Measures and Data	Key process measures include the number of locations where adverse surface conditions have been replaced by an adequate riding surface, as well as documentation of the number and types of changes in policy that support this strategy. Crash frequency and severity, by type of crash, are key safety effectiveness measures. It is especially important to identify crashes related to surface irregularities and analyze them separately. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to surface irregularities should be analyzed separately. Motorcycle traffic volume data are needed to represent exposure.
Associated Needs	There are no particular public information and education needs to be addressed when this strategy is implemented. Communicating the implementation of this strategy to the motorcycle riding community would be beneficial but not essential.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Highway and other agencies should ensure that their design policies for new or reconstructed roadways incorporate inclusion of the most durable and contiguous surface available, with adequate and consistent provision of surface friction.

EXHIBIT V-11 (Continued)
Strategy Attributes for Maintaining the Roadway to Minimize Surface Irregularities and Discontinuities

	Highway maintenance agencies will need to reflect needs of motorcyclists when performing regular assessments of the state of the roadway surfaces within their jurisdiction so that problematic areas can be identified and rectified in a timely manner. Nearly any highway agency can participate in implementing this strategy, which is applicable to rural, urban, and suburban areas. This strategy is complemented by effective stakeholder partnerships. Coordinating with a state/regional motorcycle advisory group will serve to inform the motorcycle community of this effort, and will provide a conduit for information to the agency of potential problem areas. Internet and web-based resources could be utilized for reporting problem locations, to maximize potential benefits.
Issues Affecting Implementation Time	Depending on the type of surface irregularity, this strategy can be implemented within a few days to a few months of identifying a surface irregularity. However, instituting a broad-based program may take well over a year.
Costs Involved	Costs involved will be those costs associated with increased maintenance and installation of advanced warning signs. Some training costs may also be experienced.
Training and Other Personnel Needs	Highway agency personnel may require training to understand the needs and capabilities of motorcyclists on roadways and to identify locations where surface irregularities may pose a safety problem for motorcyclists. If a highway agency chooses to develop a public reporting system, additional personnel and training may be necessary.
Legislative Needs	None identified.
Other Key Attributes	
Compatibility of Different Strategies	This strategy can be used in conjunction with most others for improving safety for motorcyclists.
Other Key Attributes to a Particular Strategy	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

Many cities have established "pothole hotlines" that allow road users to call a local number to report the presence of a pothole or surface irregularity. City officials then take that information and take appropriate actions to repair the pothole as quickly as possible. Example cities that have implemented this strategy include St. Louis, Missouri, and Durham, North Carolina. The Seattle Department of Transportation has a pothole hotline, as well as a web-based street maintenance request form in which riders can submit a request to repair potholes, street signs or other traffic controls. For more information, visit http://www.cityofseattle.net/transportation/potholereport.htm.

Strategy 11.1 A5—Maintain Roadway Surfaces in Work Zones to Facilitate Safe Passage of Motorcycles (T)

General Description

There is a continual process of upgrading and refurbishing our nation's roadway systems in order to meet the ever-increasing demand for traffic capacity and safety. During construction, it is important that the roadway surface allocated for traffic use is adequate for all users, including motorcyclists. Work zones often require that lanes be shifted or new surfaces be erected on an alternate route so that construction can be undertaken on the original road. During this process, it is essential that the traveled surface be kept free of obstructions and obstacles such as construction debris, extreme or unexpected surface undulations, temporary surface covers or markings that offer little or no traction for motorcycles (see Strategy 11.1 A3 for more information on utilizing high-traction surfaces), and significant surface elevation drops and rises generally occurring at joints between permanent roadway and temporary surfaces during the construction period.

It is important that roadway surfaces in work zones be maintained to facilitate safe passage of motorcycles. Roadway surface irregularities that are common in work zones, but that are problematic for motorcyclists, include the following:

- Pavement drop-offs are often abrupt and difficult to see (see Exhibit V-12). Signing is suggested.
- Gravel roads present a difficult riding surface for many motorcyclists, especially when loosely packed (see Exhibit V-13). Gravel on the roadway creates a traction problem, particularly in curves.
- Large temporary steel plates create an abrupt edge and a very slick surface (see Exhibit V-14). In low-light conditions, they are difficult to detect.

EXHIBIT V-12
Inconspicuous Pavement Drop-off Due to Repaving

EXHIBIT V-13
Gravel Road through Work Zone

EXHIBIT V-14
Temporary Steel Plate

- Pre-grinding of asphalt surfaces in preparation for paving creates an undulating surface and often a parallel ledge to the adjacent roadway.
- Large grooves, gaps or roadway seams parallel to the direction of travel can trap the tire(s) and cause a crash.

Possible countermeasures for some of these irregularities include the following:

- Repaving:
  - Provide a tapered edge that does not catch a motorcycle's tire.
  - Reduce the possibility of "edge traps" by paving no further in a day than can be paved back in the adjacent lane. This reduces the chance of a motorcycle hitting the pavement edge in low-light conditions.
- Steel plates:
  - Treat with non-slip surface material (see Exhibit V-15).
  - Treat edges with contrasting color for increased visibility (see Exhibit V-15).
  - Taper pavement to plate surface to reduce the risk of the edge catching a motorcycle's tire.

Where such surface irregularities are unavoidable, such as chip seal or pavement grinding, advance warning signs should be placed upstream of the problem area to alert motorcyclists of an impending roadway surface problem. For information on advance warning signs, see Strategy 11.1 A7. Alternate routes for motorcycles could be suggested, if possible.

EXHIBIT V-15
Steel Plate Example with Non-slip Surface and Contrasting Color

EXHIBIT V-16
Strategy Attributes for Maintaining Roadway Surfaces in Work Zones to Facilitate Safe Passage of Motorcycles

Technical Attributes	
Target	The target of this strategy is work zones, as well as the agencies and contractors responsible for maintaining safe operating conditions in work zones.
Expected Effectiveness	No quantitative estimates of the safety effectiveness of this strategy are available. However, providing a smoother, more continuous roadway surface is considered an effective step towards providing a more comfortable and safe environment for motorcyclists.
Keys to Success	The success depends to a large extent on there being policies and contractor requirements for maintaining motorcycle-friendly conditions throughout work zones. Policies for design traffic operation during construction can help avoid a problem occurring in the field. Requirements for contractors will minimize the exposure of motorcyclists to unsafe conditions that may result in spite of design policies. Regular inspection of work zones by the agency charged with oversight of contractors will facilitate compliance with the safety requirements for motorcycle-friendly conditions. Another key to success is the ability of agency and contractor field staff to identify surface irregularities and discontinuities in a timely manner, and either replace them with a motorcycle-friendly surface or provide advance warning signs.
Potential Difficulties	It may be difficult to convince key stakeholders, including contractors who are trying to keep schedule and cost down, that it is cost effective to invest in refinements to temporary conditions within work zones to accommodate a small volume of motorcycles. The tendency may be to treat the problem with warning and special speed control signs. A potential difficulty in successfully accomplishing this strategy lies in the fact that work zones inherently contain many discontinuous and varying surface types, among other factors, that present maneuvering challenges to motorcyclists. It will be important to educate field personnel at all levels of management about the problem motorcyclists have with certain roadway surfaces.
Appropriate Measures and Data	Key process measures include the number of agencies adopting desired policies, as well as of the number of work zones where adverse surface conditions have been avoided, either by providing an adequate riding surface at the beginning of construction/maintenance work or by treating existing roadway surface problems in a work zone. Crash frequency and severity, by type of crash, are key safety effectiveness measures. It is especially important to identify motorcycle crashes related to surface irregularities and analyze them separately. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to surface irregularities should be analyzed separately. Motorcycle traffic volume data are needed to represent exposure.
Associated Needs	There are no particular public information and education needs to be addressed when this strategy is implemented.

EXHIBIT V-16 (Continued)
Strategy Attributes for Maintaining Roadway Surfaces in Work Zones to Facilitate Safe Passage of Motorcycles

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Highway and other agencies should ensure that their design and work zone operations policies for new or reconstructed roadways consider the roadway surface needs of motorcycles. Highway agencies should regularly assess the condition of roadway surfaces in work zones so that problematic areas can be identified and corrected in a timely manner. Nearly any highway agency can participate in implementing this strategy, which is applicable to rural, urban, and suburban areas. This strategy is complemented by effective stakeholder partnerships. Highway agencies should coordinate with a state/regional motorcycle advisory group to inform the motorcycle community of this effort and provide a conduit for motorcyclists to inform the agency of potential problem areas. Internet and web-based resources could be utilized to inform motorcyclists of problematic roadway surface conditions and allow feedback from motorcyclists on potentially problematic conditions.
Issues Affecting Implementation Time	Policy changes may take as much as 1 year to implement. Additional time will be needed to train personnel and to implement the new policy within the organizational culture. Improvements to existing work zones may be completed within a few days unless major improvements are needed.
Costs Involved	Costs should be relatively low since this strategy deals mostly with remedial and preventative measures for current practices.
Training and Other Personnel Needs	Highway agency personnel should be trained to understand the needs and capabilities of motorcyclists on roadways and identify locations where surface irregularities may pose a safety problem for motorcyclists. They should also be trained in how to prevent or treat problematic roadway surfaces.
Legislative Needs	None identified.
Other Key Attributes	
Compatibility of Different Strategies	This strategy can be used in conjunction with most others for improving safety for motorcyclists.
Other Key Attributes to a Particular Strategy	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

The Virginia Department of Transportation (VDOT) formed a Motorcycle Safety Action Team to improve the conditions on Virginia highways for motorcyclists and to improve motorcyclists' understanding of VDOT and the local governments as operators of highways. For information, visit their website at http://www.virginiadot.org/programs/resources/3motorcycle.pdf.

Strategy 11.1 A6—Reduce Roadway Debris—Such As Gravel, Shorn Treads, Snow and Ice Control Treatments (Sand/Salt), and That Resulting From Uncovered Loads—From the Roadway and Roadside (T)

General Description

Roadway debris poses a greater problem for motorcycles than for larger vehicles. Debris can deflect a motorcycle's wheel when it is struck, causing the rider to lose control of the motorcycle. Debris such as sand, cinders, gravel and substances spilled from trucks (grain, sawdust, fuel oils, etc.) can cause a motorcyclist to lose traction and control. There are certain locations where debris is a particular problem for motorcycles, such as at horizontal curves (where insufficient traction can result in running off the road or motorcycle slide-out) or locations with limited maneuvering space (such that a rider is unable to negotiate around the debris). Exhibit V-17 illustrates a horizontal curve with roadway debris.

Common types of debris that pose a particular problem to motorcyclists include:

- Dirt, gravel, cinders or wood chips resulting from uncovered truck loads (Exhibit V-18)
- Dirt, gravel or mud introduced by cars entering a paved roadway from an unpaved roadway (Exhibit V-19)
- Sand or cinders remaining from winter snow and ice treatment
- Shorn tire treads (Exhibit V-20)
- Miscellaneous debris that cannot easily be traversed (i.e., mufflers, cardboard boxes, garbage, and mattresses)

Roadway debris affecting motorcycle traffic can be divided into two categories: that which is safely traversable and that which is not. For debris that can be safely traversed, such as dirt or gravel, the rider must be cautious to avoid actions requiring increased levels of traction (e.g., turning, lane changing, and braking). Larger objects, such as tire treads, rocks, displaced utility covers and other large roadway debris can appear from beneath the vehicle ahead, right in the path of the following motorcycle. These conditions present a very precarious condition for motorcycles.

EXHIBIT V-17
Roadway Debris on Curve

A self-reported survey of Australian motorcyclists conducted by de Rome et al. (2002) found that 67 percent of those involved in single-vehicle crashes and 56 percent of those involved in multiple-vehicle crashes pointed to loss of traction as a factor. Similarly, Haworth (1999) reported that surface traction played a part in 53 percent of all motorcycle crashes and directly contributed to

EXHIBIT V-18
Debris from Uncovered Truck Load

15 percent of motorcycle crashes. For all non-traversable debris, the key concerns for motorcyclists include (1) having sufficient sight distance to recognize the obstacle and perform necessary steering to avoid a collision and (2) having sufficient space within their traveled lane to avoid the object.

Potential solutions include integration of this strategy with a street repair and maintenance hotline. An agency can be notified immediately of the presence of the debris and take immediate action to remove it from the roadway or roadside. Coordination with other departments (e.g., snow and ice control treatments, city public works, etc.) may also lead to the development of a modified road sweeping schedule that could reduce the potential for roadway debris related to the activities of other roadway maintenance departments. In areas where sand, gravel or mud is repeatedly brought onto the roadway, consideration should be

EXHIBIT V-19
Dirt from Unpaved Roadway

EXHIBIT V-20
Shorn Tire Treads

given to paving a small portion (50 ft) of the problem section nearest the intersection. Larger debris items should be removed from the roadway surface as quickly as possible to avoid being struck by an unsuspecting motorcyclist.

Highway maintenance personnel should look for debris as part of routine inspections (see Strategy 11.1 A8 below). In addition, law enforcement and other public agency personnel that travel the roads frequently should be alerted to the problem, and provided instructions on how to deal with or report it. Highway agencies may want to first target high-crash locations and routes with high motorcycle volumes.

EXHIBIT V-21
Strategy Attributes for Reducing Roadway Debris—Such as Gravel, Shorn Treads, Snow and Ice Control Treatments (Sand/Salt), and That Resulting From Uncovered Loads—From the Roadway and Roadside

Technical Attributes	
Target	The target for this strategy is roadway surfaces where debris that is a potential problem for motorcyclists accumulates.
Expected Effectiveness	Reducing roadway debris should reduce motorcycle crashes attributed to roadway debris or poor roadway surfaces. However, no quantitative estimates of the safety effectiveness of removing roadway debris are available. Further research is needed to quantify the effectiveness of this strategy. This strategy should be supplemented with an effort to better educate motorcyclists on how to handle their vehicle when they encounter situations where debris is present. See Objective 11.1C.
Keys to Success	A key to the success of this strategy is developing practical debris removal programs that are implemented in a consistent and sustained manner. Once a program is established, it is important that highway agencies devote staff to the ongoing effort of identifying locations with debris and removing the debris. Roadway surfaces need to be continually monitored. Involvement of public agency personnel can also be valuable for identifying roadway debris hazards and reporting them. Effective sanctions applied to those who contribute to road debris are a key to success. There are many areas of the United States that currently assess a fine to vehicle operators found contributing debris to roadways. One form of this is the littering fine imposed on anyone found discarding materials on or along the road. Also, there are laws in place inflicting heavy fines on motor vehicle operators found transporting “uncovered” materials as illustrated above in Exhibit V-18. Provision of mechanisms to report, record, and manage information on road debris hazards will greatly facilitate further actions. Toll-free telephone numbers and websites dedicated to receiving reports are needed.
Potential Difficulties	The major difficulty associated with removing roadway debris is the sheer enormity of the task. Because debris is continually being deposited on the roadway surface and many highway agencies have many miles of roadway within their jurisdiction, it requires a major effort to effectively combat the problem. Another potential difficulty lies in gaining support for allocating adequate resources to regularly remove debris.

EXHIBIT V-21 (Continued)
Strategy Attributes for Reducing Roadway Debris—Such as Gravel, Shorn Treads, Snow and Ice Control Treatments (Sand/Salt), and That Resulting From Uncovered Loads—From the Roadway and Roadside

Appropriate Measures and Data	Key process measures include adoption or revision of policies that support this strategy, new budgets established to support the effort, person-hours devoted to the effort, and the number of locations at which roadway debris is removed. Crash frequency and severity are key safety effectiveness measures. Separate analysis of the crash types targeted by the improvement is desirable. The number of motorcycles potentially affected by the debris removal may be used as a surrogate measure of effectiveness, at least until crash statistics become available. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to roadway debris should be analyzed separately. Traffic volume data are needed to represent exposure, particularly exposure in the areas in which the roadway debris is typically located.
Associated Needs	The major needs associated with this strategy are mechanical equipment and manpower required to remove roadway debris.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Highway agencies should consider the adoption of roadway debris removal as standard maintenance practice for roadways with moderate to high motorcycle volumes. The involvement of other public agency personnel, who drive the roads regularly, should be sought in a cooperative venture. This would require interagency contact and cooperation. Nearly any highway agency can make use of this strategy.
Issues Affecting Implementation Time	Implementation of this strategy is an ongoing effort rather than a one-time treatment. Initial implementation, including policies, interagency cooperation, introductory training, establishment of reporting centers, and management information systems could require as much as 1 year to accomplish.
Costs Involved	Costs are highly variable, depending on the extent of the system implemented, and the amount of debris typically found on the roadways in a jurisdiction. Again, this is an ongoing effort, so the costs will be ongoing.
Training and Other Personnel Needs	Limited introductory training may be needed for those being asked to report and address roadway debris.
Legislative Needs	Laws, or revisions thereto, may be needed to establish sanctions for those who cause debris on roadways.
Other Key Attributes	
	None Identified.

Strategy 11.1 A7—Provide Advance Warning Signs to Alert Motorcyclists of Reduced Traction and Irregular Roadway Surfaces (T)

General Description

Advance warning signs inform motorists of reduced traction and irregular roadway surfaces. Such signs require caution on the part of the driver and may call for a reduction in speed or other maneuver. Advance warning signs are typically geared to all types of vehicles and do not typically address one particular vehicle type. The exception to this is advance warning signs that specifically address large trucks (e.g., truck-tipping signs that warn trucks of a sharp horizontal curve, signs that warn trucks of a steep grade ahead, etc.).

Another group of roadway users that could benefit from advance warning signs is motorcyclists. There are a number of roadway conditions that are potentially problematic for motorcyclists. With proper advance warning, motorcyclists can take necessary steps to safely negotiate through those conditions. Advance warning signs for motorcyclists should be considered for the following situations:

- *Where speed may have to be reduced*—Roadway surface irregularities (e.g., gravel, uneven pavement, longitudinal grooves, steel grate bridge deck, and pavement ending) and reduced traction surfaces (e.g., water across roadway, moss in perpetual wet and shaded areas) may require a reduction in speed (see Exhibit V-22).
- *Where lateral placement is limited or may have to be modified*—Roadway surface irregularities (e.g., gravel, uneven pavement, longitudinal grooves and gaps) and wind gust areas may require a change in lateral placement (see Exhibit V-23).
- *Potential conflict zones*—Anywhere that surface traction or stability may be compromised (e.g., gravel, oil treatments, longitudinal differences in pavement elevation) represents a potential conflict zone.
- *Work zones*—The frequency of steel plates, gravel, sand, uneven pavement, and longitudinal grooves in construction and work zones make these areas particularly problematic for motorcyclists.

EXHIBIT V-22
Grooved Pavement Warning Sign

EXHIBIT V-23
Irregular Roadway Surface and Advance Warning Sign

Advance warning signs in these situations may be beneficial for all drivers. However, due to the unique characteristics of motorcycles, it is particularly important that advance warning signs be placed well in advance of the location with reduced traction or irregular roadway surface to provide motorcyclists with sufficient time to react appropriately. Highway agencies may want to first target high-crash locations and routes with high motorcycle volumes. Exhibit V-24 illustrates an example of an advance warning sign geared to motorcyclists. Further research should be conducted to determine the feasibility of developing a series of basic motorcycle warning signs that could be integrated into the MUTCD.

EXHIBIT V-24
Advance Warning Sign for Motorcyclists

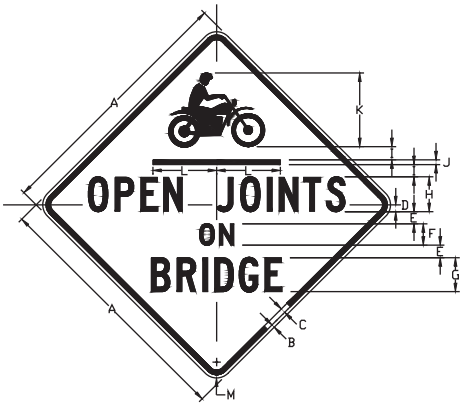


EXHIBIT V-25
Strategy Attributes for Providing Advance Warning Signs to Alert Motorcyclists of Reduced Traction and Irregular Roadway Surfaces

Technical Attributes	
Target	The target of this strategy is locations with reduced traction or irregular roadway surfaces that cannot be otherwise mitigated.
Expected Effectiveness	The effectiveness of this strategy in reducing crashes has not been satisfactorily quantified. Nevertheless, there is a general consensus that advance warning signs can help reduce confusion and maximize perception/reaction time at locations with reduced traction or irregular roadway surface. Further research to develop safety effectiveness measures for this strategy is desirable.
Keys to Success	A key to success in applying this strategy is to identify appropriate locations that would benefit from advance warning signs. The location of the sign is important because advance warning signs that are placed either too far or not far enough in advance of a problematic roadway condition will make the signing less effective. Table 2C-4 in the MUTCD (http://mutcd.fhwa.dot.gov/kno-millennium.htm) presents guidelines for advance placement of warning signs relative to the type of roadway condition and the posted or 85th-percentile speed on the roadway. Advance warning signs should be applied with consistency and uniformity. Engineering judgment should, where possible, be accompanied by a human factor assessment of the need for advance warning signs. Cooperation between agencies will also be a key to success since one agency will be responsible for identification of the problematic roadway condition and the development of appropriate signage while another agency will be responsible for installation. Another key to success is the ability and commitment of the highway agency to adequately maintain the signs.
Potential Difficulties	Care should be taken not to overuse advance warning signs, and to place appropriate distance between the different signs. The objective is not to overload the driver with information so that the signs become the cause of confusion. Agencies should strive to use advance warning signs only where a special problem or circumstance indicates the need, and to maintain a certain consistency and uniformity to their application.

EXHIBIT V-25 (Continued)
Strategy Attributes for Providing Advance Warning Signs to Alert Motorcyclists of Reduced Traction and Irregular Roadway Surfaces

Appropriate Measures and Data	Key process measures are the number and type of advance warning signs placed, or the number of locations for which advance signing is provided. Crash frequency and severity, by type, are key safety effectiveness measures. Both total crashes and crash types potentially affected by the use of advance warning signs should be analyzed separately. Geographic analysis of crash location can lead to the identification of "black spots" where countermeasures may be most useful. Driver behavior (e.g., erratic maneuvers, near misses, conflicts) may be used as surrogate safety measures. Traffic volume data are needed to represent exposure.
Associated Needs	None identified.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Adoption of new highway signs should proceed through the normal MUTCD process before being widely used. It is possible that some pilot testing can be done at the state or local level, but under strictly controlled conditions and using a valid evaluation design. Nearly any highway agency can participate in the implementation of this strategy. State highway agencies that implement this strategy may serve as a role model for local agencies, even to the extent of developing a "best practices" manual for local agencies to use in making decisions about providing advance warning signs. A general policy may need to be developed to provide the foundation for a long-term and consistent commitment to the strategy. This strategy is complemented by effective stakeholder partnerships. Coordinating with a motorcycle advisory group will serve to inform the motorcycle community of this effort, and will provide a conduit for information to the agency of potential problem areas.
Issues Affecting Implementation Time	This strategy does not require a long development process. Signing improvements can typically be implemented in 3 months or less. Policy development and adoption, if required, could extend the implementation period.
Costs Involved	Short-term costs for implementing this strategy include the cost of the signs themselves. Longer-term costs include the cost to maintain the signs.
Training and Other Personnel Needs	Training regarding use of this strategy should be provided in highway agency training courses concerning the use of traffic control devices, including the special needs of motorcyclists.
Legislative Needs	None identified.
Other Key Attributes	
Compatibility of Different Strategies	This strategy can be used in conjunction with most other strategies for improving safety.
Other Key Attributes to a Particular Strategy	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

The Oregon Department of Transportation posts motorcycle-specific signs warning motorcyclists of changing roadway conditions, such as "Rain Grooves Ahead." The New Hampshire Department of Transportation also posts motorcycle-specific warnings. The Virginia Department of Transportation formed a Motorcycle Safety Action team to (1) heighten awareness of motorcyclists with resident engineers, (2) add language to the VA Work Zone Protection Manual and classroom training, (3) create signs for longitudinal joints, (4) create signs for certain transverse (expansion) joints, (5) meet with various utility providers regarding hazards for motorcyclists, (6) develop an informational flyer for distribution, and (7) evaluate an anti-skid treatment for steel plates. For information, visit their website at http://www.virginiadot.org/programs/resources/3motorcycle.pdf.

Strategy 11.1 A8—Incorporate Motorcycle Safety Considerations into Routine Roadway Inspections (E)

General Description

Typically, highway agencies perform a routine visual site investigation of the entire roadway network within their jurisdiction. The investigator reviews the condition of such roadway elements as pavement, pavement markings, traffic signs, traffic signals, and roadside elements (including guide rail) to identify potential problems and repair needs. While the investigation may be conducted with all vehicles in mind, it is more likely that the unique characteristics and needs of motorcycles are not thoroughly considered. Previous strategies have identified a number of roadway conditions (i.e., surface irregularities and discontinuities) that may not be a problem for motor vehicles, but are problematic for motorcyclists, including:

- Roadway debris such as tire treads, rocks, mufflers and other large objects that can cause loss of stability and control.
- Roadway debris such as sand, gravel, mud and moss that can cause a loss in traction.
- Temporary surface treatments such as gravel roads and culvert fills, steel plates, abrupt pavement drops and rises can erode with time and become increasingly problematic for motorcycles.

Such roadway surface problems should be identified by highway agency personnel through routine roadway inspections. In fact, motorcycle considerations could be incorporated into maintenance management systems.

EXHIBIT V-26
Strategy Attributes for Incorporating Motorcycle Safety Considerations into Routine Roadway Inspections

Technical Attributes	
Target	The strategy is targeted at maintenance and other personnel who periodically conduct inspections of roads in their jurisdiction.
Expected Effectiveness	No quantitative estimates of the safety effectiveness of this strategy are available. However, identifying and fixing roadway conditions that are problematic for motorcyclists would be considered an effective step towards providing a more comfortable and safe environment for motorcyclists.

EXHIBIT V-26 (Continued)
Strategy Attributes for Incorporating Motorcycle Safety Considerations into Routine Roadway Inspections

Keys to Success	The key to success is identifying problematic roadway conditions in a timely manner and conducting a high-quality repair. Establishing policies and procedures within the agencies will be important to success. It will also be helpful for efforts to be made to sensitize staff to hazards faced by motorcyclists.
Potential Difficulties	The greatest difficulty is developing the skills and perspectives necessary for the personnel responsible for roadway inspections to recognize potential conflict areas for motorcyclists. Another potential difficulty is overcoming the tendency of highway agencies to assume that the needs of all single-track vehicles (e.g., motorcycles and bicycles) are the same. The needs of motorcycle riders are very different from those of bicycle riders and should not be grouped together.
Appropriate Measures and Data	Key process measures include documenting the existence of the desired policies and the number of locations where adverse roadway conditions have been corrected. Crash frequency and severity, by type of crash, are key safety effectiveness measures. It is especially useful to identify crashes related to poor roadway conditions and analyze them separately. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to poor roadway conditions should be analyzed separately. Motorcycle traffic volume data are needed to represent exposure.
Associated Needs	None identified.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	This strategy depends on adequate training of highway agency inspection personnel to properly identify roadway conditions that are problematic for motorcyclists. This strategy also depends on allocation of funds to conduct repairs. Nearly any highway agency can participate in implementing this strategy. This strategy is complemented by effective stakeholder partnerships. Coordinating with a motorcycle advisory group can serve to inform the motorcycle community of this effort and provide a conduit through which motorcyclists can inform the agency of potential problem areas.
Issues Affecting Implementation Time	Establishing policy and procedures may take as long as 6 months to 1 year, including time to inform and train personnel to implement any changes. It is likely that repairs can be implemented within a few days to a few months of identifying the problem.
Costs Involved	The costs involved in this strategy depend largely on the extent of problems identified and corrected.
Training and Other Personnel Needs	Highway agency personnel should be trained to identify roadway conditions that are problematic for motorcyclists, and instructed on how to correct them.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Strategy 11.1 A9—Provide a Mechanism for Road Users to Notify Highway Agencies of Roadway Conditions That Present a Potential Problem to Motorcyclists (E)

General Description

A number of roadway conditions (i.e., surface irregularities and discontinuities) that are problematic for motorcyclists have been identified in previous strategies within this objective. Such roadway surface problems should be identified by highway agency personnel through routine roadway inspections, as discussed in Strategy 11.1 A8. However, regularly inspecting all roadway miles within their jurisdiction is a daunting task for highway agency personnel, and it is possible that a surface irregularity (e.g., pothole, gravel, etc.) may go unnoticed for several days. Motorcyclists, on the other hand, are very adept at recognizing surface irregularities that are problematic for them. Therefore, highway agencies would benefit from having a mechanism (e.g., toll-free number, website, etc.) whereby motorcyclists or other roadway users can report roadway surface problems. A toll-free number could be answered by a member of the highway agency staff or it could provide a voicemail for callers to leave a message. Of course, voicemail left at the toll-free number or email sent to a website would need to be checked regularly and in a timely manner by highway agency staff.

EXHIBIT V-27
Strategy Attributes for Providing a Mechanism for Road Users to Notify Highway Agencies of Roadway Conditions That Present a Potential Problem to Motorcyclists

Technical Attributes	
Target	The strategy is targeted at road users who may want to report hazardous conditions for motorcyclists to the responsible agency.
Expected Effectiveness	No quantitative estimates of the safety effectiveness of this strategy are available. However, providing a smoother, more continuous roadway surface would certainly be considered an effective step towards providing a more comfortable and safe environment for motorcyclists.
Keys to Success	If the reporting system is to be used, road users must be made aware of it. Success will also depend upon how timely and appropriately the agency responds to reports of problematic roadway conditions.
Potential Difficulties	Potential difficulties include malfunctioning of the mechanism (i.e., website goes down, data are not managed properly) and poor response time to reported problems. Also, there is a potential tort liability issue with this strategy that would need to be resolved within the highway agency. That is, once an agency is put on notice of a problem, they may be considered liable; should they not address the problem in a timely manner, there is an increased risk of a successful lawsuit from someone encountering the problem.
Appropriate Measures and Data	Key process measures include documentation of the establishment of a road-user reporting system, the number of reports received, the number of locations checked, and the number of locations where adverse roadway conditions have been corrected.

EXHIBIT V-27 (Continued)
Strategy Attributes for Providing a Mechanism for Road Users to Notify Highway Agencies of Roadway Conditions That Present a Potential Problem to Motorcyclists

	Crash frequency and severity, by type of crash, are key safety effectiveness measures. It is especially important to identify crashes related to poor roadway conditions and analyze them separately. Crash frequency and severity data are needed to evaluate such improvements. If feasible, both total crashes and crashes related to poor roadway conditions should be analyzed separately. Motorcycle traffic volume data are needed to represent exposure, particularly in areas where road maintenance problems have been reported.
Associated Needs	None identified.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	This strategy depends on the allocation of key resources (i.e., money and staff) to receive, manage, and respond to reports of problematic roadway conditions. Attempts may be made to add the activity of receiving and managing reports to staff that are already very busy. If the effort is going to be effective, the reports need to be handled in an expeditious manner. Nearly any highway agency can participate in implementing this strategy. This strategy is complemented by effective stakeholder partnerships. Coordinating with a motorcycle advisory group can serve to inform the motorcycle community of this effort and provide a conduit for motorcyclists to inform the agency of potential problem areas.
Issues Affecting Implementation Time	It may take 6 months to establish the system for receiving and managing the reports. The timeframe required for reacting to reports, once received by maintenance personnel, will depend upon the nature of the roadway problem reported. It is likely that repairs can be implemented within a few days to a few months of identifying the problem.
Costs Involved	The costs involved in this strategy depend largely on the nature of the problem reported. Establishing a call-in number and a website, along with software to enter and manage the reports, should be relatively low-cost. However, some equipment may be needed to facilitate this strategy.
Training and Other Personnel Needs	Highway agency personnel should be trained to work the “hotline” mechanism—to receive and quickly respond to reported problems, as well as monitor progress to ensure response and quality control.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

Many cities and regions have implemented pothole hotlines and Internet-based notification systems. Some examples include:

St. Louis, Missouri
http://stlcin.missouri.org/release/getpressdetails.cfm?Auto=670

Durham, North Carolina
http://www.ci.durham.nc.us/departments/works/pothole.cfm

Seattle, Washington
http://www.cityofseattle.net/transportation/potholereport.htm

Additionally, motorcyclist groups and organizations have created reporting resources for their memberships that include the phone numbers or websites of various highway agencies within a specific district or region. Members report roadway problems they encounter while on the road. Oregon's Governor's Motorcycle Safety Advisory Committee created a business card-sized resource listing the phone numbers of the major highway districts in Oregon. These cards were made available to motorcyclists across the state through motorcycle dealers and clubs.

Objective 11.1 B—Reduce the Number of Motorcycle Crashes Due to Rider Impairment

Strategy 11.1 B1—Increase Motorcyclist Awareness of the Risks of Impaired Motorcycle Operation (T)

General Description

Riding a motorcycle while under the influence of alcohol, drugs or other intoxicants is a leading cause of fatal crashes involving motorcycles. While alcohol involvement in motorcycle crashes has shown a steady decline (from 49 percent in 1992 to 27 percent in 2006), over one-third of operators (36 percent) involved in fatal crashes were found to have been drinking prior to the crash (FARS, 2006). Alcohol involvement among motorcycle crashes is higher than crashes involving other vehicle types (FARS, 2006). In 2006, almost one-half (41 percent) of all motorcycle riders who died in single-vehicle crashes were intoxicated (i.e., blood alcohol content of 0.08 g/dL or greater), and almost two-thirds (59 percent) of those killed in single-vehicle crashes on weekend nights were intoxicated (FARS, 2006). Clearly, the operation of a motorcycle combined with alcohol or other substances can lead to deadly consequences for motorcycle riders and passengers.

The *National Agenda for Motorcycle Safety* (NAMS) provides guidance for enhancing motorcycle safety at the national, state, and local levels. Based on information and ideas from a broad, multidisciplinary spectrum of stakeholders, as well as the most objective data available, a number of proposals for improving motorcycle safety were developed and categorized into three groups: urgent, essential, and necessary. One of the "urgent" items that addresses the problem of alcohol and other impairments as they relate to motorcycle safety is the following: Continue to discourage mixing alcohol and other drugs with motorcycling.

The following points were identified as essential:

- Study how alcohol, drugs and other substances, including over-the-counter medications, can affect a motorcyclist's operating skills
- Study the alcohol, drug, and other substance use patterns of motorcyclists
- Educate law enforcement about unique alcohol-related behavior of motorcyclists
- Encourage partnerships with groups already involved in alcohol/substance abuse issues related to motor vehicle crashes, e.g., Mothers Against Drunk Driving (MADD), Students Against Destructive Decisions (SADD)

Motorcycles require a greater level of finesse and skill to operate than automobiles or small trucks. Because they are single-track vehicles, motorcycles have to be balanced at a stop and are less stable at low speeds. Operating a motorcycle requires the coordinated use of both hands and both feet. Riders are exposed to the elements which, after extended exposure, can dull the rider's senses. Motorcycles are harder to see in traffic, a condition amplified in low light conditions. With the amount of skill and attention required to safely operate a motorcycle, anything that impairs concentration, coordination, and judgment can be fatal.

The article "Finding Fault in Motorcycle Crashes in Hawaii: Environmental, Temporal, Spatial and Human Factors" (Kim, 2001) identifies the following factors:

> Factors that increase the odds of a motorcyclist being at-fault in a collision include if the motorcyclist was inattentive, or exhibited misjudgment, engaged in speeding or improper overtaking, or followed too closely. Drivers were more likely to be at-fault if they exhibited inattention or misjudgment, they failed to yield, or their vision was impaired. Alcohol-impaired drivers were 16.9 times more likely than sober drivers to be classified at-fault. While turning actions also increased the odds of a driver being at-fault, accidents occurring on curved roads increased the odds of the motorcyclist being classified at-fault.

The *National Agenda for Motorcycle Safety* (NHTSA, 2000) lists some additional factors.

> The effects of prescription, over-the-counter, and illegal drugs are unknown as they relate to motorcycle crashes. The dulling affects of extended exposure to the elements (heat, cold, wind, rain, etc), or the effect of other impairments such as drowsiness, allergies, etc. are known to play a role in crashes, but these relationships have not been studied in detail.

Most transportation safety measures target motorists and fail to consider the unique conditions faced by the motorcycle riding population. Transportation safety practitioners should examine statewide/regional crash data to determine the extent of the problem that a state or region faces with impaired motorcycle operation, including the use of drugs other than alcohol. Findings should be incorporated into the highway agency safety plan. Enforcement officials should be advised and trained in how to recognize impaired motorcycle operators. Public information programs should be designed to (a) target the demographic over-represented in motorcycle crashes, (b) inform the public of the problem of impaired motorcycle operation, and (c) foster and promote the safe and responsible use of motorcycles.

The report, *Drinking, Riding, and Prevention: A Focus Group Study* (Becker et al., 2003) explores effective prevention and intervention approaches for dealing with the drinking rider problem. The findings indicate:

- Riders often discourage their peers from riding after drinking, but a culturally reinforced respect for rider freedom and individual responsibility sets boundaries for peer actions.

- Rider concern for the safety and security of the motorcycle itself nearly always overshadows concern for individual safety and contributes to drinking and riding. That is, motorcyclists are less inclined to abandon their motorcycle to accept a ride home than motor vehicle drivers are to abandon their vehicle.
- Motorcycle impoundment and court-ordered payment of costs for vehicle storage, alcohol treatment programs, and other costs are considered persuasive countermeasures.

The report concludes that "the results suggest that future drinking-and-riding prevention efforts should incorporate peer approaches and social norms modeling. Crisis Intervention Techniques may be valuable in preventing already impaired riders from operating their motorcycles."

Success in this strategy requires a coordinated effort among government, motorcycle users, and law enforcement to identify problem areas and times. A comprehensive plan of public information, education, enforcement and intervention should be developed.

EXHIBIT V-28
Strategy Attributes for Increasing Motorcyclist Awareness of the Risks of Impaired Motorcycle Operation

Technical Attributes	
Target	The primary target is the population of motorcycle operators, especially those that are over-represented in motorcycle crashes in the state/region.
Expected Effectiveness	No formal evaluation has been conducted to determine the effectiveness of this strategy at reducing motorcycle fatalities.
Keys to Success	Success in this strategy requires a coordinated effort among government, motorcycle users, and law enforcement to identify problem areas and times. This stakeholder group should work together to fully understand the scope of the problem, the target audience, and available community resources. Law enforcement and judicial communities should be involved to help develop methods to increase awareness of impaired operation, implement solutions and enforce violations. Motorcycle safety advisory and advocacy groups should be enlisted to provide key support and leadership to the motorcycling community. Drug recognition evaluators (DRE) should be among the key stakeholders involved with this initiative. A comprehensive plan of public information, education, enforcement and intervention should be developed. Examples include: • Media and/or Public Service Announcement campaign • DRE training for motorcycle safety instructors/program personnel • Development of educational materials targeting motorcyclists • Drinking/drugs/riding meetings or conferences with the motorcycling community leaders, DRE and other key stakeholders • Enhanced enforcement training, awareness and support Public information and education campaigns should be targeted to the local demographic over-represented in alcohol-related crashes. The Motorcycle Safety Foundation (MSF) has created a set of alcohol awareness ads in a variety of sizes and formats. MSF provides these ads free of charge.

EXHIBIT V-28 (Continued)
Strategy Attributes for Increasing Motorcyclist Awareness of the Risks of Impaired Motorcycle Operation

Potential Difficulties	A potential difficulty with this strategy is accurately targeting the appropriate group of motorcyclists. That is, it may be difficult for highway agencies, and the group of stakeholders with which they are working, to identify where motorcyclists congregate and can be expected to view the public information material.
Appropriate Measures and Data	Increased awareness among the community of transportation safety specialists, data analysts, and policy makers is one appropriate measure of expected effectiveness. Reliable data are needed for both program operation and program evaluation. The representation of alcohol and other drugs in motorcycle crash data should be identified. Data on crash involvement of motorcycle operators should be monitored and measured against baseline data. Findings should be shared with key stakeholders and support enlisted. Specific deterrence measures should include statewide/regional analysis of the following variables: • Number of motorcycle crashes • Location of motorcycle crashes • Crash type comparison—single-vehicle versus multi-vehicle • Crash type comparison with +BAC • Number of fatalities, percentage with +BAC • Time of crash, percentage daytime versus nighttime +BAC • Representation of other drugs • Representation of unlicensed/unendorsed riders, percentage with +BAC • Age of impaired/under influence operation, age group(s) over-represented • Baseline comparison of above indicators to other vehicle types Program countermeasures, such as public information and education programs, should include methods to evaluate program effectiveness. Police and court systems should track citations and convictions for motorcycle operators found driving under the influence of intoxicants (DUII). The agency's FARS specialist should track and publish statewide annual motorcycle crash statistics that include the number of crashes where alcohol has been involved.
Associated Needs	The media play a critical role in information dissemination. Special public information and education programs are necessary to supplement the improvement program. Alliance with the motorcycle community will provide contacts with key stakeholders, event notification and access to the targeted demographic.

EXHIBIT V-28 (Continued)
Strategy Attributes for Increasing Motorcyclist Awareness of the Risks of Impaired Motorcycle Operation

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees comprise motorcycle leaders, authorities and activists from across the state, and include representatives from state police, DMV, transportation safety and the state's motorcycle safety program. Partnering with MSAC groups is essential to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community.
Issues Affecting Implementation Time	A public awareness campaign aimed at motorcyclists should be targeted around the prime riding season, when public awareness material can be distributed at locations where motorcyclists are most likely to be congregating (e.g., riding events, etc.). Highway agencies need to begin working on this strategy well in advance of the prime riding season in order to have the public awareness campaign ready.
Costs Involved	The costs associated with increasing the awareness of impaired motorcycle operation can vary widely, depending on the scope of activities. At a minimum, key personnel should be assigned to coordinate the treatment by working with data analysts, statisticians, safety practitioners, licensing and enforcement personnel and the motorcycle community. There will also be costs associated with a public information campaign.
Training and Other Personnel Needs	Increasing the awareness of impaired motorcycle operation does not require training or additional agency personnel, but it does require awareness of the problem by personnel assigned to treat drinking and driving issues, a priority to take corrective action, and a willingness to partner with key stakeholders to begin the process of effecting change. Support of the Drug Recognition Expert (DRE) program is important. DRE trainers can educate the stakeholder group on the effects of drugs/alcohol on a rider's ability to operate a motorcycle safely. The DRE trainers can provide necessary education and information for motorcycle safety personnel/instructors and at advisory committees and motorcyclist group/club meetings.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

EXHIBIT V-29
MSF Advertisement

Information on Agencies or Organizations Currently Implementing This Strategy

The National Association of State Motorcycle Safety Administrators (SMSA) collects samples of campaigns, advertisements, billboards, posters, brochures and bumper stickers that several states have used to treat the impaired riding problem. Contact SMSA for more information: http://www.smsa.org/motorcycle_awareness/promotional_materials/.

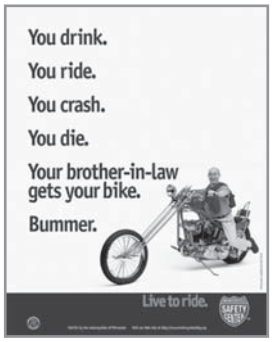
The Motorcycle Safety Foundation (MSF) has developed drinking and riding public service announcements (PSAs) for print and web applications in a variety of sizes and formats and will provide them at no cost to the state. Contact the MSF for more information: http://msf-usa.org.

Riders Helping Riders (RHR) is an instructional program developed by NHTSA designed to encourage motorcyclists to intervene to prevent drinking and riding by their motorcyclist peers. The program provides a "toolkit" of techniques for separating drinking from riding, discouraging riders from becoming impaired, recognizing impairment, and discouraging impaired riders from riding. More information can be found on NHTSA's website: http://www.nhtsa.dot.gov/portal/site/nhtsa/template.MAXIMIZE/menuitem.d7975d55e8abbe089ca8e410dba046a0/?javax.portlet.tpst=4670b93a0b088a006bc1d6b760008a0c_ws_MX&javax.portlet.prp_4670b93a0b088a006bc1d6b760008a0c_viewID=detail_view&itemID=0d6576ca7dcb8110VgnVCM1000002fd17898RCRD&overrideViewName=Article.

EXHIBIT V-30
AMA Advertisement

The American Motorcyclist Association (AMA) has partnered with NHTSA to create, broadcast and support campaigns that address the drinking rider problem. The website below features a wide range of educational and informational resources, in

EXHIBIT V-31
Samples of Minnesota Public Information Materials



addition to links to other motorcycle safety programs: http://www.ridestraight.com.

Various states have created public information materials and campaigns targeting the drinking rider.

- Oregon: http://www.oregon.gov/ODOT/TS/
- Connecticut: http://www.ride4ever.org/
- Missouri: http://www.mmsp.org/index.php?option=com_content&task=view&id=28&Itemid=47
- Minnesota: http://www.motorcyclesafety.state.mn.us/

For more information on state motorcycle safety activities, visit the SMSA website: http://www.smsa.org/index.php.

Strategy 11.1 B2—Expand Existing Impairment Prevention Programs to Include Motorcycle Riders and Specific Motorcycle Events (T)

General Description

Many motorcyclists accept the risk of riding in exchange for the perception of freedom and adventure. The popularity of motorcycling has soared, spawning the promotion of rider groups, rallies and events. Motorcycle-related functions have increased in number and size, and are scheduled year-round throughout the United States. A visit to the AMA website (http://www.amadirectlink.com/news.asp) yields 25 different types of riding events, from Bike Show to Fun Run, Poker Run, and the Gypsy tour. Some manufacturers promote riding by sponsoring riding groups and events. An example of the strength of group affiliation and brand loyalty can be witnessed in the motorcycle industry's rider group. The Harley Owner's Group (HOG) is the largest group, with over 800,000 members around the world. Honda's Rider Club of America (HRCA) boasts a membership of 300,000 members. Other rider organizations not operated by the marquee include BMW Owners of America, the Gold Wing Road Riders Association, and the Yamaha Royal Star Touring and Riding

Association, to name a few. A variety of niche groups also exist, such as: Women on Wheels, Christian Motorcycle Association, Antique Motorcycle Club of America, or the Blue Knights Enforcement Motorcycle Club.

Hundreds of sponsored rides, rallies and motorcycling events are held each year and in every state. They are typically scheduled during the summer and can attract thousands of riders. A good reference is http://motorcycleevents.com. While these events are fun for motorcycle riders, the presence of alcohol at some of these events can bring about an increase in alcohol-related motorcycle crashes. According to *Analysis of Alcohol-Related Motorcycle Crashes in Florida and Recommended Countermeasures* (Turner and Georggi, 2001):

> Approximately one-third of all alcohol-related motorcycle crashes in Florida occur in the springtime months (March through May). March has the highest proportion of alcohol-related crashes (13 percent), which may be related to annual motorcycle events (Bike Week) held in Florida during that month. More motorcyclists were killed at Bike Week 2000 (11 motorcyclists died) than during any other time in the event's 59-year history (Tampa Tribune, 2000). Thus, it may be worthwhile to intensify efforts to promote responsible riding well in advance of the annual motorcycle event.

The report also states that, "The cumulative effect of vehicle, road, and environmental factors in alcohol-related motorcycle crashes is negligible which suggests that human factors play a greater role in motorcycle-alcohol crashes than factors associated with the vehicle, road and the environment surrounding the crash."

The effect of such events on the community health care system can be staggering, as described in *Epidemiology of Mass Casualties during Bike Week 2000, Daytona Beach, Florida* (Kanny et al., 2003).

> Although fatalities first called attention to the problem, nonfatal injuries outnumbered fatalities 20:1. The manpower resources of civil service and health resources could become overwhelmed or exhausted in circumstances in which many people are injured or killed throughout a relatively long period. The situation deserves future study. Better risk factor surveillance is needed to help prevent crashes.

EXHIBIT V-32
Crash, Injury and Death Frequency by Study Period
Source: Kanny et al., 2003

*Crash, injury, and death frequency by study period.**

	Bike Week 2000		Bike Week 1999	
Characteristics	**No.**	**%**	**No.**	**%**
People involved	570	100	387	100
Crashes	281		201	
Deaths	11	2	5	1
Hospitalizations	72	13	55	14
ED visits	147	26	108	28
Total injured	230	40	168	43
Uninjured	340	60	219	57

* Percentages may not add up to 100% because of rounding.

Many groups and organizations meet in bars and taverns. Some groups sponsor tavern-to-tavern rides, and some rallies find a large percentage of attendees relaxing in bars and beer gardens. In fact, the alcoholic beverage industry has even sponsored motorcycle events.

In recent years, some organizers have taken steps to curb drinking and riding by hosting activities and events such as concerts, parades, bike shows, swap meets, guided tours, etc. Some groups prohibit alcohol while others close the gates at the end of the day to prevent participants from riding away after drinking. Others provide free shuttle service. Both riders and event organizers have taken action to curb drinking and riding because no one wants avoidable injury or fatal crashes due to alcohol to occur. However, much ground can be gained in the fight to reduce the number of alcohol-related crashes, injuries, and fatalities by partnering with event organizers to keep the event safe and enjoyable.

A highway agency can target this audience by coordinating with key stakeholders and event planners to foster and promote responsible viewpoints on drinking and riding. With thousands of riders descending upon a community or region, the potential for crashes and injuries is magnified. Awareness and early action can reduce injuries and fatalities. Personnel currently involved in drinking/driving programs for motorists should expand those programs to include motorcyclists and partner with event organizers and other stakeholders to promote a safe event.

EXHIBIT V-33
Strategy Attributes for Expanding Existing Impairment Prevention Programs to Include Motorcycle Riders and Specific Motorcycle Events

Technical Attributes	
Target	The target for this strategy includes motorcycle riders, promoters and organizers of motorcycle rallies and events, law enforcement, and transportation safety personnel.
Expected Effectiveness	There have been no formal evaluations of the effectiveness of this strategy. However, with a large concentration of riders traveling key routes to and from events, the opportunity to enhance safety and promote responsible riding has never been better.
Keys to Success	Keys to success lie in forming strategic alliances with the motorcycling community, such as with a motorcycle safety advisory committee. This community can work closely with the highway agency to (a) inform and include the agency in event planning and (b) identify countermeasures and create opportunities for the agency to treat the drinking/riding problem. Team members should be drawn from enforcement, engineering and highway agency transportation safety and motorcycle safety officials, as well as members of the motorcycling community responsible for events. Officials currently involved in alcohol/drug crash prevention programs should be involved.
Potential Difficulties	Potential reluctance of the highway agency to capitalize on this opportunity presents the greatest difficulty, as the activity may be seen as simply an enforcement issue. Transportation safety officials who are treating the drinking/driving problem may not be aware of the extent of the drinking/riding problem for motorcyclists and may lack the necessary resources to treat the issue. Active partnering with the motorcyclists and highway agency motorcycle safety specialists is the first step in problem identification and treatment.

EXHIBIT V-33 (Continued)
Strategy Attributes for Expanding Existing Impairment Prevention Programs to Include Motorcycle Riders and Specific Motorcycle Events

Appropriate Measures and Data	Reliable data are needed for both program operation and program evaluation. Identify the presence of regional riding events and determine expected attendance per event. Establish baseline data by researching motorcycle crash history (frequency and severity) associated with the time and location of the event(s). Identify the representation of alcohol and other drugs in these data. Compare these data with present data before, during, and after the event. Specific measures should include: • Name, affiliation and location of all known riding events statewide • Number of contacts made with stakeholders and event organizers • Number of events where partnering strategy is employed o Number of event attendees o Number of motorcycle crashes in the region where event is taking place o Number of fatalities o Representation of alcohol o Representation of other drugs o Representation of impaired operation (0.01-0.07 BAC) o Time of day o Location of crashes o Rider age of impaired/under the influence operation Program countermeasures, such as public information and education programs, should include measures to determine the effectiveness of the message and effort. Police and court systems should track citations and convictions for motorcycle operator DUII.
Associated Needs	None identified.

Organizational and Institutional Attributes

Organizational, Institutional and Policy Issues	This strategy can bring about immediate awareness, goodwill and success. Motorcyclists want a safe event, and often fail to recognize even simple measures that can bring about that safety, such as peer-to-peer intervention, or providing security for motorcycles that impaired riders would otherwise be reluctant to leave unattended overnight. Active partnering with motorcycle community leaders, law enforcement, transportation and motorcycle safety officials and event organizers will assure the safest event possible. Include personnel currently involved with drinking/driving programs. It is possible that the insurance industry would be interested in playing a role as well. Many resources already exist that can be applied to this constituency at these events. This strategy can easily be combined with other motorcycle safety strategies that involve key stakeholders.

EXHIBIT V-33 (Continued)
Strategy Attributes for Expanding Existing Impairment Prevention Programs to Include Motorcycle Riders and Specific Motorcycle Events

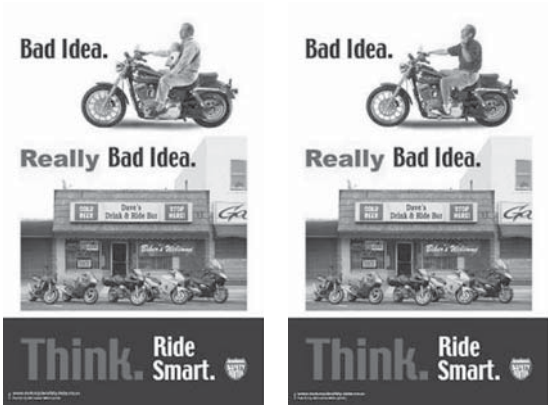
Issues Affecting Implementation Time	Adequate lead-time must be established to help ensure safe and successful events and to develop promotional materials. Personnel currently active in drinking/driving programs should be engaged to allow time for adequate planning. The stakeholder team will require data and time to analyze conditions surrounding event locations.
Costs Involved	Costs vary widely depending on the size of the motorcycle event and the specific action taken; however, many elements of this strategy can be implemented at very low costs.
Training and Other Personnel Needs	Expanding existing impairment prevention programs to include motorcycle riders and specific motorcycle events does not necessarily require training or additional agency personnel, but it does require an awareness of the over-representation of alcohol involvement in motorcycle crashes as compared to crashes involving other vehicle types. It also requires a priority to address this issue and a willingness to partner with key stakeholders to begin the process of effecting change.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

An example of an effective treatment can be found in the Motorcycle Safety Foundation's (MSF) "Take it Easy" campaign for Daytona Bike Week, 2001. The campaign featured billboards, buses, street banners, posters and airwaves concentration. The "Take It Easy" theme was chosen because it is a commonly used phrase that applied to all aspects of safe riding and driving, including observing all traffic laws, riding or driving unimpaired and respecting all roadway users. The "Take it Easy" goal was to reduce the number of crashes and fatalities associated with Bike Week. See Exhibit V-34. Visit the MSF website at:

EXHIBIT V-34
Take It Easy Campaign

EXHIBIT V-35
Example of Minnesota Motorcycle Safety Program Posters



http://www.msf-usa.org/index_new.cfm?pagename=Search&content=12D63D09-A0CC-53D5-64764948F882EC77&spl=1&Criteria=&content=B9DA9457-A0CC-53D5-644C591F676562BC&spl=0.

MSF has created a set of print public service announcements in a variety of sizes and formats. MSF provides these free of charge. Visit: http://www.msf-usa.org/.

The Minnesota Motorcycle Safety Program has produced creative posters designed to capture the attention of motorcyclists. Other examples can be found by visiting their website. Visit: http://www.motorcyclesafety.state.mn.us/.

Strategy 11.1 B3—Target Law Enforcement to Specific Motorcycle Rider Impairment Behaviors That Have Been Shown to Contribute to Crashes (T)

General Description

The problems associated with impaired operation of motorcycles are detailed in Strategy 11.1 B1, "Increase Motorcyclist Awareness of the Risks of Impaired Motorcycle Operation." Research has shown that, in 2005, motorcyclists were about 37 times as likely as passenger car occupants to die in a traffic crash, and 8 times as likely to be injured (NHTSA, 2006b). A large number of the motorcycle fatalities can be attributed to motorcyclists riding under the influence. Traffic Safety Facts from 2006 also reports the following:

- In fatal crashes reported in 2006, alcohol involvement among motorcycle drivers was higher than alcohol involvement for passenger cars and light truck drivers.
- Of the motorcyclists involved in fatal crashes, 89 percent were operators (riders).
- In 2006, over one-third of motorcycle operators involved in crashes were found to have been drinking prior to the crash.
- The ratio of intoxicated motorcycle operators to impaired motorcycle operators was nearly 4 to 1.
- Motorcycle operators were almost twice as likely to test positive for alcohol in single-vehicle crashes compared to multiple-vehicle crashes.

Enforcement of DUII laws is an essential element of any comprehensive transportation safety plan. Arming the enforcement community with the necessary tools and training to detect impaired motorcyclists is the key to reducing the number of alcohol-related crashes, injuries and fatalities.

In order to address this problem, NHTSA sponsored research to develop a set of behavioral cues that can be used by law enforcement personnel to accurately detect motorcyclists who are operating their vehicles while intoxicated. This research resulted in the development of the "Detection of DWI Motorcyclists" training guide, a "Motorcycle DWI Detection Guide," and a training video.

Seventeen cues were identified in this resource that best discriminate between impaired and normal operation of a motorcycle. The cues were labeled as "excellent predictors" and "good predictors." The "excellent" cues predicted impaired motorcycle operation at least 50 percent of the time. The "good" cues predicted impaired motorcycle operation 40 to 49 percent of the time. Most of the behaviors in the "excellent" category were drawn from the special coordination and balance requirements of riding a two-wheeled vehicle. The cues include:

- Drifting during turn or curve
- Trouble with dismount
- Trouble with balance at stop
- Turning problems
- Late braking during turn
- Improper lean angle during turn
- Erratic movements during turn
- Inattentive to surroundings
- Inappropriate or unusual behavior
- Weaving
- Erratic movements while going straight
- Operating without lights at night
- Recklessness
- Following too closely
- Running stop light or sign
- Evasion
- Wrong way

These training and guidance materials help officers (1) detect impaired motorcyclists, (2) articulate observed behaviors on arrest reports, and (3) support their expert testimony during legal proceedings. These materials are available from NHTSA (NHTSA, 2007).

Highway agency personnel should partner with enforcement officials to foster and support officer training and deployment of this resource. Ideally, this training should be incorporated as part of the Standard Field Sobriety Testing taught to law enforcement. All enforcement

agency personnel should complete training to become better aware of the visual cues associated with impaired motorcycle operation. This resource and training is especially effective during periods when there is a large concentration of riders that match the following profile (FARS, 2006):

- Male—87 percent of fatalities are male
- Ages 35–39, 40–44 and 45–49—these age groups represent the highest alcohol involvement of all age groups
- Riding large motorcycles—operators of motorcycles with large engines had the highest alcohol/crash involvement when compared to operators of other motorcycle engine sizes
- Riding at night—motorcycle operators killed in traffic crashes at night were 4 times as likely to have BAC levels of 0.08 g/dL or higher than those killed during the day (43 percent and 12 percent, respectively).
- Not wearing a helmet
- Improperly licensed

EXHIBIT V-36
Strategy Attributes for Targeting Law Enforcement to Specific Motorcycle Rider Impairment Behaviors That Have Been Shown to Contribute to Crashes

Technical Attributes	
Target	The target of this strategy includes law enforcement agencies, motorcyclists, and large motorcycling events.
Expected Effectiveness	This strategy has been tried as a means of reducing the incidence of impaired motorcycle operation. While some agencies have reported success, there have not been any formal evaluations of the effectiveness of this strategy at reducing crashes involving impaired motorcyclists. However, when this strategy is incorporated with other DWI strategies and enforcement, the effectiveness of the enforcement effort to target DWI motorcyclists should improve.
Keys to Success	Keys to success include: • Coordination with regional/local law enforcement and transportation and motorcycle safety authorities • Involvement of the motorcycling community, such as the Motorcycle Safety Advisory Group • Involvement of motorcycling event organizers • Training of police personnel to use impairment recognition practices for motorcyclist DWI • Targeting of enforcement in conjunction with public information and education at events • Involvement of media to support the activity

EXHIBIT V-36 (Continued)
Strategy Attributes for Targeting Law Enforcement to Specific Motorcycle Rider Impairment Behaviors That Have Been Shown to Contribute to Crashes

Potential Difficulties	A potential difficulty includes achieving cooperation and coordination of multiple agencies across multiple jurisdictions. Also, this may not be a popular campaign with motorcyclists. Some riders may complain that they are being unfairly targeted or take issue with the validity of the visual cues. Event organizers may be reluctant to cooperate.
Appropriate Measures and Data	Performance can be measured in the short term by the number of stops, number of arrests, percentage of DWI motorcyclists stopped/arrested, and number of alcohol-related crashes and fatalities reported before and after the implementation of the strategy.
Associated Needs	Partnerships with enforcement, transportation safety and the motorcycling community are critical for long-term success.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Engineering, enforcement and transportation safety personnel often view each other as distinct and autonomous entities whose work does not overlap. This strategy requires a team effort between agencies and with the motorcycling community in order to maximize the benefits.
Issues Affecting Implementation Time	The law enforcement personnel will require NHTSA materials and training. Targeting enforcement will require coordination within and among enforcement agencies. Enforcement personnel need to be trained and deployed. Outcome measures need to be defined and data captured to determine effectiveness of effort and expense.
Costs Involved	Costs can vary depending on the scope of effort and specific action(s) taken. There will be costs associated with training and materials as well as with organizing and coordinating with the stakeholder team.
Training and Other Personnel Needs	Law enforcement personnel need to complete training to recognize DWI motorcyclists. The more personnel that are trained, the greater the benefit.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

"The Detection of DWI Motorcyclists" is a valuable training tool that has been in circulation for more than ten years. More information may be found at the following website: http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/610DWIMotorcyWeb/pages/index.htm.

Objective 11.1 C—Reduce the Number of Motorcycle Crashes Due to Unlicensed or Untrained Motorcycle Riders

Strategy 11.1 C1—Increase Awareness of the Causes of Crashes Due to Unlicensed or Untrained Motorcycle Riders (E)

General Description

Every year thousands of riders and passengers are injured or killed in motorcycle crashes nationwide. The number of fatal motorcycle crashes has been increasing at an alarming rate since 1997—from 2,116 in 1997 to 3,592 in 2003, representing a 70 percent increase. This trend cannot be easily explained, and research into motorcycle crash causation remains inadequate. A thorough motorcycle crash research study has not been conducted since the landmark "Hurt Study" (Hurt et al., 1981). In the 25 years since the Hurt Study, vast changes have occurred in the motorcycling profile, as reported in *The National Agenda for Motorcycle Safety* (NHTSA, 2000):

- The riding demographic has aged considerably, from 24 in 1980 to 38 in 2000.
- Motorcycle popularity and use have increased. Motorcycles are larger, have greater performance than those of the 1980s, and cost more. Vehicle design, engine size, suspension, braking systems and lighting have all seen dramatic improvements. Sport bikes and cruisers—styles that didn't exist when the Hurt Study data was collected in the late 1970s—are top sellers.
- States have improved licensing programs and established rider training and motorcycle safety programs across the nation, yet the effectiveness of these programs has not been measured or quantified.

In the absence of contemporary or timely crash facts, validation of existing countermeasures cannot be fully quantified, leaving safety advocates and practitioners to study statistical patterns and extrapolate crash indicators. Timely and comprehensive crash causation factors are needed to understand the rising trends in motorcycle crashes and to develop countermeasures in enforcement, engineering, rider education and training, licensing and public information. One of the four "urgent" recommendations of the National Agenda for Motorcycle Safety was: "Immediate action should be taken by government and industry to address the critical questions in motorcycle safety through comprehensive, in-depth studies as well as studies focused on specific topics."

Motorcycle crash data are needed in order to be able to understand and quantify rider exposure and effective response in crash situations so that effective treatment can be applied. The samples below are just a few factors that could be measured by a comprehensive in-depth motorcycle crash causation research project. Such a study could answer some of the following questions:

- Did the rider perceive the hazard? When did the rider perceive the hazard? What prevented an earlier assessment?
- Did the rider use both brakes effectively? If not, how was the braking characterized?
- Did the rider swerve or make any attempt to avoid the obstacle? Was this an appropriate reaction given the circumstance?

- Did alcohol, drugs or fatigue contribute to the crash?
- What other factors contributed to the crash (roadway conditions, weather, mechanical problems)?
- Was the operator wearing protective equipment (helmet and other protective apparel)? What was the extent of injury and what effect did the protective equipment have on injury reduction?
- Had the operator completed a rider training program?
- Was the operator properly licensed and/or endorsed to operate a motorcycle?

In the meantime, much can be gained by understanding statistical patterns and trends in motorcycle crashes. Standard crash data elements such as time of day, age of rider, type of bike, speed, the presence of protective apparel, alcohol involvement, and licensing status provide insight into the general trends and patterns of motorcycle crashes. Highway agency officials should continue to seek information on motorcycle crashes, and use this information to craft programs designed to target problems, improve safety and educate the motoring and motorcycling public.

Motorcycle Licensing Programs

The National Agenda for Motorcycle Safety identified five "essential" recommendations for licensing improvement:

- Commission studies to ensure that licensing tests measure skills and behaviors required for crash avoidance
- Identify and remove barriers to obtaining a motorcycle endorsement
- Develop and implement programs to allow all state motorcycle safety programs to issue motorcycle endorsements immediately upon successful completion of rider training courses
- Enforce penalties for operating a motorcycle without a proper endorsement
- Encourage states and jurisdictions to provide motorcycle-specific training to license examiners administering testing for motorcyclists

One "necessary" recommendation was identified: Develop an enhanced motorcycle licensing model using appropriate Graduated Driver Licensing (GDL) concepts and evaluate its effectiveness.

Motorcycle licensing programs and requirements for testing are in place in all states and the District of Columbia. The licensing components include a special motorcycle operator's manual, knowledge test, skills test, learner's permit and license endorsement. In many states, these licensing programs are waived for completion of a state-approved motorcycle rider training course. Most licensing agencies waive knowledge and/or skill tests for eligible applicants who hold licenses from another jurisdiction that maintain similar standards as the issuing jurisdiction. Likewise, many states waive knowledge

and/or skills tests for applicants who have completed a motorcycle safety program from another jurisdiction.

These licensing programs are necessary to measure the readiness of riders to ride safely. The operator's manual provides important information and strategies for safe riding. The knowledge test measures the understanding of that material, and the skills test quantifies the rider's readiness to venture safely onto public roads.

Most states use skills tests developed by the Motorcycle Safety Foundation in cooperation with the American Association of Motor Vehicle Administrators (AAMVA) and NHTSA, although in 16 jurisdictions, locally designed off-street tests are used. Typically, one of the following tests is used:

- The Alternate Motorcycle Operator Skill Test (Alternate MOST)

  An off-street test comprising six individual skill tests designed to measure basic vehicle control and hazard response skills. The test features a sharp turn, normal stop, cone weave, U-turn, quick stop and obstacle avoidance maneuver.

- The Motorcycle Licensing Skills Test (MLST)

  The MLST features electronic or manual timing equipment that converts speed traveled through a timing zone to a score. The test features a straight path and sharp turn, quick stop, swerve and curve negotiation.

- The Motorcyclist In-Traffic Test (MIT)

  The MIT evaluates rider judgment in actual traffic situations. The test measures 8 to 11 riding behaviors. The examiner follows the applicant in a car and transmits instructions through a receiver carried by the applicant.

In order for the skills test to be valid, it must be objectively scored. Examiners do not have to be motorcycle operators to administer these tests, but they do need to complete specialized training to learn the policies and demonstrate scoring objectivity and accuracy.

Even though much has been done to establish educational resources and testing mechanisms, many riders avoid the licensing process and ride illegally. In 2003, one in four motorcycle operators (24 percent) involved in fatal crashes was operating the vehicle with an invalid license. This compares with only 12 percent of drivers of passenger vehicles in fatal crashes without a valid license (FARS, 2003). Typically these riders who are operating the vehicle with an invalid license are actually operating a vehicle "out of class," meaning that an automobile license exists but the license is not lawfully endorsed for motorcycle operation.

The licensing process is a critical first step for anybody wanting to operate a motorcycle on public roads. The material in the operator's manual and the content of the knowledge and skills tests must be based on timely and accurate data and must measure the skills and strategies necessary for the safe operation of a motorcycle. Minimum standards and pass rates must be defined for these tests to be valid. Objective scoring and unbiased treatment of applicants ensure that every applicant has the best opportunity to demonstrate readiness and comply with state law. Finally, law enforcement should provide consistent enforcement for violations of "operating a vehicle out of class," including citing the operator and impounding the motorcycle.

Rider Training Programs

The National Agenda for Motorcycle Safety (NAMS) identified three "essential" and three "necessary" priorities for rider education and training. The following are "essential":

- Expand motorcycle safety programs to accommodate all who need or seek training.
- Conduct uniform follow-up research into the effectiveness and impact of rider education and training.
- Merge rider education and training and licensing functions to form one-stop operations.

The following are "necessary":

- Increase the number of states conducting Motorcycle Safety Program Assessments.
- Establish benchmarks for rider education and training effectiveness and program operation excellence.
- Explore the effectiveness of on-street training.

Motorcycle rider education and training has been shown to provide effective treatment for motorcycle crashes, as identified in the research report, "Evaluation of the California Motorcyclist Safety Program (CMSP)" (Billheimer, 1998). This report documented the impact of the CMSP on motorcycle crashes within California using the following measures:

- Analyzed crash trends over the 9-year life of the program
- Compared accident experience of California riders with those in the rest of the United States
- Assessed accident rates of persons completing classes in contrast with persons not having completed classes

The findings showed:

- Motorcycle crashes dropped 67 percent from 1986 to 1995; fatalities dropped by 69 percent during the same time period.
- Crashes involving riders under the age of 18 (for whom training is mandatory) dropped 88 percent from 1987 to 1995.
- Accident rates of untrained novice riders were more than double the rates of their trained counterparts for at least 6 months after training.

Motorcycle rider education and training enjoys the broad support of industry, government and users. In fact, groups such as ABATE ("A Brotherhood Against Totalitarian Enactments," "A Brotherhood Aimed Toward Education," or "American Bikers Aimed Toward Education") have been among the most active supporters. This group of motorcyclists believes that education and training are the most effective ways to reduce motorcycle crashes, injuries and fatalities. They share the common mission to "promote motorcycle awareness, education,

safety and liberty through community involvement and legislative action." For more information about this group, visit their website at: http://www.abateoforegon.net/.

Forty-seven states support self-funded motorcycle safety and rider training programs. Funding is typically derived from fees on motorcycle endorsements and/or registrations. Some jurisdictions rely heavily on course fees.

Most jurisdictions offer rider training programs created and supported by the Motorcycle Safety Foundation and typically include training for beginning and experienced riders and instructor training programs. Approximately three million riders have completed rider training since 1973, with 250,000 riders passing through a training program each year since 2000. Some states require training for riders under the ages of 16, 18, or 21. Tuition nationwide runs from free to $350 for the beginning or experienced course (SMSA, 2003). The National Association of State Motorcycle Safety Administrators (SMSA) maintains an extensive survey resource detailing state-by-state information on program infrastructure, contacts and services. The website is http://www.qandapro.com/report/report.php (username: survey, password: visitor).

Unfortunately, many of the jurisdictions that offer and support rider training programs cannot meet the increasing demand for courses. Many potential students report wait times for training from 3 months to as much as 1 year. Riders are opting out of the training process completely because they cannot find a training course nearby or within a reasonable period of time. Motorcycle safety programs are unable to identify and train enough instructors to meet the growing demand. Sites, personnel and equipment are in short supply. Funding in many jurisdictions is inadequate to meet this growing demand. Clearly, many state and local motorcycle safety programs need to forecast demand, prepare strategic plans for meeting the growing need for training, and implement performance measures to evaluate effectiveness of effort and expense.

Nationally, three groups have the influence to effect change in rider training programs, delivery and evaluation: the Motorcycle Safety Foundation, the National Association of State Motorcycle Safety Administrators (SMSA), and NHTSA through the Safety Countermeasures Division and state offices of highway safety. Close partners include the Motorcycle Riders' Foundation (MRF) and the American Motorcyclist Association (AMA). These groups often, but not always, cooperate on initiatives to strengthen motorcycle safety and rider training programs.

NHTSA supports a "State Motorcycle Safety Program Assessment," a technical assistance tool offered to states that allow management to review the motorcycle safety program, note the program's strengths and accomplishments, and note where improvements can be made. The assessment can be used as a management tool for planning purposes and for making decisions about how best to use available resources. The Motorcycle Safety Program Assessment process provides an organized approach for meeting these objectives.

The Motorcycle Safety Program Assessment is a cooperative effort among NHTSA, the state motorcycle program office, the state highway safety office, and other agencies or offices, such as the Department of Motor Vehicles, Department of Public Safety, Department of Transportation, and/or Department of Education, which contribute to the state's motorcycle

safety program efforts. The Motorcycle Safety Program Assessment follows the format and procedures utilized by other highway safety and emergency medical services program assessments.

The Motorcycle Safety Program Assessment examines the following components of a comprehensive motorcycle safety program:

- Program management
- Motorcycle personal protective equipment
- Motorcycle operator licensing
- Motorcycle rider education and training
- Motorcycle operation under the influence of alcohol or other drugs
- Legislation and regulations
- Law enforcement
- Highway engineering
- Motorcycle conspicuity and motorist awareness programs
- Communication program
- Program evaluation and data

For more information, see NHTSA's Uniform Guidelines for State Highway Safety Programs: http://www.nhtsa.dot.gov/nhtsa/whatsup/tea21/tea21programs/pages/MotorcyclePDF.pdf.

The demand for training has borne witness to the emergence of industry training programs. With the assistance of the Motorcycle Safety Foundation, Harley-Davidson has developed and continues to support a network of "Rider's Edge" courses that are offered and run through local dealerships. Students register at the dealership, complete classroom training at the dealership, and ride new Buell Blast motorcycles for the on-cycle portion of the training.

It is expected that motorcycle sales will continue to rise as the "baby boomer" generation continues to exercise financial freedom. In addition, the effect of increasing fuel costs and increased traffic congestion may well be the launching point for resurgence in popularity of motorcycles. Motorcycle rider education and training programs need to remain viable, responsive and strong to keep quality rider training accessible and affordable to all who are interested in riding or improving skills and safety.

The effective cure for this strategy is to support a means and mechanism for riders to complete training and licensing. In those states where licensing tests are waived for course graduates, the completion of training resolves both education and licensing issues (once the rider completes the endorsement application and payment process). Most jurisdictions allow a license testing waiver for the beginning course, but several jurisdictions also allow testing waivers for intermediate and/or experienced rider training.

EXHIBIT V-37
Strategy Attributes for Increasing Awareness of the Causes of Crashes Due to Unlicensed or Untrained Motorcycle Riders

Technical Attributes	
Target	This strategy targets the transportation community: engineering, enforcement, safety and licensing officials responsible for data analysis and program countermeasures. The motorcycle safety leaders should be involved.
Expected Effectiveness	The success of this strategy depends on the extent to which those responsible for implementing these countermeasures understand the value of reviewing data to identify motorcycle crash causation factors, especially rider training and licensing status. It is advisable to meet with the personnel involved in transportation and motorcycle safety programs to fully understand the reasons for this approach (i.e., the over-representation of unlicensed and untrained riders in motorcycle crashes, particularly in a highway agency's respective jurisdiction). The motorcycle safety, transportation safety, law enforcement and judicial communities should be involved to help craft strategies, implement solutions and identify and enforce violations. Motorcycle safety advisory and advocacy groups should be enlisted to provide key support and leadership to the motorcycling community. If over-the-road exposure data is collected to determine the number of riders who are operating a motorcycle without a proper license or endorsement and without proper training, the magnitude of the risk of being in a crash can be determined (i.e., odds ratio).
Keys to Success	Keys to success include: • Data collection and analysis • Broadening the base of support by engaging the community of key stakeholders • Training and coordinating with law enforcement and judiciary to enforce licensing and/or training laws • Public awareness and effective use of information sources • Understanding the strengths and weaknesses of the state's motorcycle safety program through a NHTSA Assessment or other impartial evaluation • Coordinating with the rider training community to expand course offerings, promote the availability of training, and train more riders. • Communicating with trained riders about the need to complete the endorsement process. The best way to implement this strategy is to persuade riders to complete training. In many states, the licensing tests are waived for course graduates.
Potential Difficulties	A potential difficulty is achieving cooperation and coordination of law enforcement and judiciary to target motorcyclists riding unlicensed/unendorsed or without training, when mandatory. The availability of rider training opportunities can be a problem. The ability to develop a system that will permit data linkage between crash data records and rider training or rider licensing may present a challenge.

EXHIBIT V-37 (Continued)
Strategy Attributes for Increasing Awareness of the Causes of Crashes Due to Unlicensed or Untrained Motorcycle Riders

Appropriate Measures and Data	Reliable data are needed for both program operation and program evaluation. The representation of unendorsed/unlicensed and/or untrained riders in motorcycle crash data should be identified. Data on crash involvement of this demographic should be monitored and measured against national motorcycle crash data. Specific measures should include: • Number of motorcycle crashes • Crash type comparison—single-vehicle versus multi-vehicle • Representation of unlicensed/unendorsed riders • Time of crash—percentage daytime versus nighttime • Baseline comparison of above indicators to other vehicle types • Baseline comparison of above indicators to federal findings Program countermeasures, such as public information and education programs, should include effectiveness measures. Police and court systems should track citations and convictions for operating a motorcycle “out of class” (i.e., without proper endorsement) or without proper training credentials. The highway agency’s FARS specialist should track and publish statewide annual motorcycle crash statistics. State motorcycle safety officials should track training figures within the state and develop a method by which training information could be linked with crash data records to form a truly comprehensive motorcycle data system. A Motorcycle Safety Program Assessment will identify program strengths and areas in need of improvement. Countermeasures can be developed and evaluated.
Associated Needs	The media play a crucial role in information dissemination. Special public information and education campaigns may be appropriate supplements to an improvement program.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Providing accurate crash and/or incident information requires cooperation among public safety agencies that possess the data. Alliances with key stakeholders—including transportation and motorcycle safety specialists, enforcement, licensing, motorcycle users and activists—can produce goodwill and support for transportation safety initiatives. The motorcycle community is a tremendous resource. Leaders are very concerned about motorcycle safety and will go to great lengths to support comprehensive motorcycle safety measures. These partnerships are essential to begin to (a) understand the problems motor cyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community. State law should be researched to understand the penalties for operating a vehicle “out of class” or without appropriate training credentials. State motorcycle safety program personnel need to analyze program strengths and responsiveness to constituent demand. Steps should be taken to strengthen the program infrastructure if training frequency is determined to be inadequate.

EXHIBIT V-37 (Continued)
Strategy Attributes for Increasing Awareness of the Causes of Crashes Due to Unlicensed or Untrained Motorcycle Riders

Issues Affecting Implementation Time	A thorough data analysis, review, discussion, meeting with key stakeholders, and adoption process may take several months. Additional data and/or data linkages may need to be obtained and developed. Depending on the agency practices, it may take more time to adopt a comprehensive plan and implement this strategy. It is advisable that at least 6 months be allowed to formulate and implement this strategic plan.
Costs Involved	Costs associated with this strategy include: • Personnel time to research, coordinate with key stakeholders, implement and evaluate this strategy. • Public information and education campaign and/or resources targeting the group over-represented in crashes involving unlicensed/endorsed or untrained riders. • Additional classes, if required. This may take legislation or a rule change to increase funding (statute or course tuition). • Conduct of a State Motorcycle Program Assessment.
Training and Other Personnel Needs	Motorcycle safety program personnel can benefit from training in how best to forecast future demand and how to improve their training infrastructure to meet current or future demand. Police should be trained to recognize the characteristics of unlicensed or unendorsed operators and to uniformly enforce licensing laws.
Legislative Needs	Motorcycle safety programs are funded through fees on endorsements or registrations. This rate may need to be increased to meet future demand.
Other Key Attributes	
	None identified.

EXHIBIT V-38
Motorcycle Safety Foundation Educational Materials

Information on Agencies or Organizations Currently Implementing This Strategy

The Motorcycle Safety Foundation (MSF) has developed training and licensing PSAs for print and web applications in a variety of sizes and formats and will provide them at no cost to the state. Contact the MSF for more information.

The TEAM OREGON Motorcycle Safety Program maintains a listserv for motorcycle patrol officers in Oregon. More than 100 officers are enrolled. The service is used to provide educational and safety information and resources to the Oregon motor officer community and has targeted unendorsed and untrained rider issues in the past.

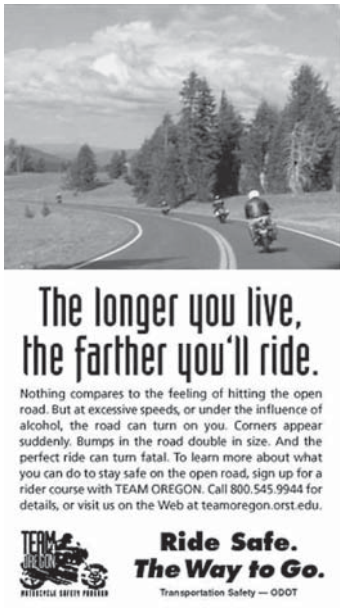
EXHIBIT V-39
SMSA's Safety Workshop Publication

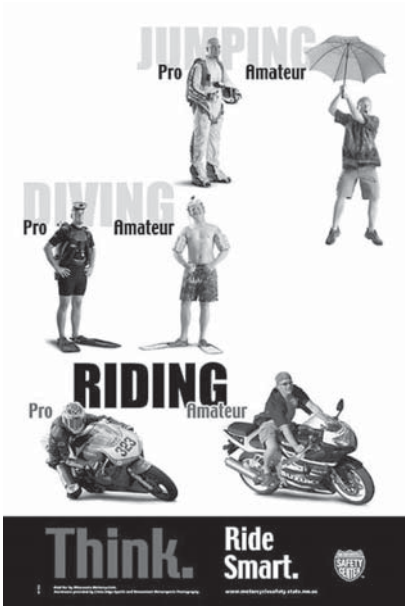
The Maryland Motor Vehicles Administration (MVA) has linked data from different sources to track motorcycle crashes, violations, injury reports and compliance with licensing regulations. Linking data from CODES, vehicle registration, operator licensing and rider training records, MVA can begin to evaluate and understand violation and crash trends and the effects of training and licensing on those crashes and violations. For more information, contact the Maryland Motorcycle Safety Program: www.motor cyclesafety@mdot.state.md.us.

The National Association of State Motorcycle Safety Administrators (SMSA) provided professional development and resources for members to forecast program growth at the 2002 National Conference in Boise, Idaho. The workshop entitled, "Forecasting the Future: A Manager's Guide to Program Health and Sustainability" was prepared and delivered by the TEAM OREGON Motorcycle Safety Program at Oregon State University. A CD complemented the presentation and provided tools to calculate the number of instructors needed to meet the anticipated demand and the number of course offerings required to meet local, regional and state demand. Many states were found to be maintaining a consistent number of instructors and sites while the demand for student training was increasing. The training and CD identify the potential problems with continuing that strategy. Many state managers have reported that the training and resources have been successfully applied to develop an improved business plan and funding appropriation. For information, contact TEAM OREGON: http://teamoregon.orst.edu. Several states have completed a Motorcycle Safety Program Assessment, including Washington, Indiana, Oklahoma, Ohio, Delaware, Missouri, West Virginia, Florida and Hawaii.

The following resources were created and produced by Oregon Department of Transportation (left) and the Minnesota Motorcycle Safety Program (right) to promote motorcycle safety and rider training.

EXHIBIT V-40
Educational Materials Produced by Oregon Department of Transportation (left) and Minnesota Motorcycle Safety Program (right)





Strategy 11.1 C2—Ensure That Licensing and Rider Training Programs Adequately Teach and Measure Skills and Behaviors Required for Crash Avoidance (T)

General Description

This strategy is an "essential" recommendation of the National Agenda for Motorcycle Safety (NAMS). As described in Strategy 11.1 C1, motorcycle licensing and training programs are well established in most states. Most licensing and rider training programs use curriculum and materials designed and supported by the Motorcycle Safety Foundation (MSF). The MSF is responsible for a series of Cycle Safety Information (CSI) reports, including: (1) annual licensing procedures and standards, (2) annual training statistics on a state-by-state basis, and (3) annual crash statistics. These are excellent resources and may be downloaded at http://www.msf-usa.org/ (click on the "Library" section).

Materials used in rider training and licensing are updated infrequently. Instructor and examiner training often fail to address current local/statewide crash causation issues. Unfortunately, even when those issues are identified, the task of integrating new motorcycle research findings into training and licensing programs is not thoroughly applied. Often, years will pass with no oversight or assurances that state/regional licensing and education programs are measuring the skills and behaviors required for crash avoidance.

Many licensing and education programs are based on the Hurt Study (Hurt et al., 1981). While changes in licensing programs have been made since the Hurt Study, the purpose of many of the changes has been to accommodate larger motorcycles in slow speed exercises.

Subtle changes have been made in technical treatment of skills and strategies in training or licensing. New training curricula continue to address the problems identified in the Hurt Study, which are believed to remain problems today. Realistically, this may or may not be true. For example, the Hurt Study identified that 92 percent of riders involved in crashes were self-trained. Thirty years later, this may have changed. Most riders from the Hurt Study showed significant deficiencies in performing emergency braking and evasive maneuvers. In most multiple-vehicle crashes today, the operator of the other vehicle is at fault for violating the motorcyclist's right-of-way. While multiple-vehicle crashes represent 54 percent of total crashes (FARS, 2003), it is unknown whether the driver of the other vehicle remains culpable for the crash causation or if other characteristics are present. Single-vehicle crashes constitute 46 percent of all fatal crashes (FARS, 2003), but the cause of these crashes is largely unknown.

Training and licensing practices should be based on current research and best practices, as prescribed in two NAMS recommendations:

- Conduct follow-up research into the effectiveness and impact of rider education and training.
- Establish benchmarks for rider education and training effectiveness and program operation excellence.

Highway agency safety personnel should research current motorcycle crash statistics to identify the crash factors facing riders in that jurisdiction and compare those findings with current testing and education practices. Those findings should be shared with groups responsible for national guidelines—MSF and the American Association of Motor Vehicle Administrators (AAMVA)—in a collaborative effort to improve safety. Changes in training or licensing should be communicated to the training and licensing communities through periodic instructor and examiner in-service training programs.

EXHIBIT V-41
Strategy Attributes for Ensuring That Licensing and Rider Training Programs Adequately Teach and Measure Skills and Behaviors Required for Crash Avoidance

Technical Attributes	
Target	The target of this strategy is state agencies with regulatory oversight of motorcycle operator licensing and motorcycle rider training (public and private).
Expected Effectiveness	No formal evaluation has been conducted to determine the effectiveness of this strategy at reducing motorcycle fatalities.
Keys to Success	The key to success of this strategy is comparing crash experience with training and licensing treatments and measures. It is important to bring together stakeholders—licensing officials, rider education and training providers and advocacy and user groups—to implement this strategy as a unified team.
Potential Difficulties	The licensing and training programs may resist changes, once identified.
Appropriate Measures and Data	Process measures could include the existence of a coordinated system, number of meetings held, number of records analyzed, comparison of crash factors against treatment of those skills, issues or strategies in training/testing, comparison of those factors to national data, etc.

EXHIBIT V-41 (Continued)
Strategy Attributes for Ensuring That Licensing and Rider Training Programs Adequately Teach and Measure Skills and Behaviors Required for Crash Avoidance

	Crashes need to be analyzed to determine the effectiveness of training/licensing in crash avoidance and whether that skill or strategy was appropriately applied for the crash situation.
Associated Needs	The joint involvement of different disciplines in determining the underlying contributing crash factors and then suggesting and implementing corrective action is critical.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Engineering, licensing, and motorcycle safety personnel often view each other as distinct and autonomous entities whose work does not overlap. This strategy requires a team effort between agencies and with the motorcycle training community. Because these personnel are from separate agencies, institutional issues may have to be overcome in order to facilitate cooperation.
Issues Affecting Implementation Time	The stakeholder team will require time to collect and analyze the data and compare it with licensing tests and training measures. Data linkages may be necessary between crash data, licensing, and training information. The scope of the effort, the nature of the changes, and the cooperation of stakeholders will all determine the time from data collection to program implementation. This will vary widely.
Costs Involved	Costs can vary widely, depending on the scope of effort and the specific actions being taken, which can be as little as suggesting change in a few questions of the licensing knowledge test to proposing major revision of the rider training manual. The author or provider should complete the task per DOT specification. Analysis, coordination with other groups, and oversight costs should be considered.
Training and Other Personnel Needs	Training and licensing personnel may need to complete refresher training to align with current rider safety needs. Operator's manuals and training guides may also need to be updated and/or customized to meet the needs of the agency.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

The Oregon Department of Transportation has implemented this strategy. When statewide data indicated that most riders were crashing in curves, the department instructed the TEAM OREGON Motorcycle Safety Program to evaluate the training curriculum against this and other local safety measures. A field test was conducted. New rider training and educational treatments were developed and a new curriculum was adopted. The new program emphasizes safe cornering theory, technique and performance. This program was also compared with national benchmarks to assure quality and accuracy.

Motorcycle Rider Education and Licensing: A Review of Programs and Practices (Baer et al., 2005a) provides a comparison of trends in rider education and motorcycle operator licensing across

the 50 states and the District of Columbia. The report presents state-by-state data on all aspects of rider education and licensing. NHTSA released a follow-up report in 2005 that details promising practices in rider education and motorcycle operator licensing (Baer et al., 2005b).

Strategy 11.1 C3—Identify and Remove Barriers to Obtaining a Motorcycle Endorsement (T)

General Description

This strategy is a NAMS "essential." It is important to identify and remove barriers to obtaining a motorcycle endorsement. It has been established that, in 2001, one in four motorcycle operators (25 percent) involved in fatal crashes was operating the vehicle with an invalid license (FARS, 2002). It is unknown how many riders are currently operating a motorcycle without proper licensure. The ability to compare registered cycle owners to endorsed operators is complicated in many states due to incompatible licensing and registration database systems. In some states, it is also not possible to quantify the number of unqualified motorcycle riders that are involved in crashes, simply because the motorcycle license endorsement is not reported on the crash reporting form.

Qualifying for a motorcycle endorsement indicates the rider has met minimum standards for knowledge, skill and safety, and is a requirement in all states. It is the skills test, more than the knowledge test, that complicates compliance:

- The testing times are inconvenient and not immediate. Appointments are required and often the wait time is several weeks or months.
- Some jurisdictions cancel the testing for rain. This starts the scheduling process all over.
- The rider has to transport their personal motorcycle to the testing site. For those who are riding on a permit, another person has to accompany him/her on another motorcycle.
- The test intimidates some riders. Common excuses are:
  - "My bike won't turn that tight."
  - "My bike won't ride that slow."
  - "My bike is too big."
  - "What do they (the examiners) know about riding a motorcycle?"
- The fear of failure is commonly present, and when a rider fails, the testing cycle starts over again—appointments, delivery, testing and fear of failure.
- The licensing system in many states allows riders to renew permits year after year, providing no incentive to complete the endorsement process.
- Law enforcement may not always enforce the violation of riding without an endorsement. Even when a rider is stopped and cited, in some cases they are allowed to ride away. The laws for operating a vehicle out of class should be consistently applied for all vehicles. In some jurisdictions, operators caught driving or riding without proper licensing credentials have their vehicles impounded.

Many licensing jurisdictions waive skills and knowledge testing for graduates of basic rider training. This has proven to be a training incentive. The advantages are many:

- Small, lightweight training motorcycles are typically provided for training and testing.
- The training builds skill, develops strategy, and improves knowledge.

- Knowledge and skill testing are included in the training program. To successfully complete the course, the rider must pass both a knowledge and a skills test.
- With the completion certificate in hand, the graduate applicant simply visits the licensing office to present the certificate and have his/her license endorsed for motorcycle operation, no appointment, no rain-out, no concern about getting a bike to the licensing office, and no threat about possibly failing the skills test and having to repeat the process.

The training and licensing partnership is the most effective means to prepare a motorcyclist to venture onto public roads safely and legally. However, it is unknown how many course graduates actually complete the last step of visiting the licensing office to acquire the "M" endorsement. This last step could be eliminated by allowing rider training providers to issue temporary endorsement certificates to eligible students. Once the licensing department receives training reports, it could mail a replacement "sticker" or other form of authorization that the applicant could adhere to his or her driver's license. Tight security, quality assurance and compliance measures would have to be established. The advantage of this solution is that the thousands of people completing rider training would not have to also visit local licensing offices. The licensing department would benefit, as would the students. Compliance with licensing of the training population should increase. The state of Pennsylvania has such an arrangement: http://www.dmv.state.pa.us/faq/faq-mcpermit.shtml.

Finally, licensing reciprocity between state-to-state licensing programs may streamline operations and eliminate unnecessary testing. Many states currently recognize other states' licensing standards and do not require legally licensed out-of-state applicants to complete the battery of operator licensing tests to qualify for a driver's license and motorcycle endorsement. Another form of reciprocity is for state licensing agencies that currently reward rider training graduates with an endorsement to extend that reward to out-of-state applicants who submit appropriate training credentials recognized by the host state. Both of these initiatives will likely reduce traffic at licensing offices and should improve compliance with state licensing laws.

For more information on motorcyclist licensing elements in the United States, see Strategy 11.1 C1. Another related strategy that addresses licensing of motor vehicle drivers can be found in *NCHRP Report 500, Volume 2,* "A Guide for Addressing Collisions Involving Unlicensed Drivers and Drivers with Suspended or Revoked Licenses."

EXHIBIT V-42
Strategy Attributes for Identifying and Removing Barriers to Obtaining a Motorcycle Endorsement

Technical Attributes	
Target	The target of this strategy is unendorsed motorcyclists.
Expected Effectiveness	This strategy has been shown to be effective in increasing the number of endorsed riders. In Minnesota, over a 4-year demonstration period, 3,320 riders completed the endorsement process during special "evening hours" programs. While it has been shown that this strategy increases the number of riders who complete the endorsement process, no formal evaluations have been conducted to determine the effectiveness of this strategy in reducing the number of motorcycle crashes or fatalities.

EXHIBIT V-42 (Continued)
Strategy Attributes for Identifying and Removing Barriers to Obtaining a Motorcycle Endorsement

Keys to Success	This strategy requires an administrative effort, and the success is dependent on the following: • *Defining the scope of the problem*. A representative sample of vehicle licensing and driving records should be compared to determine how many of the people owning motorcycles are not legally eligible to operate them. • *Identifying stakeholders and coordinating effort*. Key stakeholders include the motorcycling groups and organizations, the Motorcycle Safety Advisory Committee, transportation and/or motorcycle safety specialists, licensing officials, and law enforcement. • *Developing a plan*. The communities with the greatest population of unendorsed riders should be identified and targeted. If possible, the community of riders who lack licensing credentials to ride motorcycles should be informed of the motorcycle licensing requirements and encouraged to comply with state law. This is the most effective targeting means, for it puts the violators "on notice." Finally, highway agencies should partner with the licensing and motorcycle safety program to offer weekend or evening testing hours. • *Promoting the benefit of proper endorsement through public information and education*. Highway agencies should coordinate with the media and information sources to promote this strategy. • *Obtaining enforcement and judicial support*. This support is crucial, especially in the targeted communities.
Potential Difficulties	Obtaining cooperation from the licensing authority to provide after-hours testing may be problematic. Likewise, the state/region may not allow third-party testing, thereby eliminating outside sources (e.g., the rider training community) from assisting with this strategy.
Appropriate Measures and Data	To identify the scope of the problem, local/regional data must be compiled. It is important to know how many of the state's or region's motorcyclists are riding without an endorsement. This forms the baseline for future evaluation of the program's impact. Once the program is implemented, data should be compiled on the number and location of testing sites, the number of people participating, and how those numbers compare with past years. The number of applicants who completed the endorsement process during regular business hours over the same time period should be tracked, including how many had testing waived for successful completion of rider training. Coordination with rider training providers is advised to identify and track those who complete rider training successfully to learn how many complete the endorsement process. Coordination with law enforcement is recommended to track the number of violators identified during the program period and track the rate of compliance.

EXHIBIT V-42 (Continued)
Strategy Attributes for Identifying and Removing Barriers to Obtaining a Motorcycle Endorsement

Associated Needs	The motorcycling community should know that this program is going into effect. Highway agencies should communicate directly with that population by developing promotional materials and circulating them to dealers, clubs, and organizations, and at rallies and events. The support of the Motorcycle Advisory Committee and advocacy groups should be enlisted to further spread the word. Information regarding the number of riders who are involved in a crash, and do not have the proper qualifications, is essential to understanding the scope of the problem within a given region. If such information is not currently reported on the crash data forms, then appropriate procedures should be initiated to update the highway agency crash reporting forms to include such information.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	The goal of this strategy is to get motorcycle riders properly licensed or endorsed. The involvement of enforcement, judicial, licensing, motorcycle/transportation safety and data personnel is required. Engaging the involvement of key stake holders in the motorcycling community is important to gain consensus and cooperation. Some courts employ a “deferred judgment” approach, whereby the court gives the violator limited time to obtain proper licensure. If proper licensure is obtained, no further court action is taken. The court system needs to be supportive of whatever enforcement and licensing actions are taken. The licensing agency needs to make license status data available.
Issues Affecting Implementation Time	The time required to implement this strategy should be brief. This strategy should be timed to coincide with the warmer months and longer days of the “riding season.”
Costs Involved	Costs involved should be minimal if existing personnel are assigned. There are some expenses for data runs and promotional pieces. There will be additional costs if it is necessary to increase law enforcement beyond existing resources.
Training and Other Personnel Needs	No special training should be required. Officers already check license status of violators. They just need to be reminded to inspect a motorcyclist’s license for the appropriate designation to indicate compliance with state licensing laws.
Legislative Needs	No legislation is required to launch this strategy. However, it is advisable to review the motorcycle permit renewal policy to determine if that policy provides a long-term mechanism for avoiding the endorsement process. If so, the allowable time for a permit should be limited.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

The Minnesota Motorcycle Safety Program conducted the Enhanced Motorcycle Licensing Project, initiated in 1995 with NHTSA Section 403 assistance. The goal of the project was to increase the number of safe motorcycle operators by developing a program targeting unendorsed motorcycle operators and creating a program that simplifies the endorsement process and eliminates disincentives for compliance. The report identified the following disincentives:

- Motorcycle permits cost $2.50 and are renewable for $1.00, while the endorsement fee is $16
- Driver exam stations are overcrowded, forcing an endorsement applicant to schedule the skills test months in advance
- Skills tests were often postponed due to rain

The disincentives were removed. Extended evening motorcycle testing hours were provided at select exam stations throughout the state. A strong public information and media effort advertised the evening hours, and the state motorcycle safety program made available state-owned training motorcycles for endorsement applicants to use. An average of 800 motorcycle operators took advantage of the opportunity in each of the first 3 years of the program, with 920 operators participating in the last year, 1998. When polled, 88.5 percent of the respondents reported that evening hours were an important incentive; 33 percent disclosed that they would not have taken the skills test without evening hours. Visit http://www.nhtsa.dot.gov/people/outreach/safedige/Winter1999/n5-128.html.

The state of Maryland formed a Motorcycle Safety Task Force comprising NHTSA Region 3, Motor Vehicle Administration (MVA), the Maryland Highway Safety Office (MHSO), the National Study Center, State Police and ABATE of Maryland. The purpose of the task force was to protect motorcyclists by promoting:

- Accurate collection of information
- Additional research
- Broader outreach effort
- Increased funding available
- Development of a long-term plan that can be evaluated

The accomplishments of a diverse group such as this are far greater than individual approaches. This Task Force succeeded in:

- Gathering and linking information to identify the problem—training, licensing, registration, crash reports, hospital reports, crash reconstruction, citations, etc.
- Identifying unlicensed or improperly licensed operators as a significant problem in crashes
- Coordinating roll call training for police departments on investigating motorcycle crashes—evidence and correct information
- Inspecting helmets after a crash

EXHIBIT V-43
MSF's Licensing PSA

- Pilot testing motorcycle crash reconstruction
- Class M (Motorcycle) licensing effort included comparing vehicle registration data with licensing data to identify those who owned motorcycles but were not endorsed. The findings showed 14 percent of the state's riders lacked the M endorsement. A letter was sent to these individuals reminding them of that legal requirement. As a result, 1,700 people (a response rate of 17 percent) got an M license. After-hours testing was conducted in which 300 individuals participated.

The Motorcycle Safety Foundation (MSF) supports motorcycle licensing programs and has developed licensing PSAs for print and web applications in a variety of sizes and formats and will provide them at no cost to the state. Contact the MSF for more information.

Objective 11.1 D—Reduce the Number of Motorcycle Crashes by Increasing the Visibility of Motorcyclists

Strategy 11.1 D1—Increase the Awareness of the Benefit of High-Visibility Clothing (E)

General Description

A common complaint of many motorcyclists is that passenger car drivers often do not see them and, as a result, violate the motorcyclists' right-of-way. This issue was addressed in the Hurt Study (Hurt et al., 1981) as well, which reported many passenger car drivers as saying "I didn't see him" or "He came out of nowhere." The Hurt Study also found that "the failure of motorists to detect and recognize motorcycles in traffic is the predominating cause of motorcycle accidents." Hurt identified that riders who wore camouflage or other hard-to-see apparel were over-represented in right-of-way crashes, suggesting that conspicuity also plays a role in crash avoidance. Other research also suggests that motorcycle conspicuity is a contributing factor in motorcycle-automobile collisions (Wells et al., 2004).

The National Agenda for Motorcycle Safety (NHTSA, 2000) reports:

> One of the easiest and most effective ways for a motorcyclist to be seen by other motorists is by wearing brightly colored, upper-torso clothing and/or retro-reflective material. However, only minorities of motorcyclists choose such brightly colored apparel, whether for fashion or other reasons.

The predominant color of motorcycle apparel is black: black leather jackets, black gloves and boots, and black helmets. NAMS reports that more than one-half of the motorcycle helmets sold in the United States are black. The problem with black is that it is inconspicuous in the day and, in the absence of any retro-reflective material, invisible at night or in low-light

conditions. While motorists must be responsible for actively looking for motorcyclists, it is incumbent upon motorcyclists to recognize how conspicuity issues affect their safety and to prepare accordingly.

According to the New Zealand study, *Motorcycle Rider Conspicuity and Crash Related Injury: Case-Controlled Study,* (Wells et al., 2004):

- Riders wearing any reflective or fluorescent clothing had a 37 percent lower risk of being in a crash when compared to riders who did not wear reflective or fluorescent clothing.
- Compared with wearing a black helmet, use of a white helmet was associated with a 24 percent lower risk of being in a crash.
- Self–reported use of a light-colored helmet versus a dark-colored helmet was associated with a 19 percent lower risk of being in a crash.

Increased awareness of this issue can occur at the state level by integrating this information into driver training programs—drivers can be made more aware of the motorcycle and the motorcycle rider. Similarly, motorcycle rider training programs can emphasize the concept of motorcycle conspicuity. Rider training programs should promote conspicuity and provide specific examples of how riders can improve their visibility to surrounding traffic.

Motorcyclists can immediately and inexpensively improve conspicuity, and thus their safety, by wearing retro-reflective material on their clothes and helmets. Retro-reflective vests are especially effective at increasing visibility at night, and come in a variety of colors to complement the rider's apparel.

Highway agencies should partner with the motorcycling community and the state's motorcycle safety authority to implement this strategy through education, information and awareness.

EXHIBIT V-44
Strategy Attributes for Increasing the Awareness of the Benefit of High-Visibility Clothing

Technical Attributes	
Target	The targets of this strategy are motorcycle riders and passengers, as well as the motorcycle-safety and rider-training community.
Expected Effectiveness	The effectiveness of increasing the awareness of the benefits of conspicuous clothing has not been satisfactorily quantified.
Keys to Success	The key to success includes accurately identifying the scope of the crash problem that may be effectively treated with a public education campaign. A targeted motorist awareness campaign can add to the effectiveness of the strategy, especially in those states with a high incidence of multiple-vehicle crashes involving motorcycles (see Appendix 2). Motorcyclists may be effectively reached at rallies and similar events. It is important to involve the motorcycle rider and safety community in the development and distribution of the material used for this strategy. It may be useful to contact producers of motorcycles and motorcycle gear to identify creative ways of improving visibility (e.g., through creating attractive retro-reflective materials), and then market these to the community.

EXHIBIT V-44 (Continued)
Strategy Attributes for Increasing the Awareness of the Benefit of High-Visibility Clothing

Potential Difficulties	A potential difficulty with this strategy is accurately targeting the appropriate group of motorcyclists. That is, it may be difficult for highway agencies, and the group of stakeholders with which they are working, to identify where motorcyclists congregate and can be expected to view the public information material. Another potential difficulty is effecting change in a long-established culture. Riders may be very reluctant to put aside the traditional black leather in favor of high-visibility treatments.
Appropriate Measures and Data	Depending on the scope of effort, process measures could include the existence of a coordinated system, number of meetings held, number and type of materials produced, and number of postings and contacts made. Roadside evaluations should be conducted before and after the campaign to measure the campaign effectiveness in increased use of protective apparel.
Associated Needs	A media and information campaign would make riders aware of the benefits of high-visibility clothing.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees are comprised of motorcycle leaders, authorities and activists from across the state, and include representatives from State Police, DMV, Transportation Safety and the state's motorcycle safety program. Partnering with MSAC groups is essential to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community. Broadening organizational involvement to include the private sector, such as those that produce motorcycles and motorcycle-rider gear may add a needed dimension to the effectiveness of the strategy, through effective marketing.
Issues Affecting Implementation Time	A public awareness campaign aimed at motorcyclists should be targeted around the prime riding season, when motorcyclists are most likely to be congregating at locations where the public awareness material is distributed (e.g., riding events, etc.). Public awareness campaigns are most effective when timed to coincide with the riding season. This will entail highway agencies beginning to work on this strategy well in advance of the prime riding season, in order to have the public awareness campaign ready.
Costs Involved	Costs vary depending on the size of the campaign.
Training and Other Personnel Needs	Increasing the awareness of the benefit of high-visibility clothing does not require training or additional agency personnel, but it does require awareness of the conspicuity issues, a priority to address conspicuity issues, and a willingness to partner with key stakeholders to begin the process of effecting change.
Legislative Needs	None identified.
Other Key Attributes	
	Public education and information activities complement this strategy. Educational materials may be required to inform those implementing this strategy of effective treatment methods.

EXHIBIT V-45
Public Service Announcements for Appropriate Cycling Clothing

Information on Agencies or Organizations Currently Implementing This Strategy

In Exhibit V-45, the sample on the left from the TEAM OREGON *Basic Rider Training Rider's Guide* provides information on the characteristics of good riding gear, including conspicuity treatments.

The Motorcycle Safety Foundation (MSF) has developed training and licensing PSAs for print and web applications in a variety of sizes and formats and will provide them at no cost to the state. See the "Street Wise" sample in Exhibit V-45 on the right. Contact the MSF for more information.

The Gold Wing Road Riders Association (GWRRA) has created a publication to educate members on ways to improve conspicuity. For more information, visit: http://www.gwrra-mi.org/MAD/conspicuity.pdf.

Strategy 11.1 D2—Identify and Promote Rider Visibility-Enhancement Methods and Technology (T)

General Description

Motorcyclists who are inconspicuous are over-represented in crashes (Wells et al., 2004). Depending on the trends and patterns of crash data, conspicuity may be a significant factor in accident causation. This strategy promotes motorcyclist safety through visibility-enhancing methods and technology.

The Hurt Study (Hurt et al., 1981) found that "the failure of motorists to detect and recognize motorcycles in traffic is the predominating cause of motorcycle accidents." The study also identified intersections as the most likely place for crashes to occur and determined that the conspicuity of the motorcycle is a critical factor in these crashes. Accident involvement was significantly reduced by the use of motorcycle headlights during the day and conspicuity (e.g., light/bright colors) of the motorcycle and rider frontal surfaces.

The *National Agenda for Motorcycle Safety,* developed by NHTSA, identified a variety of recognized tactics to make motorcycles and riders more conspicuous, including

lighting, surface color and size, and rider traffic strategy (NHTSA, 2000). Lighting factors include:

- Headlights that automatically illuminate when the motorcycle is started. This technology has been featured on most motorcycles since 1979. Twenty-three states have laws requiring the use of daytime headlights for motorcycles (Motorcycle Industry Council, 2000). It is estimated that 86 percent of motorcycles on the road have their headlight on during the daytime (Turner and Hagelin, 2000).
- Auxiliary headlights, such as those found on large cruiser style motorcycles, are useful for increasing frontal visibility.
- Auxiliary LED brake lights that flash while the brakes are applied provide extra warning to following traffic. Unfortunately, these devices are not legal in all states because some states prohibit the use of flashing red lights on anything but emergency vehicles. A strong case can be made for legislation to legalize these safety devices.
- Auxiliary LED wireless brake lights can be installed on helmets and saddlebags.
- Headlight modulators are available, but not widely used. These devices cause the motorcycle headlight to pulse at 240 cycles per minute (plus/minus 40). Headlight modulators are permitted in all 50 states (FMVSS 108).
- Some modern motorcycles are equipped with position lamps that provide full-time illumination of the front turn signals. Aftermarket products are available that accomplish the same objective. Some devices illuminate the rear turn signals as red brake lights when brakes are applied.

The position of a motorcycle within the lane is a critical visibility factor. It is essential that motorcyclists place themselves in clear view of surrounding traffic. Motorcyclists that hide in traffic place themselves at greater risk of right-of-way violations. Rider training programs promote effective lane positioning to account for visibility, lane protection, roadway hazard detection, space cushion, following distance and escape path.

Highway agencies should promote measures to improve motorcycle conspicuity by supporting public information and education programs and by partnering with the rider training community to advocate for rider education, training, and safety. Increasing the use of daytime headlights and other conspicuity-enhancing measures are inexpensive and valuable interventions. States that do not currently require the use of daytime headlights for motorcycles may consider enacting such a law. States in which auxiliary LED lights are not legal may consider not only making them legal but requiring them.

EXHIBIT V-46
Strategy Attributes for Identifying and Promoting Visibility-Enhancement Methods and Technology

Technical Attributes	
Target	The target of this strategy is motorcycle riders and passengers, as well as the motorcycle safety and rider training community.
Expected Effectiveness	The effectiveness of increasing the awareness of the benefits of visibility methods has not been satisfactorily quantified.

EXHIBIT V-46 (Continued)
Strategy Attributes for Identifying and Promoting Visibility-Enhancement Methods and Technology

Keys to Success	The key to success is to involve the motorcycle rider and safety community in the research, development and distribution of information regarding this strategy. Identify state laws that prohibit visibility-enhancing methods, and work to change the laws. It may be useful to contact producers of motorcycles and motorcycle wear to identify creative ways of improving visibility (e.g., through creating attractive retro-reflective materials), and encourage their production.
Potential Difficulties	A potential difficulty with this strategy is accurately targeting the appropriate group of motorcyclists. That is, it may be difficult for highway agencies, and the group of stakeholders with which they are working, to identify where motorcyclists congregate and can be expected to view the public information material. Motorcyclists may be effectively reached at rallies and similar events. Also, visibility-enhancement methods and technology need to be affordable and readily available to motorcyclists.
Appropriate Measures and Data	Depending on the scope of effort, process measures could include the existence of a coordinated system, number of meetings held, number and type of materials produced, and number of postings and contacts made. Roadside evaluations should be conducted before and after the campaign to measure the campaign effectiveness of increased use of visibility-enhancement methods and technology.
Associated Needs	A media and information campaign.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees comprise motorcycle leaders, authorities and activists from across the state, and include representatives from state police, DMV, transportation safety and the state's motorcycle safety program. Partnering with MSAC groups is important to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community. Broadening organizational involvement to include the private sector, such as those that produce motorcycles and motorcycle-rider gear, may add a needed dimension to the effectiveness of the strategy.
Issues Affecting Implementation Time	A public awareness campaign aimed at motorcyclists should be targeted around the prime riding season, when motorcyclists are most likely to be congregating at locations where the public awareness material is distributed (e.g., riding events, etc.). Public awareness campaigns are most effective when timed to coincide with the riding season. This will entail highway agencies beginning to work on information programs well in advance of the prime riding season, in order to have the public awareness campaign ready.
Costs Involved	Costs vary depending on the scope and size of the campaign.

EXHIBIT V-46 (Continued)
Strategy Attributes for Identifying and Promoting Visibility-Enhancement Methods and Technology

Training and Other Personnel Needs	Identifying and promoting visibility-enhancement methods and technology does not necessarily require training or additional agency personnel, but it does require awareness of the conspicuity issues, knowledge of visibility-enhancement methods and technology, a priority to address conspicuity issues, and a willingness to partner with key stakeholders to begin the process of effecting change.
Legislative Needs	Some states prohibit the use of pulsing auxiliary brake lights. Products that serve to improve visibility and reduce the likelihood of crashes should be evaluated. When appropriate, laws should be revised to promote these safety measures.
Other Key Attributes	
	Public education and information activities complement this strategy. Educational materials may be required to inform those implementing this strategy of effective treatment methods.

Information on Agencies or Organizations Currently Implementing This Strategy

An Oregon law enforcement agency installed auxiliary LED brake light bars on their fleet of police enforcement motorcycles. The LED lights flash to draw attention to the stopping motorcycle. However, the state's Attorney General ruled that state law prohibits flashing red lights for use in any circumstance other than on emergency vehicles where allowed. The LED devices were removed. The state law was subsequently changed to allow such devices.

Objective 11.1 E—Reduce the Severity of Motorcycle Crashes

Strategy 11.1 E1—Increase the Use of FMVSS 218 Compliant Helmets (P)

General Description

The objective of this strategy is to reduce the severity of motorcycle crashes by increasing the use of FMVSS 218 compliant helmets among motorcycle riders.[1] When worn, helmets are estimated to be 37 percent effective in preventing fatalities in crashes. Enactments of universal helmet laws have consistently been associated with a 90- to 100-percent increase in helmet usage, a 20- to 40-percent decrease in fatalities and fatality rates, and approximately a 67-percent decrease in serious head and brain injuries. Universal helmet laws are the only proven way to increase the use of FMVSS 218 compliant helmets. On the other hand, the repeal or weakening of such laws has been associated with a 40- to 50-percent decline in usage and a 20- to 100-percent increase in fatalities and serious injuries, particularly head and brain injuries. These findings have been replicated over several cycles of legislative activity, including two periods of law enactments (1966–1975 and 1990–1995) and two periods of repeals (1977–1981 and 1996–present).

[1] The National Highway Traffic Safety Administration (NHTSA) has developed and enforces Federal Motor Vehicle Safety Standard 218 (FMVSS 218) which provides minimum performance requirements for helmets designed for use by motorcyclists.

Recently, there has been a decline in nationwide helmet usage, particularly from 2000 to 2006, when compliant usage declined from 71 to 51 percent. Coupled with this decline, there has been a dramatic increase in rider fatalities, which have more than doubled since 1995. While factors other than declining helmet use have contributed to the increase in fatalities, state-specific studies consistently show large and significant reductions in helmet use and increases in fatalities and injuries associated with recently repealed or weakened universal helmet laws. Thus, the potential for helmet use to ameliorate the negative impact of the other factors contributing to the increase in motorcycle fatalities has not been realized during this recent period of repeals and declining usage.

With regard to strategies for increasing helmet usage, there is compelling evidence regarding the impact of universal helmet use laws but little or no evidence to suggest that partial laws or other approaches have the potential to achieve high use rates.

In addition to declining helmet use, it appears that FMVSS 218 non-compliant helmets are being worn with greater frequency in recent years. Because such helmets provide no protection in a crash, they do not have fatality-reduction potential.[2] Nationwide non-compliant helmet use was observed to be between 13 and 15 percent in 2006, and there is evidence that non-compliant use is higher in some universal helmet law states. Thus, a second important objective of this strategy is to eliminate the use of non-compliant helmets.

Helmet Effectiveness

Fact: *Motorcycle helmets are effective in reducing fatalities and injuries, particularly serious head injuries.*

A 1991 study, conducted by the U.S. General Accounting Office (U.S. GAO, 1991)[3] found that:

- Helmets were 28- to 29-percent effective in reducing *fatalities.* Helmeted riders suffered fewer serious and critical injuries because of a lower incidence of *head injuries.*
- *Fatality rates* among helmeted riders involved in crashes were 32- to 73-percent lower than among non-helmeted riders (median: 55 percent).

More recent studies based on CODES data[4] reported that:

- Helmets are 35-percent effective in reducing *fatalities* and 26-percent effective in reducing *serious injuries* (Johnson and Walker, 1996).
- Helmets are about 65-percent effective in preventing *brain injuries* (NHTSA, 1998).
- Unhelmeted riders are three times more likely to have *head injuries* requiring EMS transport or hospitalization or resulting in death (Finison, 2001).

[2] In 2006, the last year for which such data were available, there was no significant difference in non-compliant helmet usage between states with universal helmet laws and those with partial or repealed laws.
[3] More recently called the U.S. General Accountability Office.
[4] The Crash Outcome Data Evaluation System (CODES) links data from police crash reports, emergency medical services, hospital emergency departments, hospital discharge files, claims and other sources. States are funded by NHTSA to link statewide crash and injury data. The purpose of the linkage is to find out who is injured in motor vehicle crashes, what types of injuries occur, and how much it cost to treat these injuries over time.

Most recently, a 2004 study of FARS data (Deutermann, 2004)[5] concluded that:

- The *effectiveness of helmets against fatalities was 37 percent,* an increase from 29 percent in the late 1980s, likely associated with improvements in helmet design and materials.[6]

Myth: *Motorcycle helmets increase the incidence of neck injuries.*

Fact: *Research has refuted these claims. Studies that have examined this issue have found fewer head and neck injuries among helmeted riders than among non-helmeted riders.*[7]

Myth: *Motorcycle helmets cause crashes by restricting the operator's field of vision or by inhibiting a rider's ability to hear warning signals*

Fact: *Research has consistently found such claims to be untrue.*[8] *The most recent in a series of studies concluded that wearing motorcycles helmets does not restrict a rider's ability to hear auditory signals or see a vehicle in an adjacent lane* (McKnight and McKnight, 1994).

As a result of the compelling evidence of the safety benefits of helmet use, the *National Agenda for Motorcycle Safety* (NAMS) concluded that:

- *In the event of a crash, no existing strategy or safety equipment offers protection comparable to a FMVSS 218 compliant helmet* (NHTSA, 2000).

Strategies to Increase Helmet Usage

Conceptually, strategies to increase helmet usage can be dichotomized into *mandatory* and *educational* approaches. Within the mandatory approach, there have been *universal helmet laws,* which require use among all age groups and under all conditions; and there have been *partial helmet laws,* which generally require use only among riders under age 21 or under age 18.[9]

Effectiveness of Universal Helmet Laws

Fact: *Observed usage among riders in universal helmet law states is 60- to 100-percent greater than in other states.* Examples include:

- Thirteen years of observations in 19 U.S. cities documented that motorcycle operator usage averaged about 96 percent in states with universal helmet laws and 45 percent in all other states.[10]

---

[5] FARS refers to the National Highway Traffic Safety Administration's Fatality Analysis Reporting System, a census of all crash-related fatalities occurring on public roadways.

[6] According to the 2004 report, one of the more significant improvements in helmet material has been the use of Kevlar, expanded polypropylene, and carbon fiber in helmet shells and linings.

[7] These studies included Newman (1974), Nebraska Dept. of Public Roads (1975), Carr, Brandt and Swanson (1981), Hurt et al. (1981), Kelley et al. (1989), Sakar, Peek, and Kraus (1995), and Rowland et al. (1996).

[8] Early research included studies by Gordon and Prince (1975), Henderson (1975), Van Moorhem et al. (1977), Lummis and Dugger (1980), and by Hurt et al. (1981).

[9] Some states also have other provisions or contingencies, such as having a minimum of $10,000 in medical insurance.

[10] Data collected in 1979, 1980, 1981, and 1982 were from surveys conducted by Opinion Research Corp. and reported by Phillips (1980 and 1983). Data collected from 1983 through 1991 were from surveys conducted by Goodell Grivas Inc. They included the following years of data and reports: 1983 use rates (Perkins, Cynecki, and Goryl, 1984); 1984 use rates (Goryl and Cynecki, 1985); 1985 use rates (Goryl, 1986); 1986 use rates (Goryl and Bowman, 1987); 1987–88 use rates (Bowman and Rounds, 1988 and 1989); and 1989–91 use rates (Datta and Guzek, 1990, 1991, and 1992).

- The 2006 National Occupant Protection Use Survey (NOPUS) found 83-percent helmet use overall in states with universal helmet laws and 50-percent use in all other states.[11]
- In addition to these survey results, at least 19 studies conducted in individual states have shown this large difference in observed usage between states with universal helmet laws and other states, leading the U.S. General Accounting Office to conclude that *helmet use is consistently higher under universal helmet laws* (U.S. GAO, 1991).

Fact: *Helmet usage among crash-involved riders in states with universal helmet laws is generally twice the rate of usage among such high-risk riders in states with partial helmet laws and no helmet laws.*

- Results from the GAO review show usage among *crash-involved riders* in universal helmet law states to be more than twice the usage among such riders in partial helmet law states. Median usage rates were 95 and 42 percent, respectively.

Fact: *When a universal helmet law is enacted (or re-enacted), observed usage generally doubles and fatalities decline by 20 to 40 percent.* Examples include:

- In Louisiana, following a 1982 re-enactment, observed usage increased from 50 to 96 percent (McSwain, and Willey, 1984).[12] Following a subsequent downgrade in 1999, usage again declined to 50 percent (Ulmer and Preusser, 2003).
- Texas twice enacted and twice repealed its universal helmet law. Usage increased from 50 to 95 percent with its initial law in 1968, then declined to below 45 percent following a repeal in 1977 (Lund et al., 1991). Usage increased for a second time, to near 100 percent following a 1989 universal helmet law re-enactment, then fell to 66 percent following a 1997 repeal (Preusser, Hedlund, and Ulmer, 2000). Two studies suggested that the 1989 re-enactment was associated with a 55-percent reduction in serious head-related injuries (Mounce et al., 1992, Fleming and Becker, 1992).
- In California, usage increased from 50 to 99 percent following enactment of a universal helmet law in 1992. Fatalities declined by 37 percent and the fatality rate (per registered motorcycle) declined by 26 percent (Kraus et al., 1994; 1995b). Another study found that the average annual number of rider fatalities was 54 percent lower in the 5 years after the law than in the 5 years prior to the law (Ulmer and Preusser, 2003), providing evidence of a long-term impact of the law.
- In Maryland, a 1992 re-enactment was followed by a 42-percent decline in average annual fatalities (5 years before the law versus 5 years after the law), based on autopsy reports (Mitchell et al., 2001).[13]

Fact: *Partial helmet laws, resulting from downgrades of universal helmet laws, are associated with large declines in observed usage (by as much as 50 percent), declines in usage among crash-involved riders (of about 40 percent), and by increases in fatalities.* Examples include:

- The 1980 Report to Congress, which reviewed all studies prior to 1980, reported that repeals or downgrades were followed by 50-percent declines in observed usage[14] and

[11] Usage rates include 15 percent non-compliant use in universal law states and 13 percent non-compliant use in other states.
[12] Note that the Louisiana law was again repealed in 1999 resulting in another decline from near 100 percent usage to about 50 percent usage (Ulmer and Preusser, 2003).
[13] After the 5-year post-law period, fatalities increased in Maryland, as they did nationwide (Ulmer and Preusser, 2003).
[14] These results are identical to those of the 19-cities surveys conducted throughout the 1980s.

declines of more than 40 percent in usage among **crash-involved riders** (from near 90 to 50 percent).[15]

More recently, universal helmet laws have been repealed in Arkansas and Texas (1997), Kentucky (1998), Louisiana (1999), Florida (2000), and Pennsylvania (2003). Evaluations have been conducted in nearly all of these states. These evaluations found:[16]

- Significant declines in **observed usage,** from pre-repeal levels of 95 to 100 percent to post-repeal levels of 50 to 60 percent.[17]
- A 35-percent median decline in **usage among crash-involved riders** in Arkansas, Texas, Kentucky, Louisiana, and Florida, from 60- to 93-percent usage under universal helmet laws to 30- to 60-percent usage after repeals.
- More importantly, a median 50-percent increase in **fatalities** (range: 20 to 100 percent). Fatalities per registered motorcycle increased as well.

Fact: *Usage among young riders covered by partial helmet laws is substantially lower under such laws than under universal helmet laws.* Examples include:

- In Texas, only 29 percent of **injured riders under age 18** were found to be helmeted under a partial helmet law (U.S. GAO, 1991).
- In North Dakota, only 44 percent of **young riders involved in crashes** were helmeted under a partial helmet law (Heilman et al., 1982).
- A 2000 downgrade in Florida was associated with a 26-percent decline in usage **among young riders killed,** along with nearly a 200-percent increase in fatalities among such riders (Ulmer and Shabanova-Northrup, 2005).

Myth: *Changes in fatalities associated with universal helmet law enactments or repeals are the result of changes in motorcycle registrations, rather than a result of the law changes.*

Facts: *During some time periods, such as when there are large changes in registrations, some of the changes in fatalities have been associated with increases or decreases in motorcycle registrations.*

Many studies have controlled for such changes by reporting impact in terms of fatalities per registered motorcycle and by comparing changes in state rates (post-law versus pre-law and/or state versus national changes in rates).

These studies show substantial increases in usage associated with universal helmet law enactments, despite downward trends nationwide, and they show large and significant reductions in fatality rates, compared with national trends. Examples include:

- Eight GAO-reviewed studies showed a median 33-percent reduction in fatalities **per registered motorcycle** under universal helmet laws, *compared with pre-enactment periods* (range: 20 percent to 58 percent).

---

[15] These early studies included Krane and Winterfield (1980) and Struckman-Johnson and Ellingstad (1979).

[16] These studies included: Preusser et al. (2000); Ulmer and Preusser (2003); Muller (2004); and Ulmer and Shabanova-Northrup (2005).

[17] The high rate of use in Florida, prior to repeal, included a substantial percent of riders wearing non-compliant helmets.

- Twelve GAO-reviewed studies showed a median 35-percent lower rate of fatalities **per registered motorcycle** under universal helmet laws, *compared with subsequent repeal or downgrade periods* (range: 12 to 62 percent).

It should be noted that, as a result of these findings, the GAO reviewers concluded that "Congress may wish to consider encouraging states to enact and retain universal helmet laws; and that . . . this could be accomplished via the use of penalties, incentives, or a combination of the two" (U.S. GAO, 1991, page 31).

More recent studies of enactments have also controlled for changes in registrations. For example:

- Following the California enactment, *fatalities* declined by 37 percent and the rate of *fatalities per registered motorcycle* declined by 26 percent (Kraus et al., 1994).
- The 1989 universal helmet law re-enactment in Nebraska was accompanied by a sharp decline in the number and *rate of injuries per registered motorcycle* (Muelleman et al., 1991).

Similarly, recent studies of repeals or downgrades have found that:[18]

- The 1998 repeal in Kentucky was followed by a 38-percent increase in *fatalities per registered motorcycle.*
- The 1999 repeal in Louisiana was followed by a 75-percent increase in *fatalities per registered motorcycle.*
- The 2000 repeal in Florida was followed by a 21-percent increase in *fatalities per registered motorcycle.*

Thus, while some change in fatalities (and injuries) can be explained by changes in registrations, large and significant changes are also associated with law changes.

Nationwide Changes in Fatalities, Registrations, and Fatality Rates Since 1975

The number of registered motorcycles has generally increased over time. As indicated, these changes are important when considering the impact on fatalities and injuries associated with helmet legislation. Following are trends in rider fatalities, motorcycle registrations, and fatalities per registered motorcycle since 1975 (when initial repeals began):

- *1975–1980 (26 repeals):* Registered motorcycles increased by 20 percent, fatalities increased by 55 percent, and fatalities per registered motorcycle increased by about 35 percent.
- *1981–1990 (little change in laws).* Registrations declined by 20 percent, fatalities declined by 25 percent, and fatalities per registered motorcycle declined by about 5 percent.
- *1990–1994 (modest number of enactments).* Registrations declined by 20 percent, rider fatalities declined by 26 percent, and fatalities per registered motorcycle declined by 12 percent.
- *1995 to 2005 (modest number of repeals):* Registered motorcycles increased by 60 percent, fatalities doubled, and fatalities per registered motorcycle increased by 28 percent.

[18] These data come from studies conducted by Ulmer and Preusser (2003).

EXHIBIT V-47
Motorcycle Rider Fatality Rates by Legislative Phase

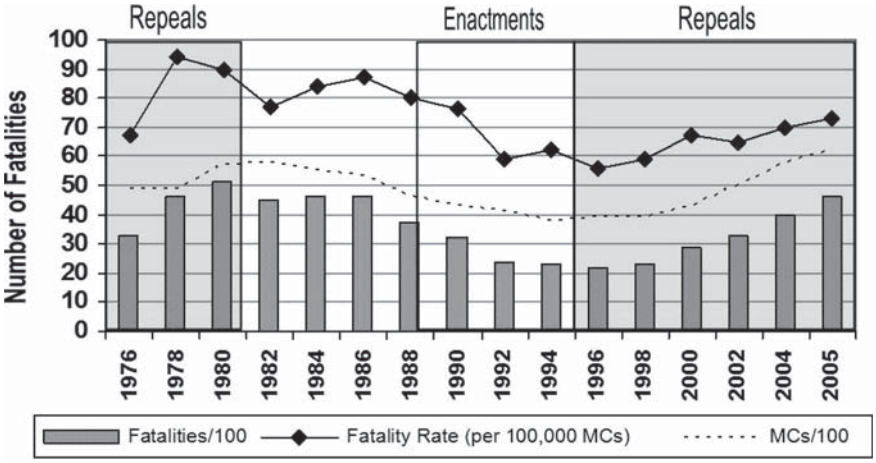


EXHIBIT V-48
Motorcycle Fatalities, Registrations, Mileage, and Fatality Rates (2-Year Intervals)

Legislative Phase	Year	Number of MC Rider Fatalities	Number of Registered Motorcycles (1,000s)	Number of Fatalities Per 100K MCs
Initial Repeals	1976	3,312	4,933	67.1
	1978	4,577	4,868	94.0
	1980	5,144	5,694	90.3
Little Activity	1982	4,453	5,754	77.4
	1984	4,608	5,480	84.1
	1986	4,566	5,262	86.7
	1988	3,662	4,584	79.9
Re-Enact	1990	3,244	4,259	76.2
	1992	2,395	4,065	58.9
	1994	2,320	3,757	62.4
Repeals And Downgrades	1996	2,161	3,872	55.8
	1998	2,294	3,879	59.1
	2000	2,897	4,346	66.7
	2002	3,270	5,004	65.4
	2004	4,028	5,781	69.7
	2005	4,553	6,227	73.1

Summary of Effectiveness: Universal and Partial Helmet Laws

- *There is strong evidence of the effectiveness of universal helmet laws in that they are associated with large and significant increases in usage and declines in fatalities, fatality rates, injuries (particularly head and brain injuries), and reduced medical costs.*
- *Partial helmet laws have been shown to be ineffective in maintaining high usage rates; these repeals or downgrades to universal helmet laws have been associated with substantial declines in usage (observed and among crash-involved riders) and with increases in fatalities and injuries.*

As a result of these facts, in September 2007, the National Transportation Safety Board (NTSB) has recently issued a recommendation that all states with partial or no helmet laws enact a universal helmet law to increase helmet use and decrease fatalities and serious injuries.

Costs Associated with Helmet Non-Use

Fact: *Repeals of universal laws have consistently been followed by substantial declines in usage (observed and among crash-involved riders) and increases in serious head and brain injuries. As such, these law changes have also been followed by increased costs associated with such injuries.*

- The most common finding is that crashes involving non-helmeted riders result in more serious head and brain injuries and that these injuries are generally the most expensive to treat.
- The costs associated with brain injuries range from $42,000 to more than $1.4 million per injured rider, depending upon the seriousness of the injury and the range of costs included (Zaloshnja et al., 2004).
- The 1998 CODES study found helmets to be 65 percent effective in reducing brain injuries (NHTSA, 1998).

Fact: *Studies that have looked at the impact of universal helmet laws on costs have generally concluded that enactment (or re-enactment) of such a law significantly reduces head and brain injuries and total costs incurred by riders involved or injured in crashes.*

For example, a critical review of this literature entitled, *Costs of Injuries Resulting from Motorcycle Crashes* found that:

- Helmet use reduced the fatality rate, the probability and severity of head injuries, the cost of medical treatment, the length of hospital stay, the necessity for special medical treatments (including ventilation, intubation, and follow-up care), and the probability of long-term disability (Lawrence et al., 2003).

In addition, this review found that:

- Slightly more than one-half of motorcycle crash victims had private health insurance coverage.
- For patients without private insurance, a majority of medical costs were paid by government sources.

Costs and Barriers Associated with Universal Helmet Laws

The actual costs associated with enacting universal helmet laws are minimal, particularly in comparison with the cost-savings associated with reductions in fatalities and injuries.

However, while the effectiveness and benefits associated with universal helmet laws are large and consistent, the barriers to enacting such laws have become formidable as well. Some motorcycle rider groups oppose such laws on the grounds that they violate personal freedoms. These groups have, in the past, mounted organized campaigns for the elimination of such laws.

If a state proposes a universal helmet law, it can be expected that some rider groups will work hard to oppose it. In addition to the issue of personal freedom, it is likely that such groups will again raise issues regarding helmet causation of neck injuries, restricted vision, and diminished ability to hear warning sounds, issues that have not been supported in the research literature.[19]

On the other hand, public support for universal helmet laws is strong. The 2000 Motor Vehicle Occupant Safety Survey (MVOSS), the last MVOSS that surveyed this issue, found that just over 80 percent of the public supported a universal helmet law. Support was lower (51 percent) among current or recent riders of motorcycles (NHTSA, 2006a).

In spite of objections by some riders, it is clear that helmet use and universal helmet laws have been proven to reduce motorcycle head injuries, fatalities, and associated costs. From an evidence-based perspective, a recent review of *Countermeasures That Work* found universal helmet laws to be the only proven effective strategy for increasing helmet use (GHSA, 2007).

Elements of a Strategy to Enact Universal Helmet Laws

Work with Motorcycle Rider Organizations. Enacting or re-enacting a universal helmet law will likely face stiff opposition from some rider organizations. It is important to work with such organizations, to the extent possible, to convince them of the proven life-saving and injury-prevention potential of such laws. That will likely be a difficult task but every effort should be made.

Form Broad-based Coalitions. Nearly all successful efforts to enact universal helmet laws have involved broad-based coalitions that have included law enforcement, insurance, medical, public health, advocacy and safety organizations.

Hire Someone to Coordinate Your Campaign. Opposition to universal helmet laws is strong and very well-organized. In order to present your case and convince a sufficient number of legislators to vote for your bill, you must also be well-organized and have someone to spear-head the activity. This will require the coordination of support and resources from many potential allies and advocates.

Gain Bipartisan Support in the State Legislature. Many successful coalitions have been able to gain sponsors from both parties.

Use Paid Lobbyists. It is important to enlist the services of paid lobbyists. They understand the dynamics of the legislature and they have existing relationships, usually among both parties.

Gain the Support of the Governor and His/Her Staff. This is a critical element in efforts to obtain a universal helmet law. There have been cases where such legislation has been enacted but the Governor failed to sign it and there have been examples where such laws have been repealed but the repeal was vetoed by the Governor. Work with the Governor's staff early to make sure they understand the strength of the evidence in support of such a law, public opinion with regard to such laws, the costs associated with helmet non-use and the cost-savings associated with helmet use.

[19] At the end of this section there are links to websites representing some of the groups and arguments in support of and opposition to universal helmet laws.

Conduct Public Opinion Polls. Measure the support for a universal helmet law. This may help to convince legislators that the vast majority of the public supports universal helmet laws.

Conduct Evaluations and Cost-Savings Analyses. It is important to understand and be able to communicate the current status of usage rates (observed and among crash-involved and injured motorcycle riders), fatalities, injuries (particularly severe head injuries), and costs associated with existing law and to predict likely changes if a universal helmet law is enacted.

Make Use of Existing Resources. Many organizations have conducted research and developed materials to aid advocates of universal helmet laws. Make use of these organizations, their websites, and the materials that they have developed.

Increasing Helmet Use Through Education

Conceptually, an alternative strategy for increasing motorcycle helmet usage is to communicate the benefits of helmet use to riders and rider groups and to promote use of FMVSS 218 compliant helmets.

The *National Agenda for Motorcycle Safety* (NHTSA, 2000) for example, states that, "All motorcyclists should choose to wear protective apparel because they understand that such apparel can reduce injuries in a crash. All motorcyclists should want to wear FMVSS 218 compliant helmets while riding to reduce head trauma resulting from a crash."

Effectiveness of Strategies to Increase Helmet Use Through Education

Evidence to Support the Potential for Impact. We found no research to suggest that riders will voluntarily choose to use safety helmets, regardless of the frequency or type of messages communicated to them, particularly messages regarding safety benefits. Such benefits have been known for more than 60 years and they have been communicated to motorcycle riders.

Efforts to Increase Seat Belt Use Through Education. Experience with safety belt usage provides some interesting parallels. Prior to 1984, when the first safety belt use law was enacted, more than 20 years of efforts to promote safety belt usage had little or no impact.[20] Usage remained well below 30 percent in any community that implemented a comprehensive communications effort. The most publicized examples were:

- In Oakland County, Michigan, where a campaign consisting of print, radio, and television ads increased usage (temporarily) from 18 to 21 percent (Oakland County Traffic Improvement Association, 1969)
- In Southeast Michigan, where a $900,000 media campaign was associated with an increase in usage from 12 to 17 percent (Motorists Information Inc., 1978)

[20] This was also the case in more than 20 foreign nations, including Australia, Canada, and several European nations, including France, Germany, Great Britain, etc. In several of these countries extensive multi-year public information and education efforts were mounted, sometimes with expensive paid media campaigns and incentive programs. None of these nations was able to attain a usage rate greater than 40 percent until a mandatory safety belt use law was enacted. After such enactment, usage immediately increased to 70–90 percent in nearly every case (Nichols, 2002).

- In California, public service campaigns in three moderate-size towns resulted in no significant increase in safety belt usage (Fleischer, 1973)
- Another controlled evaluation of an extensive cable television campaign in New York resulted in no measured impact on safety belt usage (Robertson et al., 1974)

At the national level, an intensive, 5-year program to promote safety belt usage was implemented by NHTSA in 1980. This effort included a multi-million dollar outreach and education effort, involving scores of national organizations, to educate targeted constituencies about the benefits of safety belt use. It also included one of the most popular and widely known public-service media campaigns ever implemented in the United States, the "Vince and Larry" crash dummy campaign. Outreach efforts, media campaigns, and incentive programs were implemented in many states and communities as well. As a result of these efforts, national safety belt usage increased by three percentage points (from 11 percent in 1979 to 14 percent in 1984), as measured by NHTSA's 19-city surveys (Nichols, 2002). At the time, these same surveys were documenting decreases in motorcycle helmet usage associated with law repeals and they were finding the large and significant differences in usage in states with universal helmet laws, compared to states with partial helmet laws and states with no helmet laws.

The single greatest benefit from the 1980–1984 media and outreach campaign may have been that it facilitated the enactment of safety belt laws. Whether or not that was the case, extensive nationwide lobbying for such laws began in 1985, and by 1992, 43 states and the District of Columbia had enacted a safety belt law. National usage increased rapidly and did not return to pre-law levels. In fact, subsequent media and high visibility enforcement campaigns have resulted in sustained increases in national usage to over 80 percent, with some states exceeding 90 percent.

Costs and Barriers to Increasing Helmet Use through Education

The primary barrier to promoting helmet use through education is the fact that there is *no research-based evidence,* domestically or internationally, that such a strategy is effective. In fact, based on research and experience in other areas of safety, there are consistent indications that a public education campaign, based on some combination of media, education, and incentives, would not significantly increase helmet usage.

Another barrier is cost. Any comprehensive media campaign would likely involve repeated waves of media, education, and outreach with (per wave) costs of about 3 to 6 cents per capita for paid advertising alone (based on current *Click It or Ticket* campaigns in various states).

That would translate to $10 to 20 million per wave and, unless such a campaign was designed to support enforcement of a universal helmet law, existing evidence suggests that it would not have a significant impact on usage.

Should a public education campaign be undertaken, the following elements should be included:

- Safety organizations and agencies could *partner with the motorcycle community* to promote knowledge of helmet effectiveness (and of universal helmet law effectiveness). It is important that all motorcyclists understand how FMVSS 218 helmets perform to protect them from injury.

- Additionally, it may be important to convey that helmets provide comfort from exposure to the elements (e.g., sun, wind, rain, temperature extremes, wind-borne insects and debris, etc.), thus allowing riders to concentrate more on the task of riding than on discomforts or distractions.
- A public information effort should also *address common myths* regarding the dangers of FMVSS 218 helmet use (i.e., helmets cause neck injury, restrict vision and hearing), and inform riders about the lack of protection afforded by non-compliant helmets.

In the end, however, unless such a campaign increases support for enactment of universal helmet laws, it is unlikely that it will have any significant impact on the use of safety helmets, particularly among riders most likely to be involved in a potentially fatal crash.

Improve Effectiveness of Enforcing Helmet Standard FMVSS 218

Fact: *Surveys suggest that there has been an increase in the use of helmets that are not compliant with the current FMVSS 218 helmet standard* (Peek-Asa et al., 1999; Turner and Hagelin, 2000).

- Non-compliant helmets, sometimes referred to as novelty or 'beanie-style' helmets, are intended to give the appearance that the rider is wearing a compliant helmet, thereby minimizing the chances of being stopped for a universal helmet law violation.
- Many non-compliant helmets carry a fake DOT label, but they do not comply with the FMVSS 218 standard due to minimal coverage area, lack of impact-absorbing material, and inadequate retention systems.
- At the present time, it is not clear how prevalent such helmets are among crash-involved riders.

Fact: *Non-compliant helmets make enforcement of universal helmet laws more complicated.*

- While *some resources have been provided to help law enforcement officers identify non-compliant helmets,* more needs to be done.
- Because of *difficulties in such identification and in the interpretation of FMVSS 218,* which is an engineering standard, *some law enforcement agencies have reduced their level of enforcement of universal helmet laws.*
- While non-compliant helmets may be obvious to the trained eye, *providing proof that a helmet is non-compliant in court can be difficult.*

Possible Strategy Components

- NHTSA is currently working with appropriate national, state, and local law enforcement organizations to train law enforcement officers to identify noncompliant helmets while also developing training for judges and prosecutors to adjudicate universal helmet law violations.
- NHTSA is currently preparing a proposed *revision to the FMVSS labeling requirement* to strengthen the enforceability of the standard. The objective is to enable officers to distinguish and provide evidence of non-compliance more readily.

- All stakeholders should work with the U.S. Department of Transportation to *develop strategies to ensure that all helmets offered for sale meet the FMVSS 218 standard.*
- Another strategy component would be for interested stakeholders, in cooperation with NHTSA and motorcycle helmet manufacturers, to develop *a comprehensive and regularly updated list of FMVSS 218 compliant motorcycle helmets.* This list could be available through the Internet as a tool for enforcement, consumers, training providers, and other groups seeking information on compliant helmets.

EXHIBIT V-49
Strategy Attributes for Increasing the Use of FMVSS 218 Compliant Helmets

Technical Attributes	
Target	The targets of this strategy include all stakeholders in efforts to increase motorcycle helmet use and thus reduce fatalities, injuries, and costs associated with motorcycle crashes. These targets include, but are not limited to, state agencies; public and private sector organizations; medical, public health, and safety advocacy groups; insurance companies; enforcement entities; motorcycle operators and their passengers; the motorcycle industry; and the motorcycle safety and rider training community.
Expected Effectiveness	The effectiveness of FMVSS 218 compliant helmets in reducing head injuries is proven and the implementation of a universal helmet law has consistently been shown to increase helmet usage to nearly 100 percent and to reduce fatalities by 20-40 percent (U.S. GAO, 1991). Enforceable legislation requiring the use of FMVSS 218 Compliant Helmets is the only proven means of increasing use of such helmets. Legislation and its effects on usage have been proven to reduce motorcycle fatalities when enacted, and to increase fatalities when such legislation in place is repealed. Specifically, recent universal helmet laws enacted or re-enacted in California, Maryland, Nebraska, and Washington have provided evidence of the impact of such laws. Recent repeals in Arkansas, Kentucky, Louisiana, Texas, and Florida have again shown that repeal or downgrading of such laws results in significant reductions in usage among motorcyclists on the road and in crashes and a significant increase in fatalities. There is no comparable body of research evidence of the potential for educational strategies to increase helmet use or therefore to reduce fatalities and injuries associated with increased helmet use. Such strategies have been tried but are unproven.
Keys to Success	Success should be viewed as the increased usage of FMVSS 218 compliant helmets by riders of all ages and skill levels and associated reductions in fatalities, injuries, and costs. One important factor that could contribute to success in this area is to involve the motorcycle rider and safety community in the development and implementation of this strategy and to make riders aware of the positive benefits of wearing a FMVSS 218 compliant helmet and of the evidence supporting the effectiveness of universal helmet laws. Other important components include: formation of a broad-based coalition including the enforcement community; hiring someone to coordinate the campaign; obtaining bipartisan support in the legislature; enlisting the aid of a paid lobbyist; working with the Governor and his/her staff to obtain their support; conducting public opinion polls, evaluations, and cost analyses; and making maximum use of existing resources.

EXHIBIT V-49 (Continued)
Strategy Attributes for Increasing the Use of FMVSS 218 Compliant Helmets

Potential Difficulties	Universal helmet laws are unpopular with some segments of the motorcycle riding community and these segments have made such laws very divisive and contentious issues. Where universal helmet laws exist, some motorcycle rider groups can be expected to campaign for their elimination. Similarly, when a state proposes a universal helmet law, opposition to such a law by these groups is immediate and well coordinated. In spite of their opposition, efforts should be made to work with the motorcycling community in any universal helmet law initiative. Although working relationships may be difficult in states where current universal helmet laws exist and where the rider groups are actively engaged in repeal or downgrade legislation, efforts should continue to gain the respect, understanding, and support from as broad a segment of that community as is possible. An apparently emerging problem involves the difficulty of enforcing the use of FMVSS 218 compliant helmets. Law enforcement officers often cannot determine if a helmet is indeed non-compliant and courts are sometimes unable to conclude whether a helmet complies with the standard. When this occurs, violations are frequently dismissed.
Appropriate Measures and Data	There are several important measures of effectiveness of any program intended to increase FMVSS 218 compliant helmet usage. The first is the percent of riders using such helmets, the second is the frequency and severity of head injuries among motorcycle riders and passengers involved in crashes, and the third is the number and rate of fatalities (per licensed motorcycle and/or per vehicle miles traveled). As with other occupant protection strategies, the “bottom-line” objective is a reduction in fatalities and injuries. Efforts to promote helmet usage should be held to the same standards and measures as those described above. The bottom-line is the same for any strategy or approach.
Associated Needs	NHTSA is currently working with appropriate national, state, and local law enforcement organizations to train law enforcement officers to identify non-compliant helmets while also developing training for judges and prosecutors to adjudicate universal helmet law violations. However, this task will prove challenging. Enforcing universal helmet laws that reference or incorporate FMVSS 218 has been difficult for local and state law enforcement officers. Law enforcement officers find it challenging to prove a helmet is non-compliant under state law due to the accessibility of counterfeit DOT stickers. NHTSA will continue to provide technical assistance to states, when requested, with regard to legislation and laws relating to compliant helmet use. NHTSA is also considering amending FMVSS 218 to address the falsification of helmet certifications resulting from the non-specific labeling requirements of the motorcycle helmet standard. NHTSA is also planning to implement an outreach program directed at motorcycle helmet manufacturers.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	To the extent possible, all key stakeholders should be involved in any universal helmet law initiative. This includes motorcycle rider groups; law enforcement; insurance; the motorcycle and helmet industries; and medical, public health, advocacy, employer, youth, and safety organizations.

EXHIBIT V-49 (Continued)
Strategy Attributes for Increasing the Use of FMVSS 218 Compliant Helmets

Issues Affecting Implementation Time	Depending on the magnitude of opposition, the time required to enact universal helmet legislation can be extensive. When such legislation is enacted, however, benefits are immediate and substantial. There is no known timetable for implementing a successful program to promote helmet usage because there is no documented history of success with such efforts. Based on efforts with safety belts, acceptably high usage will not be obtained until strong and unambiguous laws are enacted and enforced.
Costs Involved	The costs associated with enacting a universal helmet law include lobbying, whether paid or donated by stakeholders, law enforcement training, and costs for evaluating the impact of the law change. Other potential costs could include a public information campaign to inform riders about the new law. A public information campaign, implemented to publicize a law or its enforcement, or to make the public aware of the benefits of helmet use, can be implemented at different levels, using different combinations of broadcast, cable, print, or outdoor advertising and/or coupled with other actions. Campaigns have generally not resulted in significant behavioral change unless they have been coupled with legislation, enforcement, or sanctions. Even in these cases, costs should be anticipated for message and materials development, for the purchase of media time, and for evaluation.
Training and Other Personnel Needs	With regard to universal helmet laws, training is necessary for law enforcement personnel to identify compliant and non-compliant helmets and to properly enforce such laws. NHTSA has created a video and training sheet, “Fake Helmets, Unsafe On Any Head,” for law enforcement. This 12 and 1/2 minute instructional video, suitable for roll-call training, teaches law enforcement officers how to identify non-compliant motorcycle helmets. It also shows examples of non-compliant helmets. A link is available in the following section.
Legislative Needs	Universal helmet laws require legislative action.

Information on Agencies or Organizations Currently Implementing This Strategy

NHTSA has created a training video and brochure, “Fake Helmets, Unsafe On Any Head” (http://www.nhtsa.dot.gov/people/outreach/safesobr/21qp/html/program_pubs/moto_safety.html). This 12 and 1/2 minute instructional video teaches law enforcement officers how to identify non-compliant motorcycle helmets. It also shows some examples of non-compliant helmets. Police agencies and the military are currently using this video.

Current status of motorcycle helmet legislation is summarized by the National Conference of State Legislatures. For more information, visit http://www.ncsl.org/.

The Wisconsin Motorcycle Safety Program promoted protective apparel in this promotional piece targeting riders—http://www.dot.wisconsin.gov/safety/vehicle/motorcycle/.

The Motorcycle Safety Foundation (MSF) has developed PSAs promoting helmet usage and web applications in a variety of sizes and formats and will provide them at no cost. Contact the MSF for more information—http://www.msf-usa.org/.

EXHIBIT V-50
MSF Helmet Usage PSAs

There have been cases of motorcycle dealerships instituting a "beanie buy-back" program, where discounts are given to riders who turn in non-compliant helmets and purchase a helmet that meets FMVSS 218.

Washington State Police have developed a brochure which describes some of the differences between non-compliant helmets and FMVSS 218 compliant helmets. They have developed public awareness campaigns to promote usage of FMVSS 218 compliant motorcycle helmets: http://www.wsp.wa.gov/traveler/helmets.htm.

Additional information is available from the FHWA Motorcyclist Advisory Council: http://safety.fhwa.dot.gov/mac/index.htm.

Websites

The following websites are listed to provide information on the arguments in support of and opposition to universal helmet laws.

Organizations That Support Universal Helmet Laws

Advocates for Highway and Auto Safety:
http://www.saferoads.org/issues/fs-helmets.htm

American College of Emergency Physicians:
http://www.acep.org/

American College of Surgeons:
http://www.facs.org/fellows_info/statements/st-35.html

Trauma Foundation:
http://www.traumaf.org/featured/7-28-04motorcycle%20helmet%20laws.html

Governor's Highway Safety Association (GHSA):
http://www.statehighwaysafety.org/

National Highway Traffic Safety Administration:
http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/safebike/helmet.html
http://ntl.bts.gov/lib/6000/6200/6285/fs_mcycl.pdf

National Transportation Safety Board (NTSB):
www.ntsb.gov

Organizations That Oppose Universal Helmet Laws

American Motorcyclist Association position paper in support of promoting helmet use:
http://www.amadirectlink.com/legisltn/positions/helmet.asp

Motorcycle Rider Foundation White Papers on Helmets:
http://www.mrf.org/whitepapers.php

Strategy 11.1 E2—Increase the Use of Protective Clothing (T)

General Description

Constant exposure to the elements is physically dangerous, but wind, weather conditions, and temperature extremes can also affect a rider's concentration. Furthermore, dehydration, overheating, and hypothermia can compromise a rider's judgment and cause decreased vision, light-headedness, and impaired coordination.

Safety is the main reason to wear protective apparel, but comfort is important also. Motorcycle riding gear is designed specifically for this activity. Arm and leg lengths are cut longer to provide comfort in the seated position. Sleeves can be zipped tight and collars can be either closed (with Velcro), to block cold wind, or opened, for ventilation.

Most riding gear is constructed of leather or ballistic nylon—tough material for tough conditions. It has to be able to resist abrasion and stay affixed while sliding along the roadway or roadside surface. Body padding or body armor built into the gear dissipates impact forces and provides greater protection. The European Union has devised testing standards: CE EN1621-1&2 for elbow, shoulder, knee and spinal armor. No such armor standards exist in the United States.

Typical protective riding gear includes:

- FMVSS 218 compliant helmet
  - Helmets come in three basic styles—full face, three-quarter shell, and half-shell. The full face provides the most protection and includes a face shield to protect the face and eyes and a chinbar to protect the jaw and teeth.

- Eye protection
  - Face shields or goggles provide the most protection from wind, insects and flying debris.

- Jacket and long pants
  - Fabricated out of abrasion-resistant materials such as leather or ballistic nylon, motorcycle gear provides ventilation and closures and often comes with body padding or body armor.

- Gloves
  - Motorcycle gloves are usually made of leather. Winter gloves with gauntlets keep cold wind from going up the sleeve.

- Boots
  - Boots provide solid ankle support at a stop and better protection than low-cut shoes. Boots should also provide a good grip with the road when stopped.

- Raingear
  - Raingear has to stand up to the wind and seal out driving rain to keep the rider warm and dry.

The *National Agenda for Motorcycle Safety* identified several ways to increase use of protective apparel (NHTSA, 2000):

- Educate motorcyclists about the value of protective apparel by providing an information source on related research and a forum for the exchange of information.

- Conduct research regarding protective apparel and its effectiveness, and consider development or adoption of existing standards, if research justifies.

The objective of this strategy is to convince riders to wear clothing that provides protection and comfort from the elements as well as from the dangers of a fall from the motorcycle. Wearing protective clothing can make the difference between an uncomfortable slide and severe injury along with months of rehabilitation.

The motorcycle safety and rider training communities should be involved in this strategy to assist in the development of public information and education resources for motorcyclists to understand the benefits of helmets and protective gear.

EXHIBIT V-51
Strategy Attributes for Increasing the Awareness of the Benefit of Protective Clothing

Technical Attributes	
Target	The target of this strategy is motorcycle riders and passengers, as well as the motorcycle safety and rider training community.
Expected Effectiveness	The effectiveness of increasing the awareness of the benefits of protective clothing has not been satisfactorily quantified.
Keys to Success	The key to success is to involve the motorcycle rider and safety community in the development and distribution of the materials resulting from this strategy.
Potential Difficulties	A potential difficulty with this strategy is accurately targeting the appropriate group of motorcyclists. That is, it may be difficult for highway agencies, and the group of stakeholders with which they are working, to identify where motorcyclists congregate and can be expected to view the public information material. Motorcyclists may be effectively reached at rallies and similar events. Another potential difficulty is effecting change in a long-established culture. Riders may be very reluctant to put aside the traditional attire in favor of protective clothing.
Appropriate Measures and Data	Depending on the scope of effort, process measures could include the existence of a coordinated system, number of meetings held, number and type of materials produced, number of postings, and contacts made. Roadside evaluations can be conducted before and after the campaign to measure effectiveness in increased use of protective apparel.

EXHIBIT V-51 (Continued)
Strategy Attributes for Increasing the Awareness of the Benefit of Protective Clothing

	An advanced level of analysis could include an evaluation of motorcycle crashes and the effect of protective clothing on injury outcome. Such a study would require data linkage between crash records and hospital records as well as follow-up activities to determine what type of protective clothing was worn at the time of the crash.
Associated Needs	None identified.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees comprise motorcycle leaders, authorities and activists from across the state, and include representatives from state police, DMV, transportation safety and the state's motorcycle safety program. Partnering with MSAC groups is essential to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community. Broadening organizational involvement to include the private sector, such as those that produce motorcycles and motorcycle-rider wear may add a needed dimension to the effectiveness of the strategy, through effective marketing.
Issues Affecting Implementation Time	A public awareness campaign aimed at motorcyclists should be targeted around the prime riding season, when motorcyclists are most likely to be congregating where the public awareness material is distributed (e.g., riding events, etc.). The timing of the campaigns is most effective when it coincides with the riding season. This will entail highway agencies beginning to work on information programs well in advance of the prime riding season in order to have the public awareness campaign ready.
Costs Involved	Costs vary depending on the scope of effort.
Training and Other Personnel Needs	Increasing the awareness of the benefit of protective clothing does not necessarily require training or additional agency personnel, but it does require knowledge of how clothing can protect motorcycle riders and a willingness to partner with key stakeholders.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

The Wisconsin Motorcycle Safety Program promoted protective apparel in this promotional piece targeting riders.

Additional information is available from the FHWA Motorcyclist Advisory Council: http://safety.fhwa.dot.gov/mac/index.htm.

EXHIBIT V-52
SMSA Protective Clothing Promotional Poster

Objective 11.1 F—Increase Motorcycle Rider Safety Awareness

Strategy 11.1 F1—Form Strategic Alliances with Motorcycle User Community to Foster and Promote Motorcycle Safety (T)

General Description

An important step of any program to improve motorcycle safety is to build strategic alliances between highway agencies, law enforcement agencies, and the motorcycle rider, safety, and education communities. The motorcycle safety community is eager to be a part of the solution because they know that any improvement in motorcycle safety can have a direct effect on them (i.e., it may save their life or the life of a friend or loved one). It is recommended that the members of a strategic alliance represent a cross-section of the motorcycling community in the state or region, and that the motorcycle safety issues of that particular state or region be addressed.

Strategic alliances are critical to the success of improved motorcycle safety for a number of reasons. Alliances allow stakeholders with different ideas to have input and provide an opportunity to discover common causes and desired outcomes. Fortunately, safety is an easy issue on which to join together, and while different groups may have different ideas on the best or most appropriate ways to improve safety, usually all stakeholders can agree that reducing motorcycle fatalities and injuries is a worthy goal. With a common starting point, motorcycle safety approaches from a diverse set of perspectives can be suggested, fleshed out and refined. Where individual stakeholder groups can become very narrowly focused on a specific type of safety strategy, an alliance provides an opportunity for out-of-the box ideas and solutions to be brought forth, and forces a recognition of the legitimate concerns and goals of other stakeholders in the same community.

Any safety initiative is only as effective as the stakeholders' commitment to implement it. Strategic alliances increase the likelihood that the diverse stakeholders in the motorcycle community will buy in to the safety initiatives and encourage their use among the members of the groups they represent. Even when safety laws are passed, if they are not understood or respected, they are ineffective. A strategic alliance of law-enforcement, safety engineers, health care providers, researchers, and motorcycle riders can act as one voice to educate riders and other motorists about the importance of motorcycle safety efforts and the consequences of ignoring them. An alliance that represents not only the voice of public safety, but also the voices of riders themselves will be much more effective in promoting the message of motorcycle safety.

NHTSA discovered the benefit of collaborating with a diverse stakeholder community when it launched the *National Agenda for Motorcycle Safety* (NAMS). Developing the framework for NAMS involved participation from experts in industry, research, training, and rider communities, as well as health care, media, insurance and law enforcement. The result was a collaborative document that has gained broad-based support and action.

According to NHTSA's *Motorcycle Safety Program,* "The agency values its partnerships with stakeholders in the motorcycle manufacturing and aftermarket industries, as well as the rider and education communities . . . NHTSA views interactions with stakeholders as a crucial means to allow it to collaborate on how to best improve these and other issue areas affecting motorcycle safety" (NHTSA, 2002).

Key state or regional stakeholders include:

- State motorcycle safety manager
- State Highway Safety office
- Rider organizations—ABATE, HOG chapters, GWRRA, etc.
- Law enforcement and licensing authorities
- The state's motorcycle safety advisory committee—These groups exist in 25 states (SMSA, 2002), meet frequently and often hold public meetings to hear constituency issues and concerns. Additional information is available from the state's motorcycle safety manager. If a state doesn't have such an advisory committee, forming one is the first step of this strategy.

Further support can be gained by partnering with:

- The American Motorcyclist Association (AMA)
- The Motorcycle Rider's Foundation (MRF)
- The Motorcycle Safety Foundation (MSF)

Motorcycle issues generate interest and excitement from many quarters, and it is common for the motorcyclists in any agency office (e.g., DOT, enforcement, licensing, etc.) to take a keen interest in motorcycle-related initiatives. This interest should be encouraged and used in the development of safety initiatives. Much can be gained by involving those who have expertise in their field, personal experience as a rider, and an interest in the issues that involve both.

NAMS presented several recommendations that transportation agencies can implement with the advocacy and support of the motorcycling community. These points serve as an example of the safety ideas produced by a successful motorcycle strategic alliance:

- Identify and prioritize roadway hazards to motorcycle operation.
- Develop and revise highway standards at all levels—federal, state, county and local—to reflect the needs of motorcyclists and encourage motorcycle-friendly design, construction, and maintenance procedures.

- Create a working group to identify changes to highway standards to increase motorcycle safety.
- Post specific warnings for motorcyclists where unavoidable hazards exist.
- Revise the Manual on Uniform Traffic Control Devices (MUTCD) so that roadway signs better communicate roadway or construction conditions that present potential problems for motorcyclists.
- Educate road design and maintenance personnel about conditions that present potential problems for motorcyclists.
- Include motorcycles in the design and deployment of Intelligent Transportation Systems (ITS).

The keys to a successful strategic alliance are to identify as many diverse stakeholders as possible; encourage active participation not only by traditional safety advocates, but also by rider organizations; identify common goals around which to base the mission and goals of the alliance; and use the broad range of perspectives to look for new opportunities for safety improvement.

EXHIBIT V-53
Strategy Attributes for Forming Strategic Alliances with the Motorcycle Community to Foster and Promote Motorcycle Safety

Technical Attributes	
Target	The target of this strategy is motorcycle rider advocacy groups and organizations, the motorcycle safety and rider training community, and local motorcycle safety advisory groups.
Expected Effectiveness	No formal evaluation has been conducted to determine the effectiveness of this strategy at reducing motorcycle fatalities. Experience has shown that forming a strategic alliance has been an effective tool to advance motorcycle safety strategies because it includes all stakeholders.
Keys to Success	A key to success is the identification of key stakeholders in the state or region. Motorcycle safety education and awareness will be better served with the broad-based support of the motorcycling community. Motorcycle safety education and awareness cannot be effectively served without the broad-based support of the motorcycling community.
Potential Difficulties	Not everyone is going to agree on everything, especially when it comes to discussing universal helmet laws. This is one of the most contentious issues of this community. The secret to success is not hinging all expectations on a single issue when there are many issues to be addressed.
Appropriate Measures and Data	Appropriate measures include number of stakeholders involved, number of meetings held, organization and structure of meetings, initiative process, and communication feedback process. Effectiveness of countermeasures introduced by the strategic alliance membership is also a useful measure.
Associated Needs	Public education and information activities complement this strategy.

EXHIBIT V-53 (Continued)
Strategy Attributes for Forming Strategic Alliances with the Motorcycle Community to Foster and Promote Motorcycle Safety

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	This strategy can be implemented by any agency. Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees comprise motorcycle leaders, authorities and activists from across the state, and include representatives from state police, DMV, transportation safety and the state's motorcycle safety program. Partnering with MSAC groups is essential to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community.
Issues Affecting Implementation Time	Implementation time can vary from 1 to 4 months, depending on the length of time it takes to identify key stakeholders.
Costs Involved	Costs are negligible. There may be expenses associated with hosting meetings and hearings. To be effective, these meetings should be held in different locations around the state or region.
Training and Other Personnel Needs	None identified.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

A Motorcycle Safety Advisory Board has served Washington State since 1982. The Board consists of five members appointed by the Director of the Department of Licensing; appointments are for 2 years. The Board meets quarterly and has been instrumental in the investigation, development and support of motorcycle safety legislation. Priorities include:

- Public awareness of motorcycle safety
- Motorcycle safety education programs conducted by public and private entities
- Classroom and on-cycle training
- Improved motorcycle operator testing

For more information, visit http://apps.leg.wa.gov/rcw/.

Similar committees have been established in Oregon, Idaho, California, Arizona, Delaware, Kentucky, Indiana, Wisconsin, Montana and other states. This is an excellent resource to begin the development of this strategy.

On February 28, 2004, WisDOT convened the Wisconsin National Agenda for Motorcycle Safety (NAMS) Summit. The summit represented the first state-level workshop on motorcycle safety developed from the *National Agenda for Motorcycle Safety* report and involved extensive input from WisDOT's partners in traffic safety, including motorcycle advocacy groups, law enforcement, educational institutions and others. Those who attended the meeting participated in small group brainstorming sessions in a workshop setting to identify: (1) the problems and issues which contribute to motorcycle crashes and fatalities and (2) what each organization can do, using the resources available to them, to address the problem. The feedback obtained from all of these meetings was invaluable to the development of strategies contained within the *2004 Motorcycle Safety Action Plan* and for long-range, motorcycle safety planning efforts (Wisconsin Department of Transportation, 2004).—For more information, visit http://www.dot.wisconsin.gov/library/publications/topic/safety/motorcycleplan.pdf.

The Virginia DOT (VDOT) has been actively involved in addressing the unique characteristics of motorcyclists and their particular safety concerns on the roadway. A standing committee was formed, consisting of representatives from the DOT, local government, DMV and motorcycle community. Outcomes include:

- Greater awareness of motorcyclists' concerns
- Instructional memorandums regarding posting signs on longitudinal and transverse joints on bridges
- Collaboration with other utilities to share motorcycle safety information
- Motorcycle safety brochure to be delivered to all holders of Virginia motorcycle class operator's licenses by VDOT

Riders Helping Riders (RHR) is an instructional program designed to encourage motorcyclists to intervene to prevent drinking and riding by their motorcyclist peers. The program is based on focus group research which found that riders consider themselves to be united by an interest in riding, and willing to help other riders in need, but that a sense of individualism limits the extent to which riders are willing to intervene in drinking and riding.

RHR is intended to convince motorcyclists that an impaired rider needs their help, and that they are in the best position to provide help. The program provides a "toolkit" of techniques for separating drinking from riding, discouraging riders from becoming impaired, recognizing impairment, and discouraging impaired riders from riding. An optional role-playing module is included. At the end of class, students are asked to sign a pledge to do their best to help an impaired rider live to ride another day.

RHR was developed by NHTSA with the assistance of instructors from the South Carolina Rider Education Program and pilot tested by instructors of Georgia's Department of Driver Services, Motorcycle Safety Program. More information is available at:

http://www.nhtsa.dot.gov/portal/site/nhtsa/template.MAXIMIZE/menuitem.d7975d55e8abbe089ca8e410dba046a0/?javax.portlet.tpst=4670b93a0b088a006bc1d6b760008a0c_ws_MX&javax.portlet.prp_4670b93a0b088a006bc1d6b760008a0c_viewID=detail_view&itemID=0d6576ca7dcb8110VgnVCM1000002fd17898RCRD&overrideViewName=Article.

Websites

Motorcycle Safety Advisory Committees:

- Montana—http://motorcycle.msun.edu/advisory.htm
- Minnesota—http://www.dps.state.mn.us/mmsc/latest/MMSCHomeSecondary.asp?cid=2&mid=52
- Wyoming—http://legisweb.state.wy.us/statutes/titles/Title31/T31CH5AR15.htm
- Missouri—http://www.moga.mo.gov/statutes/C300-399/3020000136.HTM
- Idaho—http://idahostar.org/pdf/annuals/annual96.htm
- Oregon—http://www.oregon.gov/ODOT/TS/motorcyclesafety.shtml

Strategy 11.1 F2—Increase Awareness of the Consequences of Aggressive Riding, Riding While Fatigued or Impaired, Unsafe Riding, and Poor Traffic Strategies (T)

General Description

Every year, hundreds of motorcycle riders are injured or killed in motorcycle crashes. The role of alcohol, unendorsed operation, and lack of training as risk factors has been well established (Objective 11.1 B—"Reduce the Number of Motorcycle Crashes Due to Rider Impairment" and Objective 11.1 C—"Reduce the Number of Motorcycle Crashes Due to Unlicensed or Untrained Motorcycle Riders"). However, what is not known is the crash representation of such characteristics as aggressive riding, riding while fatigued, unsafe riding, and poor traffic strategies.

Motorcycling is a risky activity. In terms of vehicle miles traveled, motorcyclists are about 27 times more likely to die in a crash than someone riding in a passenger car, and six times more likely to be injured (NHTSA, 2003). Unfortunately, many motorcyclists are willing to magnify that risk by exercising poor judgment and riding recklessly. Below are samples of police descriptions of fatal crashes in 2003:

- Motorcycle versus auto: Motorcycle very high speed wheelie on Stark St.—80 yr. old woman pulled out, MC struck auto. Died at scene.
- Single vehicle: Motorcycle attempted to pass semi on right side, went off shoulder, hit road sign. Alcohol was a factor in this crash.
- Single vehicle lost control, very high speed, trying to flee from police. Double fatal. Rider observed at over 100 mph before pursuit.
- Single vehicle westbound at high speed lost control on corner of I-84 near NE 28th Ave. hit concrete center divider and launched into oncoming traffic where he was struck by a vehicle. Witnesses indicated motorcycle traveling 80 mph or faster prior to crash.

NHTSA reports that one-half of the fatalities in single-vehicle crashes relate to problems negotiating a curve prior to a crash. Over 80 percent of motorcycle fatalities in single-vehicle crashes occur off the roadway. Operator DWI was a factor in 44 percent of all single-vehicle crashes. The problem of alcohol and motorcycling is compounded with the exercise of poor

judgment and excessive, and in some cases extreme, speed. In fact, speed is a contributing factor in fatal motorcycle crashes 36 percent of the time, about twice the rate for drivers of passenger cars or light trucks (FARS, 2003). It is common to witness speeds double, and sometimes triple, that of posted limits.

While motorcycle performance continues to improve, allowing greater speeds and better handling, many riders have failed to improve their caution and judgment accordingly. Speed, reckless riding and the competitive nature of some riders place motorcycle riders at an increased risk of crashing and becoming injured or killed. Rider education should include not only skills training, but also a discussion of the potential consequences of unsafe and aggressive riding. In addition to teaching safe riding strategies, statistics on fatalities, injuries, and legal consequences should be presented to increase awareness of the dangers associated with drinking and riding, speeding, and unsafe maneuvers.

Rider training programs are a key element of motorcycle safety. They develop fundamental skills and safe riding strategies. However, such programs need to be supplemented with enforcement to be effective. Enforcement should include strict punishment and commensurate fines for aggressive or unsafe riding. Enforcement should also be highly visible and well-publicized to raise awareness not only of the safety risks of aggressive riding behaviors, but also of their legal consequences. Traffic laws violated by motorcycle riders can be more difficult to enforce than passenger vehicles because of their ability to accelerate to high speeds very quickly and to weave in and out of traffic. For the safety of the motorcyclist, the officer, and other motorists and pedestrians nearby, some law enforcement agencies have enacted "no pursuit" policies for motorcycle riders who violate traffic laws, and riders have learned that they can get away with aggressive driving behaviors. Law enforcement personnel should come together to identify new solutions for safely enforcing traffic laws among motorcycle riders.

EXHIBIT V-54
Strategy Attributes for Increasing Awareness of the Consequences of Aggressive Riding, Riding While Fatigued or Impaired, Unsafe Riding, and Poor Traffic Strategies

Technical Attributes	
Target	The target of this strategy is the group of motorcycle riders involved in high-risk and reckless riding.
Expected Effectiveness	No formal evaluation has been conducted to determine the effectiveness of this strategy at reducing motorcycle fatalities.
Keys to Success	The keys to success are identifying the target population and working cooperatively with key stakeholders to target enforcement and public awareness efforts. Stakeholders include a motorcycle advisory group as well as the law enforcement, judicial, and motorcycle safety/training community.
Potential Difficulties	Locating a data source or developing a methodology to extract this information from existing data is likely the greatest challenge. Law enforcement can provide assistance in targeting the demographic.
Appropriate Measures and Data	Appropriate measures include (1) number of harmful or hazardous events, (2) number of individuals involved and (3) frequency of these events. Outcome measures should be developed to quantify the training, enforcement and judicial responses.
Associated Needs	A media and information campaign.

EXHIBIT V-54 (Continued)
Strategy Attributes for Increasing Awareness of the Consequences of Aggressive Riding, Riding While Fatigued or Impaired, Unsafe Riding, and Poor Traffic Strategies

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	This strategy can be implemented by highway agencies responsible for highway and motorcycle safety. Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees comprise motorcycle leaders, authorities and activists from across the state, and include representatives from state police, DMV, transportation safety and the state's motorcycle safety program. Partnering with MSAC groups is essential to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community.
Issues Affecting Implementation Time	Implementation time can vary from 3 to 6 months, depending on the length of time it takes to research the problem and identify stakeholders.
Costs Involved	Costs should not be a major factor, although they can vary, depending on the scope of effort and the specific actions being taken.
Training and Other Personnel Needs	Increasing the awareness of the consequences of various motorcycle riding behaviors does not necessarily require formal training or additional agency personnel, but it does require an awareness of the issues, a priority to address the issues, and a willingness to partner with key stakeholders to begin the process of effecting change.
Legislative Needs	None identified.
Other Key Attributes	
	Public education and information activities complement this strategy. Educational materials may be required to inform those implementing this strategy of effective treatment methods.

EXHIBIT V-55
Radar Gun Measuring Motorcycle Speed of 132 mph

Information on Agencies or Organizations Currently Implementing This Strategy

Exhibit V-55 shows the speed at which a motorcyclist was captured riding (132 mph) on a rural highway with a designated speed of 55 mph.

The crash scene photo in Exhibit V-56 is the crash scene of a rider who lost control traveling at a reported speed of 95 mph in a 45-mph speed zone. The collision killed the rider and seriously injured the passenger.

EXHIBIT V-56
Crash Scene Involving Speeding Motorcyclist

"Crash Car" Display

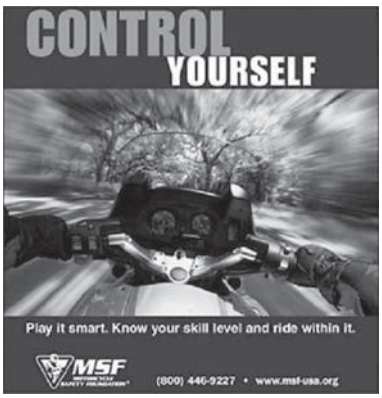
EXHIBIT V-57
Crash Car Display

The "Crash Car" display (Exhibit V-57) was acquired and reconstructed by the TEAM OREGON Motorcycle Safety Program. The motorcycle impacted the car at a reported speed of 90 mph, killing the operator and seriously injuring his passenger and the motorist. The display and storyboard were delivered across the state to schools (as part of "Project Graduation,") and to motorcycling and civic events, fairs and celebrations. It presented a sober and vivid reminder of the hazards of drinking and riding.

The Motorcycle Safety Foundation (MSF) has developed motorcyclist awareness PSAs for print and web applications in a variety of sizes and formats and will provide them at no cost to the state. Contact the MSF for more information.

Riders Helping Riders (RHR) is an instructional program designed to encourage motorcyclists to intervene to prevent drinking and riding by their motorcyclist peers. See Strategy 11.1 F1 in this guide for a detailed description of the program.

EXHIBIT V-58
MSF Motorcyclist Awareness PSAs



Strategy 11.1 F3—Educate Operators of Other Vehicles to Be More Conscious of the Presence of Motorcyclists (T)

General Description

The Hurt Study (Hurt et al., 1981) revealed many disturbing facts that forever changed the face of motorcycling in the United States, including:

> Other Vehicle Violation of the Motorcycle Right-of-Way is a predominating factor in the 900 on-scene, in-depth accident cases; 50.9 percent of all those accidents are attributable to the driver of the other vehicle involved in the accident. This fact is especially clear when the multiple-vehicle collision data show that 64.9 percent of those accidents are due to the actions of the driver of the other vehicle. The typical accident in this category is portrayed by the automobile in traffic turning left into the path of the oncoming motorcycle. In such an accident, the culpability is exclusively due to the action of the driver of the automobile. The greatest part of this accident-cause factor is related to the failure of the automobile driver to see the oncoming motorcycle, or to see it in time to avoid the collision.
>
> This dominant culpability of the driver of the other vehicle is a critical exposition of the failure to detect a relatively unfamiliar vehicle on a collision path where motion conspicuity is absent. It emphasizes the special need for high contrast conspicuity for the motorcycle and rider. A special sampling of 62 of these cases showed that there were no drivers of the accidents involving automobiles who had any motorcycle experience; hence the motorcycle was an unfamiliar as well as inconspicuous target.

Not much has changed since that finding. FARS data show the following statistics (FARS, 2003):

- About one-half (54 percent) of all motorcycles involved in fatal crashes in 2003 collided with another motor vehicle.
- In 78 percent of the two-vehicle crashes, the motorcycles involved were impacted in the front; only 5 percent were struck in the rear.
- In 38 percent of the two-vehicle fatal crashes involving a motorcycle and another vehicle, the other vehicle was turning left while the motorcycle was going straight, passing, or overtaking the vehicle.
- In 27 percent of the two-vehicle crashes, both vehicles were going straight.

Motorcyclists are still affected by motorists who fail to see them and pull into their path, often cutting off any chance of escape and resulting in an injury crash. The *National Agenda for Motorcycle Safety* identified the following factors that, when combined, can cause drivers to overlook motorcyclists (NHTSA, 2000):

- Motorcycles and riders represent a relatively small component of the total traffic mix. Visual recognition is reduced.
- Many drivers are not expecting to see motorcyclists in traffic and therefore do not anticipate routine encounters.
- Motorcycles are smaller visual targets and much more likely to become obscured.

- Automobiles and trucks have obstructions (door and roof pillars, outside mirrors, etc.) and blind spots that can obscure or hide a motorcyclist.
- Other conditions affecting the vehicle, including precipitation, glare, and cargo, can impair a driver's view and obscure a motorcyclist.
- Roadside objects, other vehicles, and light patterns can make it difficult to discern a motorcyclist.

The problem of drivers not seeing motorcyclists is expected to get worse. That is, as the population of drivers continues to age, vision problems will likely become more prevalent (see *NCHRP Report 500, Volume 9,* "A Guide for Reducing Collisions Involving Older Drivers"). Tips on watching for motorcycles should be placed in older driver handbooks.

The objective of this strategy is to promote public information campaigns to better educate motorists to be more conscious of the presence of motorcycles in the traffic mix. Several states have mounted clever motorist awareness campaigns to deliver that message (samples are provided at the end of this section). Distribution methods include driver education programs, driver manuals and tests, and remedial education programs for violators. Media include billboards, bus advertising, radio, and literature or posters displayed wherever motorists linger—visitor centers, motor vehicle offices, auto shows, gas pumps, banks, etc. Messages can be printed on license renewal notices or other general population mailings.

Public information campaigns could be coordinated with *Motorcycle Awareness Month,* a month designated by many state motorcycling groups to heighten the awareness of motorcycling. Typically, but not always, Motorcycle Awareness month is in May and aligns with the *Motorcycle Awareness and You (MAY)* theme. This event serves as an excellent opportunity for officials to engage with those involved in the motorcycling movement. Many DOTs support this activity with public information and education resources designed to draw awareness to the presence of motorcycles on our streets and highways, and to urge motorists to "Watch for Motorcycles."

Highway agencies should involve the motorcycle safety and rider training community in this strategy. Motorcycle groups will likely seize the opportunity to assist with motorist and motorcyclist awareness programs.

EXHIBIT V-59
Strategy Attributes for Educating Operators of Other Vehicles to be More Conscious of the Presence of Motorcyclists

Technical Attributes	
Target	The target of this strategy is operators of vehicles other than motorcycles.
Expected Effectiveness	No formal evaluation has been conducted to determine the effectiveness of this strategy at reducing motorcycle crashes, injuries or fatalities.
Keys to Success	The key to success is to involve the motorcycle rider and safety community in the development and distribution of this strategy. Representatives of the driver education, operator licensing and law enforcement communities can greatly assist.

EXHIBIT V-59 (Continued)
Strategy Attributes for Educating Operators of Other Vehicles to be More Conscious of the Presence of Motorcyclists

Potential Difficulties	A potential difficulty with this strategy is accurately targeting the appropriate group. A media and information campaign has to be very broad-based in order to reach the population of drivers of other vehicles.
Appropriate Measures and Data	Depending on the scope of effort, process measures may include the existence of a coordinated system, number of meetings held, number and type of materials produced, number of postings, and contacts made.
Associated Needs	A media and information campaign.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Central to the success of any motorcycle safety initiative is to form alliances with key stakeholders in transportation and motorcycle safety, licensing, enforcement and the motorcycle community. Many state governments support a Motorcycle Safety Advisory Committee (MSAC) through statute or rule. Often, these committees comprise motorcycle leaders, authorities and activists from across the state, and include representatives from state police, DMV, transportation safety and the state's motorcycle safety program. Partnering with MSAC groups is essential to begin to (a) understand the problems motorcyclists face and (b) provide a mechanism to convey information between researchers, policy makers and the state leaders and activists within the motorcycling community.
Issues Affecting Implementation Time	A public awareness campaign aimed at motorcyclists should be targeted around the prime riding season, when public awareness material can be distributed at locations where motorcyclists are most likely to be congregating (e.g., riding events, etc.). Personnel should identify the designation of a motorcycle awareness month. This period serves as an excellent time to work with stakeholders to advance this strategy. Campaigns are most effective when timed to coincide with the riding season. This will require highway agencies to work on information programs well in advance of the prime riding season, in order to have the public awareness campaign ready.
Costs Involved	Costs will vary depending on the scope of effort.
Training and Other Personnel Needs	Educating operators of other vehicles to be more conscious of the presence of motorcyclists does not necessarily require training or additional agency personnel, but it does require an awareness of the issues, a priority to address the issues, and a willingness to partner with key stakeholders to begin the process of effecting change.
Legislative Needs	None identified.
Other Key Attributes	
	Public education and information activities complement this strategy. Educational materials may be required to inform those implementing this strategy of effective treatment methods.

EXHIBIT V-60
Oregon DOT Public Information Campaign

Information on Agencies or Organizations Currently Implementing This Strategy

The Oregon Department of Transportation (ODOT) has produced and distributed the campaigns shown above (Exhibit V-60). These images have appeared on bus advertising, billboards, and on posters that have been placed in DMV Field Offices, schools and colleges.

The Wisconsin Motorcycle Safety Program has produced and distributed the Motorcycle Awareness and You (MAY) campaign (see Exhibit V-61).

The Maryland Motorcycle Safety Program within the Motor Vehicles Division adopted the *Take it Easy* campaign (see Exhibit V-62).

EXHIBIT V-61
MAY Campaign in Wisconsin

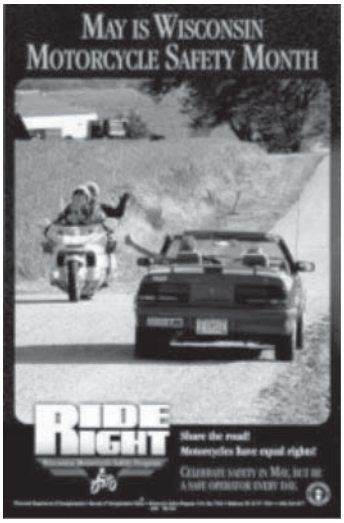


EXHIBIT V-62
Take It Easy Campaign in Maryland

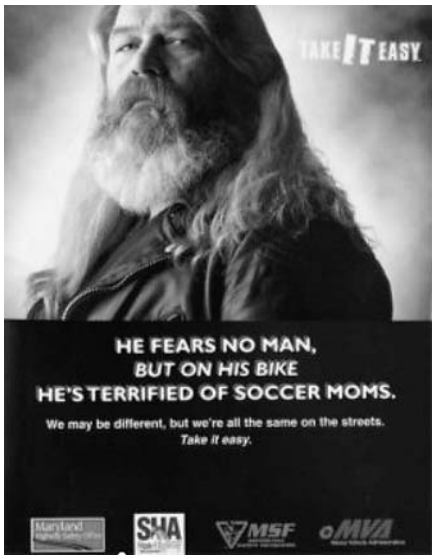


EXHIBIT V-63
MSF's Bikes Belong Campaign

The SMSA supports a website of valuable resources for Motorist Awareness. For more information, visit http://www.smsa.org/motorcycle_awareness/idea_sampler/.

The Motorcycle Safety Foundation (MSF) has developed motorist awareness PSAs (*Bikes Belong*) for print and web applications in a variety of sizes and formats and will provide them at no cost to the state (see Exhibit V-63). MSF also distributes copies of *Cars, Motorcycles, and the Common Road* video and leader's guide, a useful resource for group presentations. Contact the MSF for more information: http://msf-usa.org.

NHTSA supports Motorcyclists Awareness Month—http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/motorcyclemonth.html

NHTSA's Motorist Awareness Program—http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/motorcycle03/moto_awareness.htm

The Gold Wing Road Riders Association (GWRRA) promotes a motorist awareness program at http://www.gwrra.org/regional/MAD/.

Ride to Work (RTW) Organization advocates and supports the use of motorcycles for transportation, and provides information about transportation riding to the public. Every year RTW proclaims one day "Ride to Work Day." RTW encourages:

- Employer recognition and support for motorcycling
- Public and government awareness of the positive value of motorcycling

For more information, visit: http://www.ridetowork.org/home.php.

Websites

Motorcyclist Awareness Month

- NHTSA—http://www.nhtsa.gov/planners/sharetheroad2008/
- U.S. Senate (*MRF News*) http://www.mrf.org/articles/2004/04NR2104nr21ussenatedesignatesmayasmotorcycleawarenessmonthhousebillintroduced.htm
- Indiana—http://www.doe.state.in.us/reed/newsr/2007/05-May/motorcycleawareness.html
- Michigan—http://www.michigan-motorcycle-awareness.org/
- Idaho—http://gov.idaho.gov/mediacenter/proc/proc03/procmay/Proc_motorcycle.htm

- Virginia—http://www.governor.virginia.gov/CitizenServices/ConstituentServices/Proclamations/2008/MotorcycleAwareness.cfm
- Iowa—http://www.legis.state.ia.us/GA/76GA/Legislation/HR/00100/HR00113/960430.html

Share the Road

- Kansas—http://www.ksdot.org/burTrafficsaf/psa/pdf/khpmcsafawaremo42108.pdf.pdf
- Minnesota—http://www.dps.state.mn.us/mmsc/latest/MMSCHomeSecondary.asp?cid=4&mid=17&scat=1
- Massachusetts—http://www.mass.gov/rmv/motorcycle/tips.htm

Objective 11.1 G—Increase Safety Enhancements for Motorcyclists

Strategy 11.1 G1—Include Motorcycles in the Research, Development and Deployment of ITS (E)

General Description

Intelligent transportation systems (ITS) include a wide variety of integrated information, control and electronics technologies designed to enhance driving, improve traffic flow, and increase driving and riding safety. Applications are found both on the vehicle as well as within the transportation infrastructure. The U.S. Department of Transportation has divided ITS into seven general development areas which include:

- Travel and traffic management
- Public transportation
- Electronic payment
- Information management
- Commercial vehicle operations
- Advanced vehicle safety systems
- Emergency management

New developments are rapidly being integrated into transportation systems and too often new ITS developments have not considered motorcycles as a user of the transportation infrastructure. For example, traffic management strategies employ the use of sensors embedded in the pavement to detect the presence of a vehicle in a left-turn lane. This greatly improves the efficiency of the traffic control system; however, the sensors are often unable to detect the presence of a motorcycle, thus causing the motorcycle rider to either wait until another vehicle enters the left-turn lane to trigger the sensor, or violate traffic code and make

an unauthorized left turn. This example illustrates that while ITS has a great potential benefit for all road users, much of the research regarding ITS has been focused on automobiles.

It is important to note that this strategy focuses on the need to consider motorcycles and motorcyclists in the deployment of infrastructure-based ITS systems, rather than integrated vehicle-based systems (e.g., advanced vehicle safety systems), since the latter is the responsibility of the vehicle manufacturers.

EXHIBIT V-64
Strategy Attributes for Including Motorcycles in the Deployment of ITS

Technical Attributes	
Target	The target of this strategy is agencies and groups responsible for the deployment of ITS on public roadways.
Expected Effectiveness	The integration of motorcycles into the transportation population will increase awareness of road usage, improve traffic control and improve incident awareness involving motorcycles.
Keys to Success	Keys to success include acceptance by highway agencies and motorcycle safety advocates. It is also important that motorcycle riders understand how ITS systems can improve rider safety and rider enjoyment.
Potential Difficulties	In general, it may be difficult to develop ITS technology such that motorcycles are detected. They are a relatively small (i.e., under 200cc) and lightweight vehicle. The small size of the motorcycle may also limit the ability to install ITS technology (e.g., electronic toll collection transponders) directly onto the motorcycle. Failure to detect should not be a reason to exclude motorcycles from public roadways.
Appropriate Measures and Data	Process measures include the number of riders who participated in the ITS deployment as measured against the number of registered motorcycle riders in the area of deployment.
Associated Needs	None identified.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	This strategy can be implemented by state and local highway agencies responsible for deployment of ITS. Additional coordination with vendors and other groups may be necessary.
Issues Affecting Implementation Time	Implementation time may vary, depending on the availability of motorcycle-friendly ITS technology. Additional time may be required for research and development.
Costs Involved	No marginal costs are anticipated in carefully selecting only those ITS technologies that can detect motorcycles. Costs may be high if new technology needs to be researched and developed.
Training and Other Personnel Needs	Highway agency personnel need to test ITS technology for compatibility with motorcycles.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing This Strategy

Many states have implemented electronic toll collection for all toll roads and have developed systems which will permit motorcycles to use these toll roads (e.g., http://www.bayareafastrak.org). Some states even provide special reduced tolls for all riders that use the electronic toll collection system (http://www.e-zpassny.com).

Websites

Department of Transportation—Intelligent Transportation Systems website
http://www.its.dot.gov/

Intelligent Transportation Society of America website
http://www.itsa.org/

WP.29 World Forum for Harmonization of Vehicle Regulations—International Harmonized Research Activities—Intelligent Transport Systems Working Group
http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/infpape_125.html

National Agenda for Motorcycle Safety—position statement on deployment of ITS
http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/00-NHT-212-motorcycle/environmental59-60.html

American Motorcyclist Association—comments on need to include motorcycles in the development and deployment of ITS
http://www.ama-cycle.org

Objective 11.1 H—Improve Motorcycle Safety Research, Data, and Analysis

Strategy 11.1 H1—Develop and Implement Standardized Data Gathering and Reporting for Motorcycle Crashes (N/A)

General Description

Motorcycles are often overlooked during crash data gathering efforts. The frequency of motorcycle crashes is considerably lower than the frequency of automobile crashes; therefore, motorcycle crash data analysis is often limited to the evaluation of rider compliance with legislated safety measures (e.g., helmets, licensing).

It is acknowledged that the collection, data coding, data entry and analysis of crash data requires the assistance of many different groups (e.g., law enforcement, data entry specialists, data analysts, etc.) and the scope of the crash data collection effort is often affected by budget considerations. However, many states are recognizing the benefits of using existing crash data as a tool for monitoring highway safety and for the development of safety countermeasures. Until another comprehensive motorcycle crash causation study is conducted, this data can serve as a useful tool to better understand motorcycle crash causation.

Exhibit V-65 presents a number of sources that are available for obtaining information on motorcycle crashes. Numerous other resources for motorcycle data exist at the National Center for Statistical Analysis (NCSA—http://www.nhtsa.dot.gov/people/NCSA/) and

EXHIBIT V-65
Sources of Motorcycle Crash Data

Data Source	Data Type	Website
Fatal Analysis Reporting System (FARS)	National Fatality Data	http://www-fars.nhtsa.dot.gov/
National Automotive Sampling System (NASS)[21]	Crash Data from Selected Police Crash Reports	http://www-nass.nhtsa.dot.gov/BIN/NASSCASELIST.EXE/SETFILTER
Web-based Injury Statistics and Query System (WISQARS)	National Fatal and Non-fatal Injury Data	http://www.cdc.gov/ncipc/wisqars/

the Governor's Highway Safety Association (GHSA—http://www.statehighwaysafety.org). Additional reports are presented in the Key References section.

Most states rely on national fatality data which may or may not be indicative of the motorcycle crash patterns in their particular state. Appendixes 1 and 2 illustrate the distribution of single- and multiple-vehicle fatal motorcycle crashes for each state. The data show that each state is unique and, in many cases, state trends in motorcycle crashes are different from the national trends. For this reason, each state must develop its own solution to reducing the frequency and severity of motorcycle fatalities. For an additional discussion of approaches to data analysis, see the Model Implementation Process in this guide, especially the discussion and examples provided under Step 1.

This strategy involves the introduction to and the development of state-level data gathering and reporting of motorcycle crashes. Most states collect sufficient data to determine the number of motorcycle crashes within a state; however, standardized data gathering, data linkages and the addition of motorcycle-related elements to the state crash reporting form could significantly increase understanding of motorcycle crashes and their causes.

This strategy strongly supports the efforts of NHTSA in the development of the Model Minimum Uniform Crash Criteria (MMUCC at: http://www.mmucc.us/default.aspx?home=yes). The MMUCC includes 113 data elements, many of which can be used independently for analysis and many of which can be linked to other data sources such as hospital records, license records, etc. Appendix 3 shows the results of an analysis of 51 different traffic crash data reports in terms of whether or not the crash data form included a selected group of motorcycle related variables. The overall results of this analysis are presented in Exhibit V-66.

Once the data listed in the table are being regularly collected by states, and a consistent crash data reporting system has been established, data linkages can be initiated in order to further understand motorcycle crash causation. The CODES project is an illustration of how crash data records can be linked to hospital records in order to find detailed information regarding different types of motorcycle crashes and their associated medical outcome (http://www.

[21] Motorcycles are include in this database only when they are involved in a collision with another vehicle and that vehicle qualifies as NASS case.

EXHIBIT V-66
Analysis of Motorcycle Data Elements in 51 State Crash Reporting Forms

Data Element	Is the Data Element on the Crash Reporting Form? Yes	No	Percentage of States with This Data Element
Motorcycle As a Vehicle Type	49	2	96.1
Motorcycle Make	50	1	98.0
Motorcycle Model	33	18	64.7
Vehicle Identification Number (VIN)	40	11	78.4
Motorcycle Engine Size (cc)	3	48	5.9
Motorcycle Class License or Motorcycle Endorsement	39	12	76.5
Motorcycle Helmet Worn at Time of Crash	44	7	86.3
Number of Vehicle Occupants	23	28	45.1

nhtsa.dot.gov/portal/site/nhtsa/menuitem.9fef9613e59b4dd24ec86e10dba046a0/). Other potential projects could include links with motorcycle licensing or rider training programs to better understand the benefits of such programs within a given jurisdiction.

Information on Agencies or Organizations Currently Implementing This Strategy

Several states have begun to implement data linkages using the CODES system and many states have made efforts to increase the number of motorcycle-related data elements. The state of Wisconsin has linked motorcycle crash information with hospital information in order to determine the impact of helmet use and alcohol consumption on motorcycle crashes in their state. A complete summary of the report may be found at the following link: http://www.chsra.wisc.edu/codes/motorcycle_crash_information.htm.

The Maryland Motor Vehicle Division (MVD) has initiated a project to link motorcycle crash information with hospital, state licensing and rider training records to determine crash causation, rider behavior, licensing status and training experience. Further information can be obtained from the Maryland Motorcycle Safety Program at 1-800-638-8236 or e-mail at motorcyclesafety@mdot.state.md.us. The website for Maryland motorcycle safety programs is: http://mva.state.md.us/MVAProg/moto/default.htm.

Websites

FARS Web Encyclopedia (Query System)—http://www-fars.nhtsa.dot.gov/

NCSA State Data System—Crash Data Report: 1990–1999, Section 11: Motorcycles
http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/Rpts/2002/809_301/12motorcycles.pdf

NHTSA, *Traffic Safety Facts 2003-Motorcycles,* DOT HS 809 764
http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/PPT/PresMCFatsUpdate.pdf

NHTSA, *Safety Belt and Helmet Use in 2002-Overall Results,* DOT HS 809 500
http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/Rpts/2002/809-500.pdf

Bureau of Transportation Statistics—Motorcycle Rider Safety Data
http://www.bts.gov/publications/national_transportation_statistics/2003/html/table_02_22.html

NHTSA MMUCC website
http://www.nhtsa.dot.gov/people/perform/trafrecords/pages/mmucc/mmucc.htm

State Traffic Data Forms website
http://www.nhtsa.dot.gov/people/perform/trafrecords/crash2003/Default.htm

CODES website
http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.9fef9613e59b4dd24ec86e10dba046a0/

State of New Jersey—Crash Data Records
http://www.state.nj.us/transportation/refdata/accident/rawdata01-02.shtm

Please see the Key References section for other agencies that have implemented this strategy.

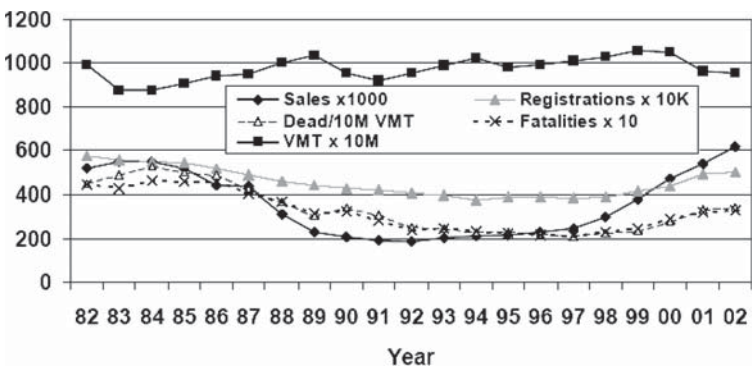
Strategy 11.1 H2—Include Motorcycle Attributes in Vehicle Exposure Data Collection Programs (N/A)

General Description

The identification of risk factors in traffic crashes requires the use of exposure data. Ideally this data source represents the population-at-risk, i.e., the population of motorcycle riders that are exposed to the same risks as those within the accident population. This allows for the analysis of over- and under-representation and the identification of specific risk factors.

This exposure data is used to compute vehicle miles traveled (VMT) which is then compared with the accident data found in the Fatality Analysis Reporting System (FARS) and the National Automotive Sampling System (NASS) to identify risk factors in traffic crashes. Exhibit V-67 illustrates motorcycle trends—with respect to sales, registrations, fatalities, and vehicle miles traveled—from 1982 to 2002.

EXHIBIT V-67
Trends in Motorcycling: New Unit Sales, Registrations, Fatalities, Vehicle Miles Traveled (VMT) and Fatalities per VMT
Source: Jim Ouellet, Head Protection Research Laboratory



Unfortunately, the methods for computing VMT data for motorcycles vary from state to state, so it is difficult to make comparisons, though FHWA is currently reassessing how to improve data and reporting. The most commonly used exposure database is the Nationwide Personal Transportation Survey (NPTS) or National Household Travel Survey (NHTS), which is conducted every 5 or 6 years. The 2001 data comparing motorcycles and cars are presented in Exhibits V-68 and V-69. Detailed tables, with comparisons for other types of vehicles, may be found in Appendix 5.

The data presented below clearly show that the travel patterns of motorcycle riders, with respect to rider age, are quite different from other road users, both in the number of annual miles driven as well as the average trip duration. This strongly suggests that special attention needs to be given to the collection of accurate motorcycle rider exposure data.

EXHIBIT V-68
Annual Miles Driven versus Age for Males in 2001
Source: NHTSA, 2001

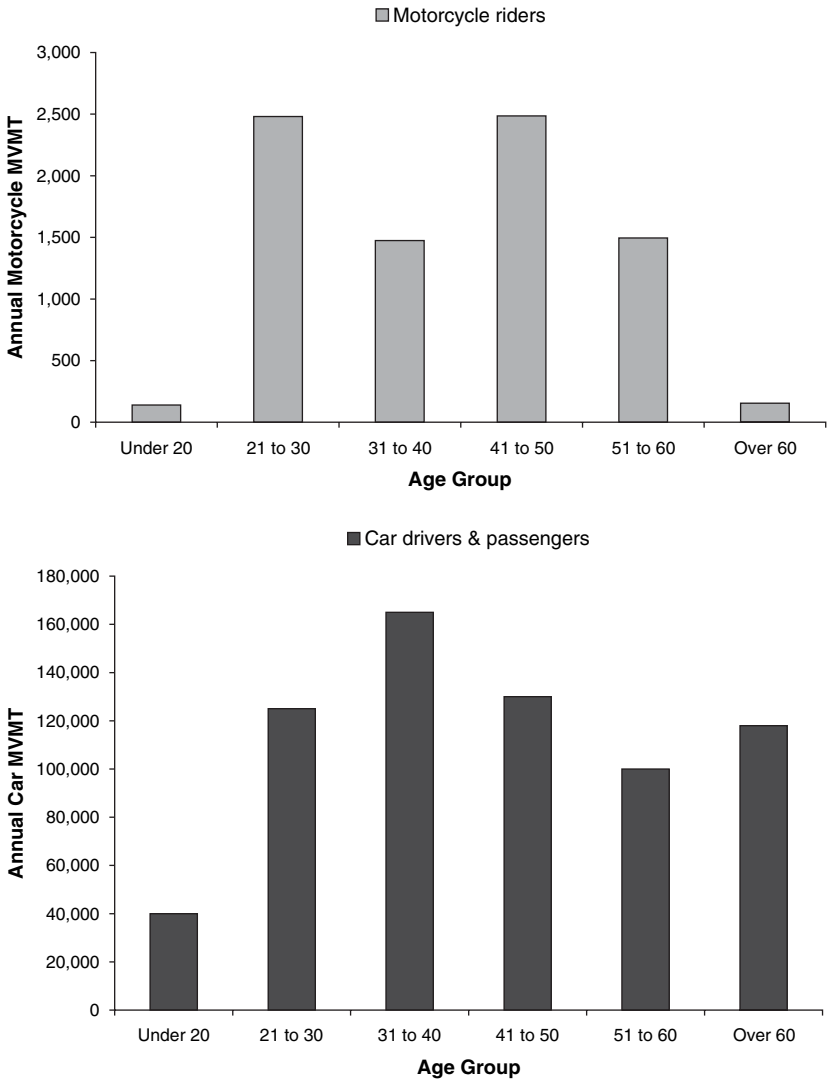
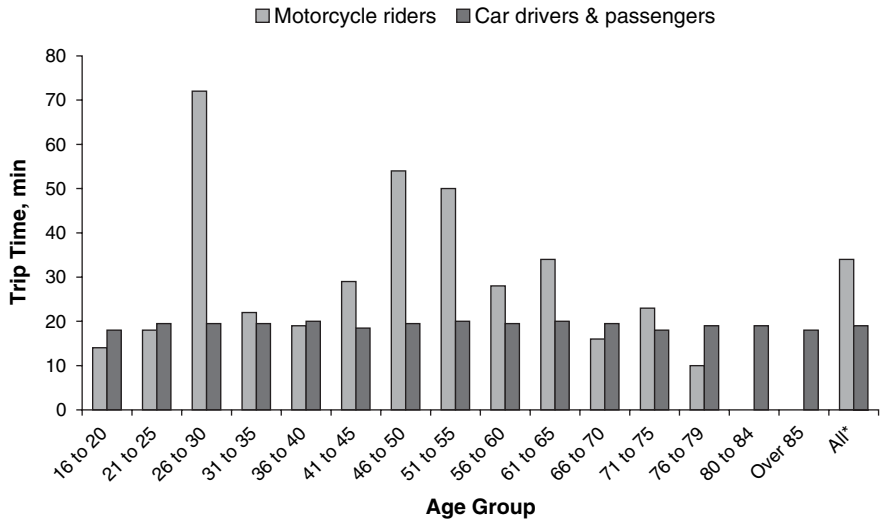


EXHIBIT V-69
Average Trip Duration versus Age for Males in 2001
Source: NHTSA, 2001



In 1996, the National Roadside Survey was conducted between 10:00 p.m. and 3:00 a.m. on Friday and Saturday nights in order to obtain information about drinking and driving as well as vehicle type, seat belt use and number of occupants. The survey was done in all 48 contiguous states; however, due to logistical problems, no motorcycle riders were surveyed as part of the study.

Unfortunately, due to the relatively small number of motorcycles and the cyclical nature of motorcycle riding, it is very difficult to obtain reliable motorcycle exposure data. Less than 2.5 percent of the people surveyed in the 2001 National Household Travel Survey (NHTS) owned a motorcycle. Due to their small size and light weight (relative to other vehicles), motorcycles are also difficult to detect with some roadway data collection devices (e.g., roadway tubes, vehicle length measurement devices, lane monitors, etc.).

Many riders own motorcycles and do not ride them on a regular basis; therefore, the use of vehicle registration data and the use of telephonic surveys does not adequately reflect the over-the-road and at-risk population of motorcycle riders. In many cases, these methods tend to over-estimate the actual riding population because, for many people, motorcycle riding is not a daily activity. Previous studies which have tried to draw conclusions without comparison to exposure data have been strongly criticized (Kraus et al., 1988).

This strategy supports the enhancement of existing over-the-road user surveys to include motorcycles.

Information on Agencies or Organizations Currently Implementing This Strategy

NHTSA has explored methods to collect motorcycle rider exposure data. A workshop was held in June 2003 to discuss potential methodologies for motorcycle rider exposure data collection and the summary report of that workshop is available.

Department of Transportation Solicitation DTNH22-01-R-05162, Methodology for Determining Motorcycle Operator Crash Risk and Impairment

Department of Transportation Solicitation DTNH22-02-R-05112, Characteristics of Motorcycle Operators Study

Websites

Federal Highway Administration—National Household Travel Survey
http://www.fhwa.dot.gov/policy/ohpi/nhts/index.cfm

NTSB Recommendation to improve VMT data
http://safety.fhwa.dot.gov/mac/final010808.htm

FHWA Motorcycle Traffic Symposium (and ongoing work)
http://www.fhwa.dot.gov/motorcycles/2007symposium.cfm

Strategy 11.1 H3—Develop a Set of Analysis Tools for Motorcycle Crashes (N/A)

General Description

In order to fully understand motorcycle crashes and crash causation, existing data must be analyzed and used to develop appropriate countermeasures. Many highway agencies currently have, or at least have access to, sufficient data to identify motorcycle crash patterns and potential countermeasures. Unfortunately, evaluation of existing data often requires the use of advanced statistical software packages which may not be available to staff and require a high level of statistical knowledge to utilize.

This strategy builds upon the efforts of Strategy 11.1 A1 and emphasizes the development of common software tools that can be used to evaluate the data collected using the Model Minimum Uniform Crash Criteria (MMUCC). These tools should be intuitive and easy to use and they should be adaptable for different types of data.

This strategy is intended to allow highway agencies to use their own crash data, which would be compared to an exposure population, to identify risk factors for motorcycle crashes in their region. Additional analysis could be performed to compare the user data to other larger data sources such as FARS. The following is a partial list of significant motorcycle crash variables which are currently available in the FARS data and are typically found within state or regional crash data:

- Time of accident
- Type of roadway
- Day of accident
- Age of rider
- Alcohol involvement
- Motorcycle engine size

It is expected that the amount of information available at the state level and at the national level will continue to grow as more and more states begin to adopt the MMUCC guidelines and crash contributing factors are reported with greater frequency.

Information on Agencies or Organizations Currently Implementing This Strategy

In an effort to consolidate and communicate between different agencies and groups within the state of Iowa, the Department of Transportation Office of Traffic Safety created a website with a set of crash analysis tools that can be used by anyone interested in better understanding Iowa crash data. This website and the associated tools can be found at the following link: http://www.dot.state.ia.us/crashanalysis/.

The University of Alabama has developed the CARE system which allows users to analyze crash and other data. In addition to crash databases and analysis tools, the website for CARE (http://care.cs.ua.edu/) tells about other data collection and analysis initiatives being carried out. The site allows for online analysis of highway crash data from several states.

NHTSA has currently developed software tools that will allow users to estimate the economic cost of crashes in their area. This software tool could easily be used to estimate the economic cost of motorcycle crashes within a given jurisdiction. The PC/Window-based software is available free of charge from the following link: http://www.nhtsa.dot.gov/people/crash/MVS/

Using Minnesota crash data, the Minnesota Motorcycle Safety Center (MMSC) has determined that the majority of motorcycle fatalities and injuries in Minnesota involve collisions with other vehicles. A complete analysis of the crash data records for the state has identified that alcohol and the lack of training and personal protective equipment are the most frequently reported contributing factors. Given this information and awareness, specific public service ad campaigns have been developed to address these issues. http://www.motorcyclesafety.state.mn.us/pages/ad2.asp http://www.dps.state.mn.us/ots/crashdata/2003CFacts/CF03-4Motorcycle.pdf

Using Utah crash data, researchers attempted to identify the factors associated with animal-vehicle collisions. It was determined that 94 percent of all motorcycle/animal crashes involved an injury to the motorcycle rider. Using the crash data, sections of roadway that reported a high frequency of animal-to-vehicle collisions were identified and specific countermeasures were introduced in an effort to reduce this type of single-vehicle motorcycle crash. The report can be found at the following link: http://www.dot.state.ut.us/main/uconowner.gf?n=200312091625312.

Websites

CODES documents available from NHTSA regarding statistical analysis of crash data
http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.9fef9613e59b4dd24ec86e10dba046a0/

National Center for Statistical Analysis
http://www.nhtsa.dot.gov/people/NCSA/

North Carolina crash data query website
http://www.hsrc.unc.edu/crash

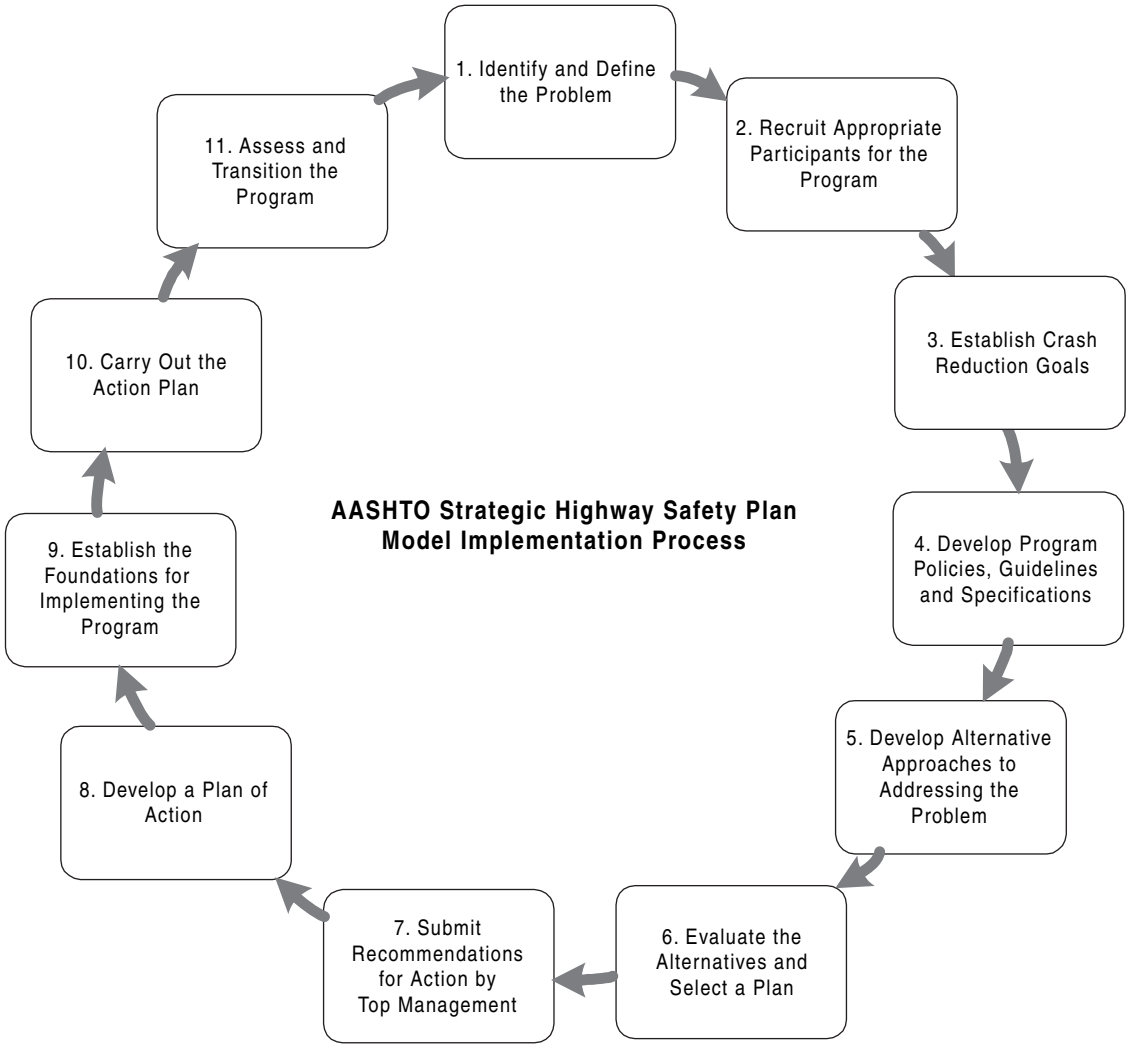
SECTION VI

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Outline for a Model Implementation Process

Exhibit VI-1 gives an overview of an 11-step model process for implementing a program of strategies for any given emphasis area of the AASHTO Strategic Highway Safety Plan. After a short introduction, each of the steps is outlined in further detail.

EXHIBIT VI-1



Purpose of the Model Process

The process described in this section is provided as a model rather than a standard. Many users of this guide will already be working within a process established by their agency or working group. It is not suggested that their process be modified to conform to this one. However, the model process may provide a useful checklist. For those not having a standard process to follow, it is recommended that the model process be used to help establish an appropriate one for their initiative. Not all steps in the model process need to be performed at the level of detail indicated in the outlines below. The degree of detail and the amount of work required to complete some of these steps will vary widely, depending upon the situation.

It is important to understand that the process being presented here is assumed to be conducted only as a part of a broader, strategic-level safety management process. The details of that process, and its relation to this one, may be found in a companion guide. (The companion guide is a work in progress at this writing. When it is available, it will be posted online at http://transportation1.org/safetyplan.)

Overview of the Model Process

The process (see Exhibit VI-1, above) must be started at top levels in the lead agency's organization. This would, for example, include the CEO, DOT secretary, or chief engineer, as appropriate. Here, decisions will have been made to focus the agency's attention and resources on specific safety problems based upon the particular conditions and characteristics of the organization's roadway system. This is usually, but not always, documented as a result of the strategic-level process mentioned above. It often is publicized in the form of a "highway safety plan." Examples of what states produce include Wisconsin DOT's Strategic Highway Safety Plan (see Appendix A) and Iowa's Safety Plan (available at http://www.iowasms.org/reports/toolbox.htm).

Once a "high-level" decision has been made to proceed with a particular emphasis area, the first step is to describe, in as much detail as possible, the problem that has been identified in the high-level analysis. The additional detail helps confirm to management that the problem identified in the strategic-level analysis is real and significant and that it is possible to do something about it. The added detail that this step provides to the understanding of the problem will also play an important part in identifying alternative approaches for dealing with it.

Step 1 should produce endorsement and commitments from management to proceed, at least through a planning process. With such an endorsement, it is then necessary to identify the stakeholders and define their role in the effort (Step 2). It is important at this step to identify a range of participants in the process who will be able to help formulate a comprehensive approach to the problem. The group will want to consider how it can draw upon potential actions directed at

- Driver behavior (legislation, enforcement, education, and licensing),
- Engineering,

- Emergency medical systems, and
- System management.

With the establishment of a working group, it is then possible to finalize an understanding of the nature and limitations of what needs to be done in the form of a set of program policies, guidelines, and specifications (Steps 3 and 4). An important aspect of this is establishing targets for crash reduction in the particular emphasis area (Step 3). Identifying stakeholders, defining their roles, and forming guidelines and policies are all elements of what is often referred to as "chartering the team." In many cases, and in particular where only one or two agencies are to be involved and the issues are not complex, it may be possible to complete Steps 1 through 4 concurrently.

Having received management endorsement and chartered a project team—the foundation for the work—it is now possible to proceed with project planning. The first step in this phase (Step 5 in the overall process) is to identify alternative strategies for addressing the safety problems that have been identified while remaining faithful to the conditions established in Steps 2 through 4.

With the alternative strategies sufficiently defined, they must be evaluated against one another (Step 6) and as groups of compatible strategies (i.e., a total program). The results of the evaluation will form the recommended plan. The plan is normally submitted to the appropriate levels of management for review and input, resulting ultimately in a decision on whether and how to proceed (Step 7). Once the working group has been given approval to proceed, along with any further guidelines that may have come from management, the group can develop a detailed plan of action (Step 8). This is sometimes referred to as an "implementation" or "business" plan.

Plan implementation is covered in Steps 9 and 10. There often are underlying activities that must take place prior to implementing the action plan to form a foundation for what needs to be done (Step 9). This usually involves creating the organizational, operational, and physical infrastructure needed to succeed. The major step (Step 10) in this process involves doing what was planned. This step will in most cases require the greatest resource commitment of the agency. An important aspect of implementation involves maintaining appropriate records of costs and effectiveness to allow the plan to be evaluated after-the-fact.

Evaluating the program, after it is underway, is an important activity that is often overlooked. Management has the right to require information about costs, resources, and effectiveness. It is also likely that management will request that the development team provide recommendations about whether the program should be continued and, if so, what revisions should be made. Note that management will be deciding on the future for any single emphasis area in the context of the entire range of possible uses of the agency's resources. Step 11 involves activities that will give the desired information to management for each emphasis area.

To summarize, the implementation of a program of strategies for an emphasis area can be characterized as an 11-step process. The steps in the process correspond closely to a 4-phase approach commonly followed by many transportation agencies:

- Endorsement and chartering of the team and project (Steps 1 through 4),
- Project planning (Steps 5 through 8),
- Plan implementation (Steps 9 and 10), and
- Plan evaluation (Step 11).

Details about each step follow. The Web-based version of this description is accompanied by a set of supplementary material to enhance and illustrate the points.

The model process is intended to provide a framework for those who need it. It is not intended to be a how-to manual. There are other documents that provide extensive detail regarding how to conduct this type of process. Some general ones are covered in Appendix B and Appendix C. Others, which relate to specific aspects of the process, are referenced within the specific sections to which they apply.

Implementation Step 1: Identify and Define the Problem

General Description

Program development begins with gathering data and creating and analyzing information. The implementation process being described in this guide is one that will be done in the context of a larger strategic process. It is expected that this guide will be used when the strategic process, or a project-level analysis, has identified a potentially significant problem in this emphasis area.

Data analyses done at the strategic level normally are done with a limited amount of detail. They are usually the top layer in a "drill-down" process. Therefore, while those previous analyses should be reviewed and used as appropriate, it will often be the case that further studies are needed to completely define the issues.

It is also often the case that a core technical working group will have been formed by the lead agency to direct and carry out the process. This group can conduct the analyses required in this step, but should seek, as soon as possible, to involve any other stakeholders who may desire to provide input to this process. Step 2 deals further with the organization of the working group.

The objectives of this first step are as follows:

1. Confirm that a problem exists in this emphasis area.
2. Detail the characteristics of the problem to allow identification of likely approaches for eliminating or reducing it.
3. Confirm with management, given the new information, that the planning and implementation process should proceed.

The objectives will entail locating the best available data and analyzing them to highlight either geographic concentrations of the problem or over-representation of the problem within the population being studied.

Identification of existing problems is *a responsive approach*. This can be complemented by a *proactive approach* that seeks to identify potentially hazardous conditions or populations.

For the responsive type of analyses, one generally begins with basic crash records that are maintained by agencies within the jurisdiction. This is usually combined, where feasible, with other safety data maintained by one or more agencies. The other data could include

- Roadway inventory,
- Driver records (enforcement, licensing, courts), or
- Emergency medical service and trauma center data.

To have the desired level of impact on highway safety, it is important to consider the highway system as a whole. Where multiple jurisdictions are responsible for various parts of the system, they should all be included in the analysis, wherever possible. The best example of this is a state plan for highway safety that includes consideration of the extensive

mileage administered by local agencies. To accomplish problem identification in this manner will require a cooperative, coordinated process. For further discussion on the problem identification process, see Appendix D and the further references contained therein.

In some cases, very limited data are available for a portion of the roads in the jurisdiction. This can occur for a local road maintained by a state or with a local agency that has very limited resources for maintaining major databases. Lack of data is a serious limitation to this process, but must be dealt with. It may be that for a specific study, special data collection efforts can be included as part of the project funding. While crash records may be maintained for most of the roads in the system, the level of detail, such as good location information, may be quite limited. It is useful to draw upon local knowledge to supplement data, including

- Local law enforcement,
- State district and maintenance engineers,
- Local engineering staff, and
- Local residents and road users.

These sources of information may provide useful insights for identifying hazardous locations. In addition, local transportation agencies may be able to provide supplementary data from their archives. Finally, some of the proactive approaches mentioned below may be used where good records are not available.

Maximum effectiveness often calls for going beyond data in the files to include special supplemental data collected on crashes, behavioral data, site inventories, and citizen input. Analyses should reflect the use of statistical methods that are currently recognized as valid within the profession.

Proactive elements could include

- Changes to policies, design guides, design criteria, and specifications based upon research and experience;
- Retrofitting existing sites or highway elements to conform to updated criteria (perhaps with an appropriate priority scheme);
- Taking advantage of lessons learned from previous projects;
- Road safety audits, including on-site visits;
- Safety management based on roadway inventories;
- Input from police officers and road users; and
- Input from experts through such programs as the NHTSA traffic records assessment team.

The result of this step is normally a report that includes tables and graphs that clearly demonstrate the types of problems and detail some of their key characteristics. Such reports

should be presented in a manner to allow top management to quickly grasp the key findings and help them decide which of the emphasis areas should be pursued further, and at what level of funding. However, the report must also document the detailed work that has been done, so that those who do the later stages of work will have the necessary background.

Specific Elements

1. Define the scope of the analysis
    - 1.1. All crashes in the entire jurisdiction
    - 1.2. A subset of crash types (whose characteristics suggest they are treatable, using strategies from the emphasis area)
    - 1.3. A portion of the jurisdiction
    - 1.4. A portion of the population (whose attributes suggest they are treatable using strategies from the emphasis area)
2. Define safety measures to be used for responsive analyses
    - 2.1. Crash measures
        - 2.1.1. Frequency (all crashes or by crash type)
        - 2.1.2. Measures of exposure
        - 2.1.3. Decide on role of frequency versus rates
    - 2.2. Behavioral measures
        - 2.2.1. Conflicts
        - 2.2.2. Erratic maneuvers
        - 2.2.3. Illegal maneuvers
        - 2.2.4. Aggressive actions
        - 2.2.5. Speed
    - 2.3. Other measures
        - 2.3.1. Citizen complaints
        - 2.3.2. Marks or damage on roadway and appurtenances, as well as crash debris
3. Define measures for proactive analyses
    - 3.1. Comparison with updated and changed policies, design guides, design criteria, and specifications
    - 3.2. Conditions related to lessons learned from previous projects
    - 3.3. Hazard indices or risk analyses calculated using data from roadway inventories to input to risk-based models
    - 3.4. Input from police officers and road users
4. Collect data
    - 4.1. Data on record (e.g., crash records, roadway inventory, medical data, driver-licensing data, citations, other)
    - 4.2. Field data (e.g., supplementary crash and inventory data, behavioral observations, operational data)
    - 4.3. Use of road safety audits, or adaptations
5. Analyze data
    - 5.1. Data plots (charts, tables, and maps) to identify possible patterns, and concentrations (See Appendixes Y, Z and AA for examples of what some states are doing)

5.2. Statistical analysis (high-hazard locations, over-representation of contributing circumstances, crash types, conditions, and populations)
5.3. Use expertise, through road safety audits or program assessment teams
5.4. Focus upon key attributes for which action is feasible:
5.4.1. Factors potentially contributing to the problems
5.4.2. Specific populations contributing to, and affected by, the problems
5.4.3. Those parts of the system contributing to a large portion of the problem

6. Report results and receive approval to pursue solutions to identified problems (a*pprovals being sought here are primarily a confirmation of the need to proceed and likely levels of resources required*)
6.1. Sort problems by type
6.1.1. Portion of the total problem
6.1.2. Vehicle, highway/environment, enforcement, education, other driver actions, emergency medical system, legislation, and system management
6.1.3. According to applicable funding programs
6.1.4. According to political jurisdictions
6.2. Preliminary listing of the types of strategies that might be applicable
6.3. Order-of-magnitude estimates of time and cost to prepare implementation plan
6.4. Listing of agencies that should be involved, and their potential roles (including an outline of the organizational framework intended for the working group). Go to Step 2 for more on this.

Implementation Step 2: Recruit Appropriate Participants for the Program

General Description

A critical early step in the implementation process is to engage all the stakeholders that may be encompassed within the scope of the planned program. The stakeholders may be from outside agencies (e.g., state patrol, county governments, or citizen groups). One criterion for participation is if the agency or individual will help ensure a comprehensive view of the problem and potential strategies for its resolution. If there is an existing structure (e.g., a State Safety Management System Committee) of stakeholders for conducting strategic planning, it is important to relate to this, and build on it, for addressing the detailed considerations of the particular emphasis area.

There may be some situations within the emphasis area for which no other stakeholders may be involved other than the lead agency and the road users. However, in most cases, careful consideration of the issues will reveal a number of potential stakeholders to possibly be involved. Furthermore, it is usually the case that a potential program will proceed better in the organizational and institutional setting if a high-level "champion" is found in the lead agency to support the effort and act as a key liaison with other stakeholders.

Stakeholders should already have been identified in the previous step, at least at a level to allow decision makers to know whose cooperation is needed, and what their potential level of involvement might be. During this step, the lead agency should contact the key individuals in each of the external agencies to elicit their participation and cooperation. This will require identifying the right office or organizational unit, and the appropriate people in each case. It will include providing them with a brief overview document and outlining for them the type of involvement envisioned. This may typically involve developing interagency agreements. The participation and cooperation of each agency should be secured to ensure program success.

Lists of appropriate candidates for the stakeholder groups are recorded in Appendix K. In addition, reference may be made to the NHTSA document at http://www.nhtsa.dot.gov/safecommunities/SAFE%20COMM%20Html/index.html, which provides guidance on building coalitions.

Specific Elements

1. Identify internal "champions" for the program
2. Identify the suitable contact in each of the agencies or private organizations who is appropriate to participate in the program
3. Develop a brief document that helps sell the program and the contact's role in it by
    - 3.1. Defining the problem
    - 3.2. Outlining possible solutions
    - 3.3. Aligning the agency or group mission by resolving the problem
    - 3.4. Emphasizing the importance the agency has to the success of the effort

   3.5. Outlining the organizational framework for the working group and other stakeholders cooperating on this effort
   3.6. Outlining the rest of the process in which agency staff or group members are being asked to participate
   3.7. Outlining the nature of commitments desired from the agency or group for the program
   3.8. Establishing program management responsibilities, including communication protocols, agency roles, and responsibilities
   3.9. Listing the purpose for an initial meeting
4. Meet with the appropriate representative
   4.1. Identify the key individual(s) in the agency or group whose approval is needed to get the desired cooperation
   4.2. Clarify any questions or concepts
   4.3. Outline the next steps to get the agency or group onboard and participating
5. Establish an organizational framework for the group
   5.1. Roles
   5.2. Responsibilities

Implementation Step 3: Establish Crash Reduction Goals

General Description

The AASHTO Strategic Highway Safety Plan established a national goal of saving 5,000 to 7,000 lives annually by the year 2005. Some states have established statewide goals for the reduction of fatalities or crashes of a certain degree of severity. Establishing an explicit goal for crash reduction can place an agency "on the spot," but it usually provides an impetus to action and builds support for funding programs for its achievement. Therefore, it is desirable to establish, within each emphasis area, one or more crash reduction targets.

These may be dictated by strategic-level planning for the agency, or it may be left to the stakeholders to determine. (The summary of the Wisconsin DOT Highway Safety Plan in Appendix A has more information.) For example, Pennsylvania adopted a goal of 10 percent reduction in fatalities by 2002,[1] while California established a goal of 40 percent reduction in fatalities and 15 percent reduction in injury crashes, as well as a 10 percent reduction in work zone crashes, in 1 year.[2] At the municipal level, Toledo, Ohio, is cited by the U.S. Conference of Mayors as having an exemplary program. This included establishing specific crash reduction goals (http://www.usmayors.org/chhs/traffic/best_traffic_initiative_toledo.htm). When working within an emphasis area, it may be desirable to specify certain types of crashes, as well as the severity level, being targeted.

There are a few key considerations for establishing a quantitative goal. The stakeholders should achieve consensus on this issue. The goal should be challenging, but achievable. Its feasibility depends in part on available funding, the timeframe in which the goal is to be achieved, the degree of complexity of the program, and the degree of controversy the program may experience. To a certain extent, the quantification of the goal will be an iterative process. If the effort is directed at a particular location, then this becomes a relatively straightforward action.

Specific Elements

1. Identify the type of crashes to be targeted
    - 1.1. Subset of all crash types
    - 1.2. Level of severity
2. Identify existing statewide or other potentially related crash reduction goals
3. Conduct a process with stakeholders to arrive at a consensus on a crash reduction goal
    - 3.1. Identify key considerations
    - 3.2. Identify past goals used in the jurisdiction
    - 3.3. Identify what other jurisdictions are using as crash reduction goals
    - 3.4. Use consensus-seeking methods, as needed

[1] Draft State Highway Safety Plan, State of Pennsylvania, July 22, 1999
[2] Operations Program Business Plan, FY 1999/2000, State of California, Caltrans, July 1999

Implementation Step 4: Develop Program Policies, Guidelines, and Specifications

General Description

A foundation and framework are needed for solving the identified safety problems. The implementation process will need to be guided and evaluated according to a set of goals, objectives, and related performance measures. These will formalize what the intended result is and how success will be measured. The overlying crash reduction goal, established in Step 3, will provide the context for the more specific goals established in this step. The goals, objectives, and performance measures will be used much later to evaluate what is implemented. Therefore, they should be jointly outlined at this point and agreed to by all program stakeholders. It is important to recognize that evaluating any actions is an important part of the process. Even though evaluation is not finished until some time after the strategies have been implemented, it begins at this step.

The elements of this step may be simpler for a specific project or location than for a comprehensive program. However, even in the simpler case, policies, guidelines, and specifications are usually needed. Furthermore, some programs or projects may require that some guidelines or specifications be in the form of limits on directions taken and types of strategies considered acceptable.

Specific Elements

1. Identify high-level policy actions required and implement them (legislative and administrative)
2. Develop goals, objectives, and performance measures to guide the program and use for assessing its effect
    - 2.1. Hold joint meetings of stakeholders
    - 2.2. Use consensus-seeking methods
    - 2.3. Carefully define terms and measures
    - 2.4. Develop report documenting results and validate them
3. Identify specifications or constraints to be used throughout the project
    - 3.1. Budget constraints
    - 3.2. Time constraints
    - 3.3. Personnel training
    - 3.4. Capacity to install or construct
    - 3.5. Types of strategies not to be considered or that must be included
    - 3.6. Other

Implementation Step 5: Develop Alternative Approaches to Addressing the Problem

General Description

Having defined the problem and established a foundation, the next step is to find ways to address the identified problems. If the problem identification stage has been done effectively (see Appendix D for further details on identifying road safety problems), the characteristics of the problems should suggest one or more alternative ways for dealing with the problem. It is important that a full range of options be considered, drawing from areas dealing with enforcement, engineering, education, emergency medical services, and system management actions.

Alternative strategies should be sought for both location-specific and systemic problems that have been identified. Location-specific strategies should pertain equally well to addressing high-hazard locations and to solving safety problems identified within projects that are being studied for reasons other than safety.

Where site-specific strategies are being considered, visits to selected sites may be in order if detailed data and pictures are not available. In some cases, the emphasis area guides will provide tables that help connect the attributes of the problem with one or more appropriate strategies to use as countermeasures.

Strategies should also be considered for application on a systemic basis. Examples include

1. Low-cost improvements targeted at problems that have been identified as significant in the overall highway safety picture, but not concentrated in a given location.
2. Action focused upon a specific driver population, but carried out throughout the jurisdiction.
3. Response to a change in policy, including modified design standards.
4. Response to a change in law, such as adoption of a new definition for DUI.

In some cases, a strategy may be considered that is relatively untried or is an innovative variation from past approaches to treatment of a similar problem. Special care is needed to ensure that such strategies are found to be sound enough to implement on a wide-scale basis. Rather than ignoring this type of candidate strategy in favor of the more "tried-and-proven" approaches, consideration should be given to including a pilot-test component to the strategy.

The primary purpose of this guide is to provide a set of strategies to consider for eliminating or lessening the particular road safety problem upon which the user is focusing. As pointed out in the first step of this process, the identification of the problem, and the selection of strategies, is a complex step that will be different for each case. Therefore, it is not feasible to provide a "formula" to follow. However, guidelines are available. There are a number of texts to which the reader can refer. Some of these are listed in Appendix B and Appendix D.

In addition, the tables referenced in Appendix G provide examples for linking identified problems with candidate strategies.

The second part of this step is to assemble sets of strategies into alternative "program packages." Some strategies are complementary to others, while some are more effective when combined with others. In addition, some strategies are mutually exclusive. Finally, strategies may be needed to address roads across multiple jurisdictions. For instance, a package of strategies may need to address both the state and local highway system to have the desired level of impact. The result of this part of the activity will be a set of alternative "program packages" for the emphasis area.

It may be desirable to prepare a technical memorandum at the end of this step. It would document the results, both for input into the next step and for internal reviews. The latter is likely to occur, since this is the point at which specific actions are being seriously considered.

Specific Elements

1. Review problem characteristics and compare them with individual strategies, considering both their objectives and their attributes
    - 1.1. Road-user behavior (law enforcement, licensing, adjudication)
    - 1.2. Engineering
    - 1.3. Emergency medical services
    - 1.4. System management elements
2. Select individual strategies that do the following:
    - 2.1. Address the problem
    - 2.2. Are within the policies and constraints established
    - 2.3. Are likely to help achieve the goals and objectives established for the program
3. Assemble individual strategies into alternative program packages expected to optimize achievement of goals and objectives
    - 3.1. Cumulative effect to achieve crash reduction goal
    - 3.2. Eliminate strategies that can be identified as inappropriate, or likely to be ineffective, even at this early stage of planning
4. Summarize the plan in a technical memorandum, describing attributes of individual strategies, how they will be combined, and why they are likely to meet the established goals and objectives

Implementation Step 6: Evaluate Alternatives and Select a Plan

General Description

This step is needed to arrive at a logical basis for prioritizing and selecting among the alternative strategies or program packages that have been developed. There are several activities that need to be performed. One proposed list is shown in Appendix P.

The process involves making estimates for each of the established performance measures for the program and comparing them, both individually and in total. To do this in a quantitative manner requires some basis for estimating the effectiveness of each strategy. Where solid evidence has been found on effectiveness, it has been presented for each strategy in the guide. In some cases, agencies have a set of crash reduction factors that are used to arrive at effectiveness estimates. Where a high degree of uncertainty exists, it is wise to use sensitivity analyses to test the validity of any conclusions that may be made regarding which is the best strategy or set of strategies to use. Further discussion of this may be found in Appendix O.

Cost-benefit and cost-effectiveness analyses are usually used to help identify inefficient or inappropriate strategies, as well as to establish priorities. For further definition of the two terms, see Appendix Q. For a comparison of the two techniques, see Appendix S. Aspects of feasibility, other than economic, must also be considered at this point. An excellent set of references is provided within online benefit-cost guides:

- One is under development at the following site, maintained by the American Society of Civil Engineers: http://ceenve.calpoly.edu/sullivan/cutep/cutep_bc_outline_main.htm
- The other is *Guide to Benefit-Cost Analysis in Transport Canada*, September 1994, http://www.tc.gc.ca/finance/bca/en/TOC_e.htm. An overall summary of this document is given in Appendix V.

In some cases, a strategy or program may look promising, but no evidence may be available as to its likely effectiveness. This would be especially true for innovative methods or use of emerging technologies. In such cases, it may be advisable to plan a pilot study to arrive at a minimum level of confidence in its effectiveness, before large-scale investment is made or a large segment of the public is involved in something untested.

It is at this stage of detailed analysis that the crash reduction goals, set in Step 3, may be revisited, with the possibility of modification.

It is important that this step be conducted with the full participation of the stakeholders. If the previous steps were followed, the working group will have the appropriate representation. Technical assistance from more than one discipline may be necessary to go through more complex issues. Group consensus will be important on areas such as estimates of effectiveness, as well as the rating and ranking of alternatives. Techniques are available to assist in arriving at consensus. For example, see the following Web site for an overview: http://www.tc.gc.ca/finance/bca/en/Printable_e.htm.

Specific Elements

1. Assess feasibility
    - 1.1. Human resources
    - 1.2. Special constraints
    - 1.3. Legislative requirements
    - 1.4. Other
    - 1.5. This is often done in a qualitative way, to narrow the list of choices to be studied in more detail (see, for example, Appendix BB)
2. Estimate values for each of the performance measures for each strategy and plan
    - 2.1. Estimate costs and impacts
        - 2.1.1. Consider guidelines provided in the detailed description of strategies in this material
        - 2.1.2. Adjust as necessary to reflect local knowledge or practice
        - 2.1.3. Where a plan or program is being considered that includes more than one strategy, combine individual estimates
    - 2.2. Prepare results for cost-benefit and/or cost-effectiveness analyses
    - 2.3. Summarize the estimates in both disaggregate (by individual strategy) and aggregate (total for the program) form
3. Conduct a cost-benefit and/or cost-effectiveness analysis to identify inefficient, as well as dominant, strategies and programs and to establish a priority for the alternatives
    - 3.1. Test for dominance (both lower cost and higher effectiveness than others)
    - 3.2. Estimate relative cost-benefit and/or cost-effectiveness
    - 3.3. Test productivity
4. Develop a report that documents the effort, summarizing the alternatives considered and presenting a preferred program, as devised by the working group (for suggestions on a report of a benefit-cost analysis, see Appendix U).
    - 4.1. Designed for high-level decision makers, as well as technical personnel who would be involved in the implementation
    - 4.2. Extensive use of graphics and layout techniques to facilitate understanding and capture interest
    - 4.3. Recommendations regarding meeting or altering the crash reduction goals established in Step 3.

Implementation Step 7: Submit Recommendations for Action by Top Management

General Description

The working group has completed the important planning tasks and must now submit the results and conclusions to those who will make the decision on whether to proceed further. Top management, at this step, will primarily be determining if an investment will be made in this area. As a result, the plan will not only be considered on the basis of its merits for solving the particular problems identified in this emphasis area (say, vis-à-vis other approaches that could be taken to deal with the specific problems identified), but also its relative value in relation to investments in other aspects of the road safety program.

This aspect of the process involves using the best available communication skills to adequately inform top management. The degree of effort and extent of use of media should be proportionate to the size and complexity of the problem being addressed, as well as the degree to which there is competition for funds.

The material that is submitted should receive careful review by those with knowledge in report design and layout. In addition, today's technology allows for the development of automated presentations, using animation and multimedia in a cost-effective manner. Therefore, programs involving significant investments that are competing strongly for implementation resources should be backed by such supplementary means for communicating efficiently and effectively with top management.

Specific Elements

1. Submit recommendations for action by management
    - 1.1. "Go/no-go" decision
    - 1.2. Reconsideration of policies, guidelines, and specifications (see Step 3)
    - 1.3. Modification of the plan to accommodate any revisions to the program framework made by the decision makers
2. Working group to make presentations to decision makers and other groups, as needed and requested
3. Working group to provide technical assistance with the review of the plan, as requested
    - 3.1. Availability to answer questions and provide further detail
    - 3.2. Assistance in conducting formal assessments

Implementation Step 8: Develop a Plan of Action

General Description

At this stage, the working group will usually detail the program that has been selected for implementation. This step translates the program into an action plan, with all the details needed by both decision makers, who will have to commit to the investment of resources, and those charged with carrying it out. The effort involves defining resource requirements, organizational and institutional arrangements needed, schedules, etc. This is usually done in the form of a business plan, or plan of action. An example of a plan developed by a local community is shown in Appendix X.

An evaluation plan should be designed at this point. It is an important part of the plan. This is something that should be in place before Step 9 is finished. It is not acceptable to wait until after the program is completed to begin designing an evaluation of it. This is because data are needed about conditions before the program starts, to allow comparison with conditions during its operation and after its completion. It also should be designed at this point, to achieve consensus among the stakeholders on what constitutes "success." The evaluation is used to determine just how well things were carried out and what effect the program had. Knowing this helps maintain the validity of what is being done, encourages future support from management, and provides good intelligence on how to proceed after the program is completed. For further details on performing evaluations, see Appendix L, Appendix M, and Appendix W.

The plan of action should be developed jointly with the involvement of all desired participants in the program. It should be completed to the detail necessary to receive formal approval of each agency during the next step. The degree of detail and complexity required for this step will be a function of the size and scope of the program, as well as the number of independent agencies involved.

Specific Elements

1. Translation of the selected program into key resource requirements
    - 1.1. Agencies from which cooperation and coordination is required
    - 1.2. Funding
    - 1.3. Personnel
    - 1.4. Data and information
    - 1.5. Time
    - 1.6. Equipment
    - 1.7. Materials
    - 1.8. Training
    - 1.9. Legislation
2. Define organizational and institutional framework for implementing the program
    - 2.1. Include high-level oversight group
    - 2.2. Provide for involvement in planning at working levels
    - 2.3. Provide mechanisms for resolution of issues that may arise and disagreements that may occur
    - 2.4. Secure human and financial resources required

3. Detail a program evaluation plan
    - 3.1. Goals and objectives
    - 3.2. Process measures
    - 3.3. Performance measures
        - 3.3.1. Short-term, including surrogates, to allow early reporting of results
        - 3.3.2. Long-term
    - 3.4. Type of evaluation
    - 3.5. Data needed
    - 3.6. Personnel needed
    - 3.7. Budget and time estimates
4. Definition of tasks to conduct the work
    - 4.1. Develop diagram of tasks (e.g., PERT chart)
    - 4.2. Develop schedule (e.g., Gantt chart)
    - 4.3. For each task, define
        - 4.3.1. Inputs
        - 4.3.2. Outputs
        - 4.3.3. Resource requirements
        - 4.3.4. Agency roles
        - 4.3.5. Sequence and dependency of tasks
5. Develop detailed budget
    - 5.1. By task
    - 5.2. Separate by source and agency/office (i.e., cost center)
6. Produce program action plan, or business plan document

Implementation Step 9: Establish Foundations for Implementing the Program

General Description

Once approved, some "groundwork" is often necessary to establish a foundation for carrying out the selected program. This is somewhat similar to what was done in Step 4. It must now be done in greater detail and scope for the specific program being implemented. As in Step 4, specific policies and guidelines must be developed, organizational and institutional arrangements must be initiated, and an infrastructure must be created for the program. The business plan or action plan provides the basis (Step 7) for this. Once again, the degree of complexity required will vary with the scope and size of the program, as well as the number of agencies involved.

Specific Elements

1. Refine policies and guidelines (from Step 4)
2. Effect required legislation or regulations
3. Allocate budget
4. Reorganize implementation working group
5. Develop program infrastructure
    - 5.1. Facilities and equipment for program staff
    - 5.2. Information systems
    - 5.3. Communications
    - 5.4. Assignment of personnel
    - 5.5. Administrative systems (monitoring and reporting)
6. Set up program assessment system
    - 6.1. Define/refine/revise performance and process measures
    - 6.2. Establish data collection and reporting protocols
    - 6.3. Develop data collection and reporting instruments
    - 6.4. Measure baseline conditions

Implementation Step 10: Carry Out the Action Plan

General Description

Conditions have been established to allow the program to be started. The activities of implementation may be divided into activities associated with field preparation for whatever actions are planned and the actual field implementation of the plan. The activities can involve design and development of program actions, actual construction or installation of program elements, training, and the actual operation of the program. This step also includes monitoring for the purpose of maintaining control and carrying out mid- and post-program evaluation of the effort.

Specific Elements

1. Conduct detailed design of program elements
    - 1.1. Physical design elements
    - 1.2. PI&E materials
    - 1.3. Enforcement protocols
    - 1.4. Etc.
2. Conduct program training
3. Develop and acquire program materials
4. Develop and acquire program equipment
5. Conduct pilot tests of untested strategies, as needed
6. Program operation
    - 6.1. Conduct program "kickoff"
    - 6.2. Carry out monitoring and management of ongoing operation
        - 6.2.1 Periodic measurement (process and performance measures)
        - 6.2.2 Adjustments as required
    - 6.3. Perform interim and final reporting

Implementation Step 11: Assess and Transition the Program

General Description

The AASHTO Strategic Highway Safety Plan includes improvement in highway safety management. A key element of that is the conduct of properly designed program evaluations. The program evaluation will have been first designed in Step 8, which occurs prior to any field implementation. For details on designing an evaluation, please refer to Step 8. For an example of how the New Zealand Transport Authority takes this step as an important part of the process, see Appendix N.

The program will usually have a specified operational period. An evaluation of both the process and performance will have begun prior to the start of implementation. It may also continue during the course of the implementation, and it will be completed after the operational period of the program.

The overall effectiveness of the effort should be measured to determine if the investment was worthwhile and to guide top management on how to proceed into the post-program period. This often means that there is a need to quickly measure program effectiveness in order to provide a preliminary idea of the success or need for immediate modification. This will be particularly important early in development of the AASHTO Strategic Highway Safety Plan, as agencies learn what works best. Therefore, surrogates for safety impact may have to be used to arrive at early/interim conclusions. These usually include behavioral measures. This particular need for interim surrogate measures should be dealt with when the evaluation is designed, back in Step 8. However, a certain period, usually a minimum of a couple of years, will be required to properly measure the effectiveness and draw valid conclusions about programs designed to reduce highway fatalities when using direct safety performance measures.

The results of the work are usually reported back to those who authorized it and the stakeholders, as well as any others in management who will be involved in determining the future of the program. Decisions must be made on how to continue or expand the effort, if at all. If a program is to be continued or expanded (as in the case of a pilot study), the results of its assessment may suggest modifications. In some cases, a decision may be needed to remove what has been placed in the highway environment as part of the program because of a negative impact being measured. Even a "permanent" installation (e.g., rumble strips) requires a decision regarding investment for future maintenance if it is to continue to be effective.

Finally, the results of the evaluation using performance measures should be fed back into a knowledge base to improve future estimates of effectiveness.

Specific Elements

1. Analysis
    - 1.1. Summarize assessment data reported during the course of the program
    - 1.2. Analyze both process and performance measures (both quantitative and qualitative)

   1.3. Evaluate the degree to which goals and objectives were achieved (using performance measures)
   1.4. Estimate costs (especially vis-à-vis pre-implementation estimates)
   1.5. Document anecdotal material that may provide insight for improving future programs and implementation efforts
   1.6. Conduct and document debriefing sessions with persons involved in the program (including anecdotal evidence of effectiveness and recommended revisions)
2. Report results
3. Decide how to transition the program
   3.1. Stop
   3.2. Continue as is
   3.3. Continue with revisions
   3.4. Expand as is
   3.5. Expand with revisions
   3.6. Reverse some actions
4. Document data for creating or updating database of effectiveness estimates

SECTION VII

Key References

Allen, M., and Weiss, H. (1998). *Using Linked Data To Evaluate Collisions with Fixed Objects in Pennsylvania.* Report No. DOT HS 808 800. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, October 1998.

American Association of State Highway and Transportation Officials (2002). Roadside Design Guide, 3rd Edition.

American Honda Motor Company: http://powersports.honda.com/index.asp?bhcp=1.

American Motorcyclist Association: http://ama-cycle.org/.

Baer, J., Baldi, S., and Cook, A. (2005b). *Promising Practices in Motorcycle Rider Education and Licensing.* Report No. DOT HS 809 922. Washington, DC: National Highway Traffic Safety Administration. http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/MotorcycleRider/index.html.

Baer, J., Cook, A. L., and Baldi, S. (2005a). *Motorcycle Rider Education and Licensing: A Review of Programs and Practices.* Report No. DOT HS 809 852. Washington, DC: National Highway Traffic Safety Administration. www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/McycleRiderWeb/pages/index.htm.

Becker, L. R., McKnight, A. S., Nelkin, V. S., and Piper, D. L. (2003). *Drinking, Riding, and Prevention: A Focus Group Study.* Report No: DOT HS 809 490. Sponsored by National Highway Traffic Safety Administration. Calverton, MD: Pacific Institute for Research and Evaluation.

Bigelow, W. (2001). *Traumatic Brain Injury Associated with Motorcycle Crashes in Wisconsin, 1991–1997.* Orlando, FL: Paper Presented at the International Motorcycle Safety Conference.

Billheimer, J. W. (1998). Evaluation of the California Motorcyclist Safety Program. In *Transportation Research Record 1640.* Washington, DC: Transportation Research Board, National Research Council, pp. 100–109.

Bowman, B. L. and Rounds, D. A. (1988). *Restraint System Usage in the Traffic Population: 1987 Annual Report.* Report No. DOT HS 807 342. Washington, DC: National Highway Traffic Safety Administration.

Bowman, B. L., and Rounds, D. A. (1989). *Restraint System Usage in the Traffic Population: 1988 Annual Report.* Report No. DOT HS 807 447. Washington, DC: National Highway Traffic Safety Administration.

Bryden, J. E., and Fortuniewicz, J. S. (1986). Traffic Barrier Performance Related to Vehicle Size and Type. In *Transportation Research Record 1065.* Washington, DC: Transportation Research Board, National Research Council, pp. 69–78.

Cairns, H., and Holburn, H. (1943). Head Injuries in Motorcyclists. *British Medical Journal* 1:591–598.

Carr, W. P., Brandt, D. B., and Swanson, K. (1981). Injury patterns and helmet effectiveness among hospitalized motorcyclists. *Minnesota Medicine* 64:521–527.

Connecticut Department of Transportation, Motorcycle Safety Program: http://www.ride4ever.org/.

Creaser, J. I., Ward, N. J., Rakauskas, M. E., Boer, E., Shankwitz, C., and Nardi, F. (2007). "Effects of Alcohol on Motorcycle Riding Skills." National Highway Traffic Safety Administration. http://www.nhtsa.dot.gov/portal/nhtsa_static_file_downloader.jsp?file=/staticfiles/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810877.pdf.

Datta, T. K., and Guzek, P. (1990). *Restraint System Use in 19 U.S. Cities: 1989 Annual Report.* Report No. DOT HS 807 595. Washington, DC: National Highway Traffic Safety Administration.

Datta, T. K., and Guzek, P. (1991). *Restraint System Use in 19 U.S. Cities: 1990 Annual Report.* Washington, DC: National Highway Traffic Safety Administration.

Datta, T. K., and Guzek, P. (1992). *Restraint System Use in 19 U.S. Cities: 1991 Annual Report.* Report No. DOT HS 808 148. Washington, DC: National Highway Traffic Safety Administration.

De Rome, L., Stanford, G., and Wood, B. (2002). *Positioned MCC Survey of Motorcyclists.* Australia: Motorcycle Council of NSW, Inc.

Deutermann, W. (2004). *Motorcycle Helmet Effectiveness Revisited.* Report No. DOT HS 809 715. Washington, DC: National Highway Traffic Safety Administration.

Domhan, M. (1987). Guardrails and Passive Safety for Motorcyclists. Vehicle Highway Infrastructure: Safety Compatibility. Warrendale, PA: Society of Automotive Engineers, pp. 205–208.

Dorris, A. L., and Purswell, J. L. (1978). *Impact of Motorcycle Helmet Usage in Oklahoma.* University of Oklahoma. Report No. DOT HS 803 681. Washington, DC: National Highway Traffic Safety Administration.

Fatality Analysis Reporting System (1994–2007). Web-Based Encyclopedia. National Highway Traffic Safety Administration. Available at: http://www-fars.nhtsa.dot.gov/Main/index.aspx.

Fatality Analysis Reporting System (2003). Traffic Safety Facts. Report No. DOT HS 809 775 and DOT HS 809 764. Washington, DC: National Center for Statistics and Analysis, National Highway Traffic Safety Administration.

Fatality Analysis Reporting System (2004). National Center for Statistics and Analysis, National Highway Traffic Safety Administration. Nashville, TN: Presentation at the 30th International Traffic Records Forum, July 26, 2004. (May be found in Appendix AA.)

Federal Highway Administration (1997). User's Guide for the Public Use Data Files: 1995 Nationwide Personal Travel Survey. Publication No. FHWA-PL-98-002.

Finison, K. (2001). *Using CODES Linked Data to Evaluate Motorcycle Crashes in Maine.* Orlando, FL: Paper presented at the International Motorcycle Safety Conference.

Finison, K., and DuBrow, R. (1999). *Analysis of 1996 Maine Crashes Involving Vehicles that Ran Off the Road.* Report No. DOT HS 808 889. Washington, DC: Department of Transportation, National Highway Traffic Safety Administration, April 1999.

Fleischer, G. A. (1973). A study of the effectiveness of a radio/TV campaign on safety belt use. *Journal of Safety Research,* 5(1).

Fleming, H. S., and Becker, E. R. (1992). The impact of the Texas 1989 motorcycle helmet law on total and head-related fatalities, severe injuries, and overall injuries. *Medical Care* 30:832–845.

Foldvary. L. A., and Lane, J. C. (1964). The effect of compulsory safety helmets on motorcycle accident fatalities. *Australian Road Research* 2(1):7–14.

Glassbrenner, D. (2005a). Motorcycle helmet use in 2004—overall results. *Traffic Safety Facts: Research Note.* Report No. DOT HS 810 867. Washington, DC: National Highway Traffic Safety Administration.

Glassbrenner, D. (2005b). Motorcycle helmet use in 2005—overall results. *Traffic Safety Facts: Research Note.* Report No. DOT HS 809 937. Washington, DC: National Highway Traffic Safety Administration.

Glassbrenner, D., and Ye, J. (2006). Motorcycle helmet use in 2006—overall results. *Traffic Safety Facts: Research Note.* Report No. DOT HS 810 678. Washington, DC: National Highway Traffic Safety Administration.

Gordon, S., and Prince, J. (1975). *Field of View With and Without Motorcycle Helmets.* Report No. DOT HS 801 758. Washington, DC: National Highway Traffic Safety Administration.

Goryl, M. E. (1986). *Restraint System Usage in the Traffic Population: 1985 Annual Report.* Report No. DOT HS 806 978. Washington, DC: National Highway Traffic Safety Administration.

Goryl, M. E., and Bowman, B. L. (1987). *Restraint System Usage in the Traffic Population: 1986 Annual Report.* Report No. DOT HS 807 080. Washington, DC: National Highway Traffic Safety Administration.

Goryl, M. E., and Cynecki, M. J. (1985). *Restraint System Usage in the Traffic Population.* Report No. DOT HS 806 714. Washington, DC: National Highway Traffic Safety Administration.

Governor's Highway Safety Association (2007). Countermeasures That Work. Available at: http://www.ghsa.org/html/publications/pdf/CountermeasuresThatWork_2009.pdf.

Harley-Davidson Motor Company: www.harley-davidson.com.

Harwood, D. W., Council, F. M., Hauer, E., Hughes, W. E., and Vogt, A. (2000). *Prediction of the Expected Safety Performance of Rural Two-Lane Highways.* Report No. FHWA-RD-99-207. Federal Highway Administration, December 2000.

Harwood, D. W., Kohlman Rabbani, E. R., Richard, K. R., McGee, H. W., and Gittings, G. L. (2003). *NCHRP Report 486: Systemwide Impact of Safety and Traffic Operations Design Decisions for 3R Projects*. Washington, DC: Transportation Research Board of the National Academies.

Haworth, N. (1999). *Road Factors in Motorcycle Crashes.* Monash University Accident Research Centre. Presentation to the Victorian Motorcycle Advisory Council Workshop on Motorcycling and the Road Environment held at VicRoads, June 1999.

Hedlund, J. H. (2005). *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices.* Prepared for the National Highway Traffic Safety Administration, U.S. Department of Transportation, by the Governors Highway Safety Association. http://www.ghsa.org/html/publications/pdf/GHSA_Countermeasures.pdf.

Heilman, D. R., Weisbuch, J. B., Blair, R. W., and Graf, L. L. (1982). Motorcycle-related trauma and helmet usage in North Dakota. *Annals of Emergency Medicine,* 11(12):659–654.

Henderson, R. L. (1975). *Effect of Safety Helmets on Auditory Capability.* Report No. DOT HS 801 758. Washington, DC: National Highway Traffic Safety Administration.

Hotz, G. A., Cohn, S. M., Popkin, C., Ekeh, P., Duncan, R., Johnson, E. W., Pernas, F., and Selem, J. (2003). The impact of a repealed motorcycle helmet law in Miami-Dade County. *The Journal of Trauma,* 52(3):131–150.

Huang, W. J. (1999). Development of the Intelligent Motorcycle Transportation Systems in Urban Areas. Washington, DC: ITS America 9th Annual Meeting.

Hurt, H. H., Ouellet, J. V., and Thom, D. R. (1981). Motorcycle Accident Cause Factors and Identification of Countermeasures, Vol. I: Technical Report, Vol. II: Appendices and Supplemental Data, *NTIS PB-206 443, PB-206 450.* Los Angeles, CA: University of Southern California.

Hurt, H. H., Thom, D. R. and Smith, T. A. (1996). *Updating the twenty-year-old DOT helmet standard* (FMVSS 218). Association for the Advancement of Automotive Medicine, 40th Annual Proceedings.

Johnson, S. W., and Walker, J. (1996). The Crash Outcome Data Evaluation System (CODES). Report No. DOT HS 808 338. Washington, DC: National Highway Traffic Safety Administration.

Kanny, D., Schieber, R. A., Jones, B. H., Ryan, G. W., and Sorensen, B. J. (2003). Epidemiology of Mass Casualties during Bike Week 2000, Daytona Beach, Florida. *Annals of Emergency Medicine, 41*(6): 792–797.

Karlson, T., Bigelow, W., and Beutel, P. (1998). *Serious Lower Extremity Injuries from Motor Vehicle Crashes, Wisconsin 1991–1994.* Report No. DOT HS 808 791. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, September 1998.

Kelley, P., Sanson, T., Strange, G., and Orsay, E. (1989). A Prospective Study of the Impact of Helmet Usage on Motorcycle Trauma. Chicago: University of Illinois Affiliated Hospitals.

Kim, K. (2001). Finding Fault in Motorcycle Crashes in Hawaii: Environmental, Temporal, Spatial and Human Factors. In *Transportation Research Record: Journal of the Transportation Research Board 1779.* Washington, DC: Transportation Research Board, National Research Council, pp. 182–188.

Krane, S. W., and Winterfield, L. A. (1980). Impact of Motorcycle Helmet Usage in Colorado: A Three Year Study. Denver: Colorado Division of Highway Safety.

Kraus, J. F., Peek, C., McArthur, D. L., and Williams, A. F. (1994). The effect of the 1992 California motorcycle helmet usage law on motorcycle crash fatalities and injuries. *Journal of the American Medical Association* 272:1506–1511.

Kraus, J. F., Peek, C., and Williams, A. (1995a). Compliance with the 1992 California motorcycle helmet use law. *American Journal of Public Health* 85:96–99.

Kraus, J. F., Peek, C., Shen, H., and Williams, A. (1995b). Motorcycle crashes: injuries, rider, crash and vehicle characteristics associated with helmet use. *Journal of Traffic Medicine* 23:29–35.

Kraus, J. F., Riggins, R. S., and Franti, C. E. (1974). *Some Factors Associated with Severity of Injuries in Motorcycle Collisions.* Publication HS-015190. Washington, DC: Third International Congress on Automotive Safety Proceedings, pp. 5-15–25.

Kraus, J. F., Zador, P., Arzemanian, S., and Anderson, C. (1988). "Motorcycle Design and Crash Injuries in California." *Bulletin of the New York Academy of Medicine,* 64:788–803.

Kweon, Y. J., and Kockelman, K. M. (2002). Overall injury risk to different drivers: combining exposure, frequency, and severity models. Washington, DC: Transportation Research Board 81st Annual Meeting.

Lawrence, B. A., Max, W., and Miller, T. R. (2003). *Costs of Injuries Resulting from Motorcycle Crashes: A Literature Review.* Report No. DOT HS 809 242. Washington, DC: National Highway Traffic Safety Administration.

Lewin, W., and Kennedy, W. F. C. (1956). Motorcyclists, Crash Helmets, and Head Injuries. *British Medical Journal,* June 2, 1956, pp. 1253–59.

Lummis, M. L. and Dugger, C. (1980). *Impact of the Repeal of the Kansas Motorcycle Helmet Law: 1975–78.* University of Kansas, College of Health Sciences. Report No. DOT HS 804 018. Washington, DC: National Highway Traffic Safety Administration.

Lund, A. K., Williams, A. F., and Womack, K. N. (1991). Motorcycle helmet use in Texas. *Public Health Reports* 106:576–578.

Maher, S. M. (2000). Intelligent Transportation Systems and Motorcycle Safety: A Review of Current Trends in the Development and Deployment of Intelligent Transportation Systems and the Identification of Opportunities to Enhance Motorcycle Safety. Proceedings of the 2000 International Motorcycle Conference, iFZ.

Maryland Motorcycle Safety Task Force (2004), Maryland Motor Vehicles Administration: http://www.sha.state.md.us/safety/motorcycle.asp.

McKnight, A. J., and McKnight, A. S. (1994). The effects of motorcycle helmets upon seeing and hearing. Report No. DOT HS 808 399. Washington, DC: National Highway Traffic Safety Administration.

McSwain, N. E., Jr., and Petrucelli, E. (1984). Medical consequences of motorcycle helmet nonusage. *Journal of Trauma,* 24(3):233–236.

McSwain, N. E., and Willey, A. B. (1984). Impact of the Re-Enactment of the Motorcycle Helmet Law in Louisiana. New Orleans: Tulane University School of Medicine.

Minnesota Department of Public Safety (1998). Enhanced Motorcycle Licensing Project: http://www.nhtsa.dot.gov/people/outreach/safedige/Winter1999/n5-128.html.

Minnesota Motorcycle Safety Program: http://www.motorcyclesafety.state.mn.us/.

Mitchell, K. A., Kufera, J. A., Ballestros, M. F., Smialek, J. E., and Dischinger, P. C. (2001). *Autopsy Study of Motorcycle Fatalities: The Effect of the 1992 Maryland Helmet Use Law.* Orlando, FL: Paper presented to the International Motorcycle Safety Conference.

Motorcycle Council of NSW, Inc. References on Protective Clothing—http://www.roadsafety.mccofnsw.org.au/a/90.html.

Motorcycle Industry Council (2000): http://www.mic.org.

Motorcycle Safety Foundation: http://www.msf-usa.org/.

Motorcycle Safety Foundation (2004). How Are Your Rider Training Programs Delivered? http://www.msf-usa.org.

Motorists Information, Inc. (1978). Michigan Safety Belt Project. Detroit, Michigan.

Mounce, N., Brackett, Q., Hinshaw, W., Lund, A. K., and Wells, J. K. (1992). *The Reinstated Comprehensive Motorcycle Helmet Law in Texas.* Arlington, VA: Insurance Institute for Highway Safety.

Muelleman, R. L., Mlinek, E. J., and Collicott, P. E. (1991). Motorcycle crash injuries and costs: effect of a re-enacted comprehensive helmet use law. *American Journal of Emergency Medicine,* 21: 266–272.

Muller A. (2004). Florida's motorcycle helmet law repeal and fatality rates. *American Journal of Public Health,* 94(4): 556–558.

National Association of State Motorcycle Safety Administrators: http://www.smsa.org/index.php.

National Association of State Motorcycle Safety Administrators (2002). *SMSA Annual Survey,* 2001—http://www.smsa.org/.

National Association of State Motorcycle Safety Administrators (2003). *SMSA Annual Survey,* 2003—http://www.smsa.org/index.php; username: survey; password: visitor.

National Highway Traffic Safety Administration: http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/.

National Highway Traffic Safety Administration (1980). *A Report to the Congress on the Effect of Motorcycle Helmet Use Law Repeal – A Case for Helmet Use.* Washington, DC.

National Highway Traffic Safety Administration (1996). *The Crash Outcome Data Evaluation System (CODES).* Report No. DOT HS 808 338. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/CODES/codestch.pdf.

National Highway Traffic Safety Administration (1996). *Report to Congress: Benefits of Safety Belts and Motorcycle Helmets, Based on Data from the Crash Outcome Data Evaluation System (CODES).* Report No. DOT HS 808 347. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/CODES/codesrpt.pdf.

National Highway Traffic Safety Administration (1998). Further Analysis of Motorcycle Helmet Effectiveness Using CODES Linked Data. *Research Note.* Washington DC: National Center for Statistics and Analysis.

National Highway Traffic Safety Administration (2000). *National Agenda for Motorcycle Safety.* http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/00-NHT-212-motorcycle/toc.html.

National Highway Traffic Safety Administration (2001). *Fatal Single Vehicle Motorcycle Crashes.* National Center for Statistics and Analysis. Report No. HS-809 360. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/Rpts/2001/809-360.pdf.

National Highway Traffic Safety Administration (2002). *Traffic Safety Facts 2002-Motorcycles.* Washington, DC: U.S. Department of Transportation. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSF2002/2002mcyfacts.pdf.

National Highway Traffic Safety Administration (2003a). *Drinking, Riding and Prevention: A Focus Group Study.* http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/DrinkRidePrevent/.

National Highway Traffic Safety Administration (2003b). *Final Model Minimum Uniform Crash Criteria (MMUCC) Second Edition.* http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/MMUCC/2003/MMUCC_02.pdf.

National Highway Traffic Safety Administration Motorcycle Safety Program (2003)— http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/motorcycle03/moto_operational.htm.

National Highway Traffic Safety Administration (2004). *Traffic Safety Facts 2003-Motorcycles.* Report No. DOT HS 809 764. Washington, DC: U.S. Department of Transportation. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/PPT/PresMCFatsUpdate.pdf.

National Highway Traffic Safety Administration (2005). *Traffic Safety Facts 2005.* Report No. DOT HS 810 620. Washington, DC: U.S. Department of Transportation. http://www-nrd.nhtsa.dot.gov/Pubs/810620.pdf.

National Highway Traffic Safety Administration (2006). Motorcycle Safety Program Plan http://www.nhtsa.dot.gov/portal/nhtsa_static_file_downloader.jsp?file=/staticfiles/DOT/NHTSA/Traffic Injury Control/Articles/Associated Files/MotorcycleSafety2006.pdf.

National Highway Traffic Safety Administration (2006a). Motorcycle helmet use laws. *Traffic Safety Facts. Laws.* Washington, DC.

National Highway Traffic Safety Administration (2006b). *Traffic Safety Facts 2006-Motorcycles.* Report No. DOT HS-810-806. Washington, DC: U.S. Department of Transportation. http://www-nrd.nhtsa.dot.gov/Pubs/810806.pdf.

National Highway Traffic Safety Administration (2007). "The Detection of DWI Motorcyclists" (brochure). Report No. DOT HS 807 856. http://www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/610DWIMotorcyWeb/pages/index.htm.

Nebraska Department of Public Roads (1975). A Study of Motorcycle Traffic Accidents in Nebraska. Lincoln, Nebraska.

Newman, J. (1974). *The Protective Value of Contemporary Motorcycle Helmets in the Prevention of Head Injuries.* Ottawa: University of Ottawa, Canada.

Nichols, J. L. (2002). *Methods to Increase Seat Belt Use: A Review of What Works.* Washington, D.C.: Prepared for the National Highway Traffic Safety Administration Integrated Project Team.

Oakland County Traffic Improvement Association (1969). *A Report on the Activities and Measured Effectiveness of a Public Education Program for Safety Belt Use.* Oakland County, Michigan.

Oketch, T. G. (2000). A new modeling approach to mixed-traffic streams with non-motorized vehicles. In *Transportation Research Record 1705.* Washington, DC: Transportation Research Board of the National Academies, pp. 61–69.

Ouellet, J. (1982). *Environmental hazards in motorcycle accidents.* 26th Annual Proceedings of the American Association for Automotive Medicine, Ottawa, Canada, pp. 117–129.

Peek-Asa, C., McArthur, D. L., and Kraus, J. F. (1999). The prevalence of non-standard helmet use and head injuries among motorcycle riders. *Accident Analysis and Prevention,* 31(3):229–33.

Perkins, D. D., Cynecki, M. J., and Goryl, M. (1984). *Restraint System Usage in the Traffic Population.* Report No. DOT HS 806 582. Washington, DC: National Highway Traffic Safety Administration.

Phillips, B. M. (1983). *Restraint System Usage in the Traffic Population.* Contract DTNH-22-80-C-07283. Washington, DC: National Highway Traffic Safety Administration.

Phillips, B. M. (1980). Safety Belt Use Among Drivers; Use of Child Restraint Devices; Motorcycle Helmet Usage. Contract DOT HS 7 01736. Washington, DC: National Highway Traffic Safety Administration.

Preusser, D. F., Hedlund, J. H., and Ulmer, R. G. (2000). *Evaluation of Motorcycle Helmet Law Repeal in Arkansas and Texas.* Report No. DOT HS 809 112. Washington, DC: National Highway Traffic Safety Administration.

Robertson, L. S., Kelley, A. B., O'Neill, B., Wixom, C. W., Eiswirth, R. S., and Haddon, W., Jr. (1974). A Controlled Study of the Effect of Television Messages on Safety Belt Use. Washington, DC (now Arlington, VA): Insurance Institute for Highway Safety.

Ross, H. E., Jr., Sicking, D. L., and Zimmer, R. A. (1993). *NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features*. Washington, DC: Transportation Research Board, National Research Council.

Rowland, J., Rivara, F. P., Salzberg, P., Soderberg, R., Maier, R. V., and Koepsell, T. (1996). Motorcycle helmet use and injury outcome and hospitalization costs from crashes in Washington state. *American Journal of Public Health* 86:41–45.

Sakar, S., Peek, C., and Kraus, J. F. (1995). Fatal injuries in motorcycle riders according to helmet use. *Journal of Trauma* 38:242–245.

Sala, G., and Astori, P. (1998). *New Concepts and Materials for Passive Safety of Motorcyclists.* Goteborg, Germany: Proceedings of the IRCOBI Conference, pp. 425–436.

Shankar, U. G. (2004a). Alcohol Involvement in Fatal Motorcycle Crashes. *Research Note.* Report No. HS-809 576. National Center for Statistics and Analysis. National Highway Traffic Safety Administration. http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/RNotes/2003/809-576.pdf.

Shankar, U. G. (2004). *Motorcyclist Fatalities: an Update.* San Diego, CA: Presented at Lifesavers Conference.

Shankar, U. G. (2001). *Recent Trends in Fatal Motorcycle Crashes.* National Highway Traffic Safety Administration. http://www-nrd.nhtsa.dot.gov/Pubs/809-271.pdf.

Sosin, D. M., and Sacks, J. J. (1992). Motorcycle helmet-use laws and head injury prevention. *Journal of the American Medical Association,* 267(12):1649–1651.

Struckman-Johnson, C., and Ellingstad, V. S. (1979). Impact of Motorcycle Helmet Law Repeal in South Dakota 1976–79. Report No. DOT HS 803 996. Washington, DC: National Highway Traffic Safety Administration.

Subramanian, R. (2003). *Recent Trends in Alcohol-Related Fatality Rates.* National Highway Traffic Safety Administration. http://www-nrd.nhtsa.dot.gov/Pubs/809-680.pdf.

TEAM OREGON Motorcycle Safety Program (2002). Forecasting the Future: A Manager's Guide to Program Health and Sustainability. http://teamoregon.orst.edu.

TEAM OREGON Motorcycle Safety Program (2004). BRT Classroom Field Test. Oregon State University.

TEAM OREGON Motorcycle Safety Program (2004). BRT Range Field Test. Oregon State University.

Thom, D. R., Hurt, H. H., Jr., Smith, T. A., and Ouellet, J. V. (1997). *Feasibility Study of Upgrading FMVSS No. 218 Motorcycle Helmets.* Final Report Contract No. DTNH22-97-P-02001. Washington, DC: National Highway Traffic Safety Administration.

Transportation Research Board Committee on Motorcycles and Mopeds (1994). Research Problem Statements for Motorcycles and Mopeds. In *Transportation Research Circular 424.* Washington, DC: Transportation Research Board of the National Academies.

Turner, P. A., and Georggi, N. L. (2001). Analysis of Alcohol-Related Motorcycle Crashes in Florida and Recommended Countermeasures. In *Transportation Research Record: Journal of the Transportation Research Board 1779.* Washington, DC: Transportation Research Board, National Research Council, pp. 189–196.

Turner, P. A., and Hagelin, C. A. (2000). Novelty Helmet Use by Motorcycle Riders in Florida. In *Transportation Research Record: Journal of the Transportation Research Board 1734.* Washington, DC: Transportation Research Board, National Research Council, pp. 69–76.

Ulmer, R. G., and Preusser, D. F. (2003). *Evaluation of the Repeal of Motorcycle Helmet Laws in Kentucky and Louisiana.* Report No. DOT HS 809 530. Washington, DC: National Highway Traffic Safety Administration.

Ulmer, R. G., and Shabanova-Northrup, V. S. (2005). *Evaluation of the Repeal of the All-Rider Motorcycle Helmet Law in Florida.* Report No. DOT HS 809 849. Washington, DC: National Highway Traffic Safety Administration.

U.S. General Accounting Office (1991). Highway Safety: Motorcycle Helmet Laws Save Lives and Reduce Costs to Society. Washington, DC: Resources, Community, and Economic Development Division.

U.S. Department of Transportation. 2001 National Household Travel Survey. http://www.bts.gov/publications/highlights_of_the_2001_national_household_travel_survey/.

U.S. Department of Transportation. 1995 National Personal Travel Survey. http://www.bts.gov/programs/national_household_travel_survey/.

Vance, R., Williams, J., and Rutherford, G. S. (2004). Flexcar Seattle Member Attitude and Usage Survey. Washington, DC: Transportation Research Board 83rd Annual Meeting.

Van Moorhem, W. K., Shepherd, K. P., Magleby, T. D., and Torian, G. E. (1977). *The Effect of Motorcycle Helmets on Hearing and the Detection of Warning Signals.* Salt Lake City, UT: University of Utah.

VIC Roads Motorcycle Notes—Motorcycle Signage http://www.vicroads.vic.gov.au/NR/rdonlyres/20ACC651-A990-40AD-8092-CD19A6F47D6D/0/tr2001105.pdf

Virginia Department of Transportation—Motorcycle Safety Action Team http://www.virginiadot.org/programs/resources/3motorcycle.pdf

Wang, Y., and Nihan, N. L. (2000). Estimating the Risk of Collisions Between Bicycles and Automobiles at Signalized Intersections. Washington, DC: Transportation Research Board 81st Annual Meeting.

Washington Department of Licensing—2005 http://apps.leg.wa.gov/rcw

Wells, S., Mullin, B., Norton, R., Langley, J., Connor, J., Lay-Yee, R., and Jackson, R. (2004). *Motorcycle Rider Conspicuity and Crash Related Injury: Case-Controlled Study. BMJ* 328:857 (10 April) doi:10.1136/bmj.37984.574757.EE (Published 23 January 2004).

Williams, J. M., and Cleary, J. D. (1981). *Minnesota Motorcycle Fatality Rates and the Motorcycle Helmet Law Repeal: A Summary Report.* St. Paul: Minnesota House of Representatives, Research Department.

Winn, G. L., and Bucy, D. S. (1997). *Technology vs. Culture: Improving the Efficiency of Traffic Crash Data Collection in West Virginia.* Lisbon, Portugal: Seventh International Conference: Traffic Safety on Two Continents, September 22–24, 1997.

Winn, G. L., Carr, M., and Bucy, D. S. (1999). State Crash Report Data Elements for Motorcycles. Washington, DC: Transportation Research Board 78th Annual Meeting.

Wisconsin Department of Transportation—2004 Motorcycle Safety Action Plan http://www.dot.wisconsin.gov/library/publications/topic/safety/motorcycleplan.pdf

Zaloshnja, E., Miller, T., Romano, E., and Spicer, R. (2004). Crash costs by body part injured, fracture involvement, and threat-to-life severity, United States, 2000. *Accident Analysis and Prevention,* 36:415–427.

Zegeer, C. V., Deen, R. C., and Mayes, J. G. (1981). Effect of Lane and Shoulder Width on Accident Reduction on Rural, Two-Lane Roads. In *Transportation Research Record 806.* Washington, DC: Transportation Research Board, National Research Council, pp. 33–43.

Zegeer, C. V., Reinfurt, D. W., Hummer, J., Herf, L., and Hunter, W. (1988). Safety Effects of Cross-Section Design for Two-Lane Roads. In *Transportation Research Record 1195.* Washington, DC: Transportation Research Board, National Research Council, pp. 20–32.

Zuckier, G., Jacobs, L., and Thibeault, L. (1999). *Using Linked Data To Evaluate Medical and Financial Outcomes of Motor Vehicle Crashes in Connecticut.* Report No. DOT HS 808 972. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, September 1999.

Appendixes

The following appendixes are not published in this report. However, they are available online at http://safety.transportation.org.

1 State Distribution of Single and Multiple Vehicle Crashes
2 State Distribution of Single and Multiple Vehicle Crashes as a Percentage of All Motorcycle Crashes
3 Distribution of Motorcycle Data Elements on State Crash Data Reporting Forms
4 Motorcycle Facts Update and 2003 Fact Sheet for Motorcycles
5 Exposure Data for Motorcycles and Other Types of Vehicles

A Wisconsin Department of Transportation 2001 Strategic Highway Safety Plan
B Resources for the Planning and Implementation of Highway Safety Programs
C South African Road Safety Manual
D Comments on Problem Definition
E Issues Associated with Use of Safety Information in Highway Design: Role of Safety in Decision Making
F Comprehensive Highway Safety Improvement Model
G Table Relating Candidate Strategies to Safety Data Elements
H What is a Road Safety Audit?
I Illustration of Regression to the Mean
J Fault Tree Analysis
K Lists of Potential Stakeholders
L Conducting an Evaluation
M Designs for a Program Evaluation
N Joint Crash Reduction Programme: Outcome Monitoring
O Estimating the Effectiveness of a Program During the Planning Stages
P Key Activities for Evaluating Alternative Program
Q Definitions of Cost-Benefit and Cost-Effectiveness
R FHWA Policy on Life Cycle Costing
S Comparisons of Benefit-Cost and Cost-Effectiveness Analysis
T Issues in Cost-Benefit and Cost-Effectiveness Analyses
U Transport Canada Recommended Structure for a Benefit-Cost Analysis Report
V Overall Summary of Benefit-Cost Analysis Guide from Transport Canada
W Program Evaluation—Its Purpose and Nature
X Traffic Safety Plan for a Small Department
Y Sample District-Level Crash Statistical Summary
Z Sample Intersection Crash Summaries
AA Sample Intersection Collision Diagram
BB Example Application of the Unsignalized Intersection Guide

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	Air Transport Association
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
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
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