ROADSIDE DESIGN GUIDE

4th Edition 2011

American Association of State Highway and Transportation Officials

AASHTO
The Voice of Transportation

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AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO
THE VOICE OF TRANSPORTATION

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Preface

This *Roadside Design Guide* was developed by the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Design through the Technical Committee for Roadside Safety (TCRS) under the chairmanship of Keith Cota, P.E. This book presents a synthesis of current information and operating practices related to roadside safety and is written in dual units—metric and U.S. Customary. This edition supersedes the 2006 AASHTO publication, which included the update of the Median chapter.

The roadside is defined as that area beyond the traveled way (i.e., driving lanes) and the shoulder (if any) of the roadway itself. Consequently, roadside delineation, shoulder surface treatments, and similar on-roadway safety features are not extensively discussed. Although safety can best be served by keeping motorists on the road, the focus of this guide is on safety treatments that minimize the likelihood of serious injuries when a driver does run off the road.

A second noteworthy point is that this book is a guide. It is not a standard, nor is it a design policy. It is intended to be used as a resource document from which individual highway agencies can develop standards and policies. Although much of the material in the guide can be considered universal in its application, several recommendations are subjective in nature and may need modification to fit local conditions. However, it is important that significant deviations from the guide be based on operational experience and objective analysis.

To be consistent with AASHTO's *A Policy on Geometric Design of Highways and Streets*, design speed has been selected as the basic speed parameter to be used in this guide. However, because the design speed often is selected based on the most restrictive physical features found on a specific project, reasonable and prudent drivers may exceed that speed for a significant percentage of a project length. There will be other instances in which roadway conditions will prevent most motorists from driving as fast as the design speed. Because roadside safety design is intended to minimize the consequences of a motorist leaving the roadway inadvertently, the designer should consider the speed at which encroachments are most likely to occur when selecting an appropriate roadside design standard or feature.

The 2011 edition of the AASHTO *Roadside Design Guide* has been updated to include hardware that has met the evaluation criteria contained in the National Cooperative Highway Research Program (NCHRP) *Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features* and begins to detail the most current evaluation criteria contained under the *Manual for Assessing Safety Hardware*, 2009 (MASH). For the most part, roadside hardware tested and accepted under older guidelines that are no longer applicable has been included in this edition.

The TCRS is currently working through a National Cooperative Highway Research Program (NCHRP) research project to update the Roadside Safety Analysis Program (RSAP) with the development of a "window-friendly" version. The RSAP update will be "beta" tested in 2011 and is expected to be available through AASHTO in early 2012, and will be available through a link on the web-based format of this publication.

As mentioned, design values are presented in this document in both metric and U.S. Customary units. The relationship between these values is neither an exact (i.e., soft) conversion nor a completely rationalized (i.e., hard) conversion. The metric values are those that would have been used had the guide been presented exclusively in metric units, while the U.S. Customary values are those that would have been used if the guide had been presented exclusively in U.S. Customary units. Therefore, the user is advised to work entirely in one system and not to attempt to convert directly between the two.

The reader is cautioned that roadside safety policy, criteria, and technology is a rapidly changing field of study. Changes in the roadside safety field are certain to occur after this document is published. Efforts should be made to incorporate the appropriate current design elements into the project development. Comments from users of this guide about suggested changes or modifications that result from further developmental work or hands-on experience will be appreciated. All such comments should be addressed to the American Association of State Highway and Transportation Officials, Engineering Program, 444 North Capitol Street NW, Suite 249, Washington, DC 20001.

Chapter 1
An Introduction to Roadside Safety

1.0 HISTORY OF ROADSIDE SAFETY

Roadside safety design, as one component of total highway design, is a relatively recent concept. Most of the highway design fundamentals were established by the late 1940s. Additional refinements were made in the 1950s and 1960s with the development of the Interstate system. These components included horizontal alignment, vertical alignment, hydraulic design, and sight distance to name some of the more common highway design elements. These elements have been revised and refined over the years through experience and research. However, the highway design components themselves have remained about the same for several decades.

Roadside safety design did not become a much discussed aspect of highway design until the late 1960s, and it was the decade of the 1970s before this type of design was regularly incorporated into highway projects. The purpose of this guide is to present the concepts of roadside safety to the designer in such a way that the most practical, appropriate, and cost-effective roadside design can be accomplished for each project.

1.1 THE BENEFITS OF ROADSIDE SAFETY

Roadside design might be defined as the design of the area outside the traveled way. Some have referred to this aspect of highway design as off-pavement design. A question commonly asked revolves around whether spending resources off the pavement is really beneficial given the limited nature of infrastructure funds. Perhaps some statistics can bring the potential of crash reduction and roadside safety into focus.

In 2009, 33,808 people died in motor vehicle traffic crashes in the United States—the lowest number of deaths since 1950 *(7)*. During the same time period, the number of vehicle-kilometers [vehicle-miles] of travel each year has increased by approximately six and one half times from 0.7 (0.5) billion to 4.8 (3.0) billion. Consequently, the traffic fatality rate per 100 million vehicle-kilometers [vehicle-miles] of travel has decreased approximately 85 percent from 4.58 (7.38) in 1950 to 0.71 (1.13) in 2009 (the latest year available for data on vehicle-kilometers [vehicle-miles] of travel). Figure 1-1 shows the number of fatalities and fatality rate from 1950 to 2009.

This significant reduction is due to several factors. Motor vehicles are much safer today than they have been in the past. Protected passenger compartments, padded interiors, occupant restraints, and airbags are some features that have added to passenger safety during impact situations. Roadways have been made safer through improvements in features such as horizontal and vertical alignments, intersection geometry, traversable roadsides, roadside barrier performance, and grade separations and interchanges. Drivers are more educated about safe vehicle operation as evidenced by the increased use of occupant restraints and a decrease in driving under the influence of alcohol or drugs. All these contributing factors have reduced the motor vehicle fatality rate.

Unfortunately, roadside crashes still account for far too great a portion of the total fatal highway crashes. In 2008, 23.1 percent of the fatal crashes were single-vehicle, run-off-the-road crashes. These figures mean that the roadside environment comes into play in a very significant percentage of fatal and serious-injury crashes.

Figure 1-1. Motor Vehicle Crash Deaths and Deaths Per 100 Million Vehicle Miles Traveled, 1950–2008 *(6)*

1.2 STRATEGIC PLAN FOR IMPROVING ROADSIDE SAFETY

According to the Insurance Institute for Highway Safety (IIHS) and Highway Loss Data Institute (HLDI), the proportion of motor vehicle deaths involving collisions with fixed objects has fluctuated between 19 and 23 percent since 1979 *(4)*. Almost all fixed-object crashes involve only one vehicle and occur in both urban and rural areas. Figure 1-2 shows the percentage distribution of fixed-object fatalities by the object struck in 2008. Trees were by far the most common object struck, accounting for approximately half of all fixed-object fatal crashes. Utility poles were the second most common objects struck, accounting for 12 percent of all fixed object crashes, followed by traffic barriers with 8 percent. Furthermore, for 2008, 18 percent of fixed-object crashes involved vehicles that rolled over, while 18 percent involved occupant ejection. More detailed crash statistics are available from the following website at http://www.nhtsa.gov/FARS.

In 1967, the American Association for State Highway Officials (AASHO; currently the American Association for State Highway and Transportation Officials [AASHTO]) released its *Highway Design and Operational Practices Related to Highway Safety (1)*, the first official report that focused attention on hazardous roadside elements and suggested appropriate treatment for many of them. This guide, also known as the AASHTO "Yellow Book," was revised and updated in 1974 with the introduction of the forgiving roadside concept. In 1989, AASHTO published the first edition of the *Roadside Design Guide*.

In 1998, AASHTO approved their Strategic Highway Safety Plan *(3)*, which provides objectives and strategies for keeping vehicles on the roadway and for minimizing the consequences when a vehicle does encroach on the roadside. The National Cooperative Highway Research Program (NCHRP) also has published a series of guides, called the NCHRP Report 500 *(9)*, to assist state and local agencies in their efforts to reduce injuries and fatalities in targeted emphasis areas. These guides correspond to the emphasis areas outlined in AASHTO's Strategic Highway Safety Plan. The Strategic Highway Safety Plan and associated NCHRP Report 500 guides are available from the AASHTO website at http://safety.transportation.org/guides.aspx.