Freeway Exit Gore Signage: A Survey of State Practice and Related Research

Requested by
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The Caltrans Division of Research and Innovation (DRI) receives and evaluates numerous research problem statements for funding every year. DRI conducts Preliminary Investigations on these problem statements to better scope and prioritize the proposed research in light of existing credible work on the topics nationally and internationally. Online and print sources for Preliminary Investigations include the National Cooperative Highway Research Program (NCHRP) and other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related academic and industry research. The views and conclusions in cited works, while generally peer reviewed or published by authoritative sources, may not be accepted without qualification by all experts in the field.

Executive Summary

Background

The Manual on Uniform Traffic Control Devices (MUTCD), published by the Federal Highway Administration (FHWA), defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways and private roads open to public traffic.

Section 2E.37 of the MUTCD, "Exit Gore Signs," defines the gore as "the area located between the main roadway and the ramp just beyond where the ramp branches from the main roadway."[1] The exit gore sign indicates the exiting point, or place of departure from the main roadway. The MUTCD further specifies that an exit gore sign "shall be located in the gore and shall carry the word EXIT or EXIT XX (if interchange numbering is used) and an appropriate upward slanting arrow."

Installing and repairing exit gore signs are high-risk activities for Caltrans maintenance personnel, requiring field personnel to perform the work on foot, with limited protection and in close proximity to traffic. The space for working is small, making it difficult to use barriers or shadow vehicles for protection without closing lanes. Caltrans would like to identify options for relocating exit gore signs or using innovative products that can improve safety for field personnel while complying with California MUTCD requirements.

In support of Caltrans' inquiry, this Preliminary Investigation aims to identify alternative placement methods or other practices for signing freeway exits through a survey of state departments of transportation (DOTs) and an examination of related research.

[1] Chapter 2E, "Guide Signs—Freeways and Expressways," Manual on Uniform Traffic Control Devices, 2009 Edition including Revisions 1 and 2, FHWA, page 222, May 2012; http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd09r1r2editionhl.pdf.

Summary of Findings

This Preliminary Investigation is organized into three sections:

- Exit Gore Sign Policy.
- Survey of Current Practice.
- Related Research.

Following is a summary of findings by section.

Exit Gore Sign Policy

- National guidance on exit gore signs appears in the 2009 edition of the MUTCD.
- California MUTCD, published January 13, 2012, provides state-specific guidance for exit gore signs.
- Sign specifications are provided for numbered exit gore signs described in the MUTCD and the two in use in California, per the CA MUTCD.

Survey of Current Practice

- Eighteen state DOTs responded to an eight-question survey that addressed alternatives used by these agencies for exit gore sign placement.
    - Two-thirds of the respondents shared practices for alternative exit gore sign placement.
    - Brief follow-up interviews with seven survey respondents supplemented their survey responses.
- Respondents provided information about relocating exit gore signs, using overhead sign structures and installing pavement markings.
    - Four states—Indiana, North Dakota, Ohio and Rhode Island—reported relocating signs farther back into the exit gore.
    - Only one state—Texas—responded to questions about placement of exit gore signage on the far right-hand edge of the freeway or shoulder. Texas DOT has considered these locations and others to remove the exit sign from the gore area to limit risk to maintenance personnel when replacing these signs.
    - Overhead sign structures are used in place of ground-mounted signs in urban areas within Illinois, and have been used in Colorado to sign an urban off-ramp with a challenging layout.
    - Pavement markings to identify exit lanes are used in six states—Colorado, Indiana, Kentucky, New Hampshire, Rhode Island and Washington. Applications include the use of route marker shield logos, arrows, wide dotted lines, and diagonals or chevrons.
- South Carolina DOT is experimenting with a lightweight, easy-to-replace system for exit gore signs that is composed of two square tube posts and a two-piece sign blank constructed of Alpolic material supplemented with SignFix channels and clamps for mounting.
- Texas DOT has delayed exit gore sign replacement until a lane closure could be made at an exit where an employee was recently killed and where other near misses of maintenance personnel have been reported.
- Two states are attempting to increase the conspicuity of exit gore signs.
    - North Dakota and Rhode Island DOTs use Type 1 object markers (diamond-shaped retroreflective markers used to mark obstructions within or adjacent to the roadway) on or in conjunction with exit gore signs.
    - Washington State DOT applies retroreflective sheeting on exit gore sign posts for I-5 exits near Seattle.

- South Carolina DOT is in its third year of an on-call vendor contract to repair signs. While major guide and directional signs are replaced fairly quickly after damage or removal under this contract, it can take up to 90 days for exit signs to be replaced because these sign replacements are typically completed in groups within a given area.
- South Carolina and Texas DOTs noted that exit gore signs may not be needed when other signage (for example, an overhead sign) is used to provide adequate indication of the exit gore.

Related Research

- A 2011 Texas DOT research report investigated the impact of the temporary absence of exit gore signs at two freeway exits and evaluated treatments to reduce the frequency of exit gore sign hits.
- A 2011 *Transportation Research Record* paper examined the effects of in-line pavement markings in advance of freeway interchanges, finding that drivers made lane changes farther upstream of the exit and that such markings limit unnecessary lane changes. While not specifically addressed in the paper, these changes in driver behavior might lessen the number of vehicles attempting to exit too late and hitting the exit gore sign.

Gaps in Findings

There is little published research on the issue of alternative exit gore sign placement. While survey respondents mentioned a variety of practices to address the issue of sign knock-downs and protect the maintenance personnel working on these signs, there appears to be no consensus on how to accomplish these ends. Some states move the signs farther back in the exit gore to limit future hits, while others are experimenting with signs that can be more easily placed and replaced when needed.

The Colorado DOT survey respondent indicated that additional information related to exit gore sign placement may be available from Charles Meyer, Colorado DOT's Safety and Traffic Engineering Manager (see page 4 of this Preliminary Investigation for contact information). We were unable to connect with Mr. Meyer at the time of publication of this report.

We conducted follow-up interviews with seven of the survey respondents. Attempts to contact the other survey respondents were unsuccessful. Such contacts could provide additional information useful to Caltrans.

Next Steps

Caltrans might consider the following as part of a continuing evaluation of alternatives for exit gore sign placement:

- Consulting with South Carolina DOT about its plans to test a lightweight, easy-to-install exit gore sign.
- Contacting states that have moved exit gore signs farther back in the gore area—Indiana, North Dakota, Ohio and Rhode Island—to gather additional information about the impact of this change in sign location.
- Contacting states that use additional signage to call drivers' attention to the exit gore area. Such signage includes pavement markings (Colorado, Indiana, Kentucky, New Hampshire, Rhode Island and Washington), Type 1 object markers (North Dakota and Rhode Island), and retroreflective sheeting on sign posts (Washington).
- Contacting Texas DOT to learn more about its efforts to raise awareness of the hazards to maintenance personnel in repairing or replacing exit gore signs.
- Contacting South Carolina DOT to learn more about its on-call contract for sign replacement.

Contacts

During the course of this Preliminary Investigation, we spoke to or corresponded with the following individuals:

State Agencies

Colorado
David C. Wieder
State Maintenance Engineer
Colorado Department of Transportation
david.wieder@state.co.us, 303-512-5502

Charles Meyer
Safety and Traffic Engineering Manager
Colorado Department of Transportation
Charles.E.Meyer@dot.state.co.us, 303-757-9879

Illinois
Aaron Weatherholt
Deputy Director, Division of Highways
Illinois Department of Transportation
Aaron.Weatherholt@Illinois.gov, 217-785-0888

Indiana
Jeffrey R. Parker
Logistical Support Manager
Indiana Department of Transportation
jparker@indot.in.gov, 317-591-5248

Ohio
Jim Roth
Signing Engineer
Ohio Department of Transportation
jim.roth@dot.state.oh.us, 614-752-0438

South Carolina
John (Nick) Boozer
State Traffic Operations Engineer
South Carolina Department of Transportation
boozerjn@scdot.org, 803-737-2086

Texas
Howard Holland
Director, Maintenance Division
Texas Department of Transportation
howard.holland@txdot.gov, 512-416-3048

Washington
Rick Mowlds
State Sign Engineer
Washington State Department of Transportation
mowldsr@wsdot.wa.gov, 360-705-7988

Exit Gore Sign Policy

Guidance for exit gore signs is provided by FHWA in the MUTCD. Caltrans provides state-specific guidance for California with regard to exit gore signs and sign placement using the framework of the national MUTCD.

National Guidance

Manual on Uniform Traffic Control Devices, FHWA, 2009 Edition.
http://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf
See page 222 of the MUTCD (page 264 of the PDF) for Section 2E.37 Exit Gore Signs (E5-1 Series).

Revisions to Chapter 2E—Guide Signs for Freeways and Expressways, FHWA, undated.
http://mutcd.fhwa.dot.gov/services/ppt/mutcd09training/mutcd09chapters2e_2h.ppt
This FHWA presentation discusses revisions included in Chapter 2E of the 2009 edition of the MUTCD, including these related to exit gore signs:

- A new option is added for the use of Type 1 object markers on exit gore sign supports to improve the visibility of the gore for exiting drivers. The use of the object markers on the support posts helps visually tie the sign to the ground so that the location of the gore can be more readily identified under nighttime or poor visibility conditions.
- A new option is added that allows the use of a narrow version of the exit gore sign in narrow width gore areas, such as those separated from the mainline with barrier or a narrow island.

Standard Highway Signs and Markings, 2012 Supplement to the 2004 Edition, FHWA, March 2012.
http://mutcd.fhwa.dot.gov/SHSe/shs_2004_2012_sup.pdf
This supplement contains the new and revised sign designs adopted in the 2009 edition of the MUTCD. Items relevant to exit gore signs include:

- Page 315 of the PDF provides examples of the E5-1a exit gore sign with exit number. The E5-1a sign comes in three possible widths: 78 inches, 108 inches and 138 inches.
- Page 317 of the PDF provides examples of the E5-1c narrow exit gore sign. At minimum, the overall dimensions of the new sign should be 60 inches wide by 90 inches high.

See Appendix A for examples of these signs.

California Guidance

Section 2E.37, Exit Gore Signs (E5-1 Series), Part 2, Signs, California Manual on Uniform Traffic Control Devices (FHWA's MUTCD 2009 Edition, as amended for use in California), California Department of Transportation, 2012 Edition, January 13, 2012.
http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd2012/Part2CF.pdf
Below is an excerpt from page 416 of the CA MUTCD (page 152 of the PDF). Text in blue font and strikethroughs reflect amendments to the MUTCD 2009 Edition for use in California.

Section 2E.37 Exit Gore Signs (E5-1 Series)

Support:

01 The Exit Gore (E5-1 or E5-1a) sign (see Figure 2E-28 and 2E-28(CA)) in the gore indicates the exiting point or the place of departure from the main roadway. Consistent application of this sign at each exit is important.

Standard:

02 **The gore shall be defined as the area located between the main roadway and the ramp just beyond where the ramp branches from the main roadway. The Exit Gore sign shall be located in the gore and shall carry the word EXIT or EXIT XX (if interchange numbering is used) and an appropriate up ward slanting arrow. If suffix letters are used for exit numbering at a multi-exit interchange, the suffix letter shall also be included on the Exit Gore sign and shall be separated from the exit number by a space having a width of between 1/2 and 3/4 of the height of the suffix letter. Breakaway or yielding supports shall be used.**

Guidance:

03 *The arrow should be aligned to approximate the angle of departure. Each gore should be treated similarly, whether the interchange has one exit roadway or multiple exits.*

Option:

04 Where extra emphasis of an especially low advisory ramp speed is needed, an E13-1P plaque indicating the advisory speed may be mounted below the Exit Gore sign (see Figure 2E-28 and 2E-28(CA)) to supplement, but not to replace, the exit or ramp advisory speed warning signs.

05 To improve the visibility of the gore for exiting drivers, a Type 1 object marker (see Chapter 2C) may be installed on each sign support below the Exit Gore sign.

~~06 An Exit Number (E5-1bP) plaque (see Figure 2E-22) may be installed above an existing Exit Gore (E5-1) sign when a non-numbered exit is converted to a numbered exit.~~

Standard:

07 **An Exit Gore (E5-1a) sign shall be used when the replacement of an existing assembly of an E5-1 sign ~~and an E5-1bP plaque~~ becomes necessary.**

Option:

08 The Narrow Exit Gore (E5-1c) sign may be used in gore areas of limited width where the width of the Exit Gore (E5-1a) sign would not permit sufficient lateral offset (see Section 2A.19), such as for ramp departures that are nearly parallel to the mainline roadway where the Exit Gore sign would be mounted on a narrow island or barrier. Where the E5-1c sign is mounted at a height of 14 feet or more from the roadway, the directional arrow may point diagonally downward.

Guidance:

09 *The E5-1c should not be used in gore areas where an E5-1a sign could be installed with sufficient lateral offset.*

See Appendix B for Figure 2E-28, Exit Gore Signs, and Figure 2E-28 (CA), Exit Gore Signs, thumbnail examples of exit gore signs that appear on page 447 of the CA MUTCD (page 183 of the PDF).

Section 2C.63, Object Marker Design and Placement Height, Part 2, Signs, California Manual on Uniform Traffic Control Devices (FHWA's MUTCD 2009 Edition, as amended for use in California), California Department of Transportation, 2012 Edition, January 13, 2012.
http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd2012/Part2CF.pdf
See page 293 of the CA MUTCD (page 29 of the PDF) for a description of Type 1 object marker design and height. See pages 310 through 312 of the CA MUTCD (pages 46 through 48 of the PDF) for examples of the markers.

G84-2(CA), California Department of Transportation, April 20, 2006.
http://www.dot.ca.gov/hq/traffops/signtech/signdel/specs/G84-2.pdf
See Appendix C. This document provides the design specifications for an exit gore sign when an exit number or suffix has one to two numbers or letters.

G84-3(CA), California Department of Transportation, March 9, 2009.
http://www.dot.ca.gov/hq/traffops/signtech/signdel/specs/G84-3.pdf
See Appendix D. This document provides the design specifications for an exit gore sign when an exit number or suffix has three to four numbers or letters.

Other State Guidance

Chapter 2E, Guide Signs—Freeways and Expressways, Texas Manual on Uniform Traffic Control Devices, Texas Department of Transportation, 2011 Edition, Revision 1, December 2011.
http://ftp.dot.state.tx.us/pub/txdot-info/trf/tmutcd/2011_rev1/2e.pdf
See Appendix E for Figure 2E-28, Exit Gore Signs, which provides a thumbnail example of the E5-1c narrow exit gore sign. This thumbnail representation of the E5-1c sign appears on page 231 of the Texas MUTCD (see page 43 of the PDF), and does not appear in the 2009 MUTCD or the 2012 CA MUTCD.

Survey of Current Practice

We conducted a brief online survey of members of the AASHTO Subcommittee on Maintenance to gather information from state DOTs about alternatives for exit gore sign placement to address the issue of sign knock-downs and the hazards faced by maintenance crews in replacing the signs. The survey consisted of the following questions:

> Please indicate whether your agency has used, or has considered using, each of the alternatives below. If you answer Yes, please provide a brief description.
>
> 1. Relocating the single-post freeway exit gore sign to the far right-hand edge of the freeway off ramp.
> 2. Relocating the single-post freeway exit gore sign farther back into the exit gore of the freeway off ramp and placing an alternative, appreciably larger, two-post sign up to 150 feet downstream of the 23-foot point.
> 3. Using overhead sign structures for exit gore signs above the exit gore to eliminate the need for a ground-mounted sign.
> 4. Using far right-hand shoulder placement of single- or two-post signs in place of exit gore signs.
> 5. Using pavement markings (arrows and/or exit number) in traffic lanes and/or off-ramp lanes to identify the exit lanes.
> 6. Not replacing exit gore signs after multiple knock-downs.
> 7. Not installing exit gore signs in locations where there are multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore.
> 8. Other action not referenced above to address exit gore sign knock-downs.

We received responses from 18 state DOTs:

- Arkansas.
- Colorado.
- Idaho.
- Illinois.
- Indiana.
- Iowa.
- Kentucky.
- Michigan.
- Nebraska.
- New Hampshire.
- New York.
- North Dakota.
- Ohio.
- Pennsylvania.
- Rhode Island.
- South Carolina.
- Texas.
- Washington.

See **Survey Results** beginning on page 10 for the full text of all survey responses.

The survey gathered information in six topic areas related to alternatives for exit gore sign placement:

- Relocating signs farther back into the exit gore.
- Relocating signs to the far right-hand edge of the freeway or shoulder.
- Using overhead sign structures in place of ground-mounted signs.
- Using pavement markings to identify exit lanes.
- Not replacing exit gore signs after multiple knock-downs.
- Current standards and other practices.

Key findings from the survey follow.

Relocating Signs Farther Back into the Exit Gore

- Four states—Indiana, North Dakota, Ohio and Rhode Island—reported relocating exit gore signs farther back into the exit gore.
    - In Indiana, I-beam gore signs have been moved back a few yards at a few high-hit areas, with a goal of minimizing future hits.
    - North Dakota DOT has revised its standards to place the gore sign farther back on a two-post assembly. This signage is used in conjunction with a Type 1 object marker placed at the beginning of the gore to warn drivers of the gore area.
    - In Ohio, the exit gore sign has been moved up to 75 feet farther downstream in some locations. This change in placement has been helpful in limiting exit gore sign knock-downs. However, placing signs farther back into the gore area can be problematic if drivers cut across the gore in a last-minute attempt to exit and enter closer to the end of the gore, increasing the possibility of hitting a relocated exit gore sign.
    - Rhode Island DOT reported that in some instances, an exit gore sign is placed farther back from the upstream gore point than the pre-knock-down location. Replacement signs are not necessarily appreciably larger, and the installation distances vary based on site conditions.

Relocating Signs to the Far Right-Hand Edge of the Freeway or Shoulder

- Only one state—Texas—responded to questions about placement of exit gore signage on the far right-hand edge of the freeway or shoulder. To limit risk to maintenance personnel, Texas DOT has considered these locations and others for alternate placement of exit gore signage in a desire to remove signage from the gore area.

Using Overhead Sign Structures in Place of Ground-Mounted Signs

- In Colorado, a two-lane exit from Denver International Airport utilizes exit signage in the form of an overhead sign and route shields painted on the roadway surface. The use of an overhead sign in this location is related to the layout of the ramp and not to sign knock-downs.
- Illinois DOT uses overhead signs in place of ground-mounted signs only in specific locations where it makes sense to do so (for example, urbanized areas).

Using Pavement Markings to Identify Exit Lanes

- In Colorado, a two-lane exit from Denver International Airport couples the use of an overhead sign and route shields painted on the roadway surface to serve as exit signage.
- Indiana DOT is evaluating one location where mainline markings are used for advance lane identification. An overhead sign is placed before the mainline marking, and the exit gore sign is placed in its typical location (10 to 15 yards from the gore opening or closer). It is not yet known if the mainline markings will limit exit gore sign knock-downs in this location.

- In Kentucky, arrows have been used when multiple lanes exit the Interstate.
- New Hampshire DOT uses wide dotted lines to separate the deceleration lanes from the through lanes.
- In a few select freeway locations, Rhode Island DOT has installed lane use markings (e.g., arrows, ONLYs, route marker shield logos, exit numbers) in an exit lane. Guidance provided in the MUTCD and engineering judgment is used to determine how markings are used at each site.
- Washington State DOT uses diagonal or chevron pavement markings in the gore area.

Not Replacing Exit Gore Signs After Multiple Knock-Downs

- Texas DOT has delayed exit gore sign replacement until lane closures could be made to limit the risk to maintenance crews.
- Texas and South Carolina DOTs noted that exit gore signs may not be needed when other signage is used to provide adequate indication of the exit gore.

Current Standards and Other Practices

Agencies clarified current standards for exit gore signage and reported other practices in connection with exit gore signs.

- South Carolina DOT is in its third year of an on-call vendor contract to repair signs. While major guide and directional signs are replaced fairly quickly under this contract after damage or removal, it can take up to 90 days for exit signs to be replaced because replacement is delayed until multiple projects can be completed in a given area.
- Five agencies described the posts used for standard exit gore signage.
    - Arkansas uses two I-beam or U-channel posts for all gore signs.
    - For some installations, Illinois DOT has used a strong, breakaway tubular steel post with double supports to expedite replacement rather than a 4' x 6' post that has to be reset.
    - Many of Rhode Island DOT's exit gore signs use multiple posts (typically two U-channel posts).
    - South Carolina DOT's standard exit gore sign uses an extruded panel mounted on two I-beam breakaway posts to delineate the point of no return on exit ramps. On loop ramps, the ramp advisory speed is incorporated on the bottom panel. In recent years, single-post systems such as POZ-LOC have been used to expedite sign repair by eliminating the need to order and fabricate new I-beams.
    - Washington State DOT typically uses a perforated square steel tube with a slip base for its sign posts. A double-post sign is used for exit gore signs that reflect an exit number; single-post signs are used for exit gore signs that do not include an exit number.
- Two states use or are considering using Type 1 object markers.
    - Several years ago, North Dakota DOT revised its standards to place the gore sign farther back on a two-post assembly, with a Type 1 object marker placed at the gore opening to warn drivers of the gore area.
    - In some cases, Rhode Island DOT installs Type 1 object markers, according to MUTCD guidelines, along with the exit gore sign to increase conspicuity.

- Reflective sheeting on sign posts is in use or under consideration by two states.
    - South Carolina DOT has considered applying reflective panels on exit gore sign posts but has yet to implement this practice.

    - This spring Washington State DOT started placing a three-sided cover with Type IV green retroreflective sheeting over exit gore sign posts on I-5 near Seattle.
- Other exit gore signage in use or under development includes:
    - In Pennsylvania, narrower exit gore signs have been used in cases where lateral clearance is a problem.
    - South Carolina DOT is planning to test the use of a new lightweight system for exit gore signs that is easy for maintenance crews to replace quickly without special equipment. The sign will consist of two square tube posts and a two-piece sign blank constructed of Alpolic material supplemented with SignFix channels and clamps for mounting. See page 17 of this Preliminary Investigation for details. The new signs could be adopted as a permanent replacement for the exit gore signs now in use if they prove to be cost-effective and durable.

Survey Results

The full text of each survey response is provided below. For reference, we have included an abbreviated version of each question before the response; for the full question text, please see page 7 of this Preliminary Investigation.

CTC conducted follow-up interviews to gather additional information from seven survey respondents—Colorado, Illinois, Indiana, Ohio, South Carolina, Texas and Washington. The results of these interviews are appended to the survey responses as "Summary of Follow-up Interview."

Arkansas

Contact: Tony Sullivan, State Maintenance Engineer, Arkansas Highway and Transportation Department, tony.sullivan@ahtd.ar.gov, 501-569-2231.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** Yes. We use two I-beam or U-channel posts for all gore signs.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Colorado

Contact: David C. Wieder, State Maintenance Engineer, Colorado Department of Transportation, david.wieder@state.co.us, 303-512-5502.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.

3. **Use overhead sign structures to eliminate need for ground-mounted sign?** Yes. The exit from Pena Boulevard (from Denver International Airport) to I-70 is a two-lane exit. All traffic must exit Pena; the left lane is designated for westbound I-70 traffic and the right lane is designated for southbound I-225 traffic. Designation is by overhead sign and shields painted on the roadway surface.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** Yes. The exit from Pena Boulevard (from Denver International Airport) to I-70 is a two-lane exit. All traffic must exit Pena; the left lane is designated for westbound I-70 traffic, and the right lane is designated for southbound I-225 traffic. Designation is by overhead sign and shields painted on the roadway surface.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Summary of Follow-up Interview:

With regard to the responses to question 3 and 5: The use of an overhead sign in this location is related to a configuration issue (the layout of the ramp) and is not related to sign knock-downs.

Idaho

Contact: Greg Laragan, Highways Operations Engineer, Idaho Transportation Department, greg.laragan@itd.idaho.gov, 208-334-8535.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Illinois

Contact: Aaron Weatherholt, Deputy Director, Division of Highways, Illinois Department of Transportation, Aaron.Weatherholt@Illinois.gov, 217-785-0888.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** Yes, but only in specific locations where it makes sense to do so. For example, urbanized areas. We do this a lot in the Chicago area.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.

5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** Yes. We have used a very strong but breakaway steel post design which would allow for it to be reused and would speed replacement.

Summary of Follow-up Interview:

Knock-downs are always an issue, and Illinois DOT always replaces a knocked-down sign. Placement of overhead sign structures is limited to urbanized areas given their expense. Some installations have used a strong, breakaway tubular steel with double supports to expedite replacement rather than a 4' x 6' post that has to be reset. Safety is not an issue for crews replacing exit gore signs in rural areas but is an issue in the Chicago and St. Louis areas and in other more populated areas of the state.

Indiana

Contact: Jeffrey R. Parker, Logistical Support Manager, Indiana Department of Transportation, jparker@indot.in.gov, 317-591-5248.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** Yes. INDOT is evaluating one location where we are using mainline markings for advance lane identification; we have not determined if this is effective at this point or even if the lane markings will last.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** Yes. We have moved the two I-beam gore signs back a few yards at a few high-hit areas in hopes of taking fewer hits.

Summary of Follow-up Interview:

Indiana DOT is testing a mainline marking on the east side of Indianapolis, in an area where four exit lanes provide access to three roadways (I-70W, I-70E and Shadeland Avenue). The agency placed a "TO I-70" marking in the farthest left exit lane a mile before the exit. An overhead sign identifying the exit is placed before the mainline marking. The gore sign for this exit is placed in the typical location in the gore area (10 to 15 yards from the gore opening). It is too early to tell if the mainline marking will limit exit gore sign knock-downs at this location. While not a standard practice, in some locations the agency has moved exit gore signs back 3 to 5 yards after frequent sign hits.

Iowa

Contact: Tim Crouch, State Traffic Engineer, Iowa Department of Transportation, tim.crouch@dot.iowa.gov, 515-239-1513.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.

3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Kentucky

Contact: Craig Caudill, Transportation Engineer II, Kentucky Transportation Cabinet, craig.caudill@ky.gov, 502-782-5575.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** Yes. Arrows have been used when multiple lanes exit the Interstate.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Michigan

Contact: Alonso Uzcategui, Traffic Signing Engineer, Michigan Department of Transportation, uzcateguia@michigan.gov, 517-335-2624.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Nebraska

Contact: Matt Neemann, Traffic Control Engineer, Nebraska Department of Roads, matt.neemann@nebraska.gov, 402-479-4594.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

New Hampshire

Contact: William R. Lambert, Traffic Engineer/Administrator, New Hampshire Department of Transportation, wlambert@dot.state.nh.us, 603-271-2291.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** Yes. We've been using the wide dotted lines to separate the deceleration geometry from the through lanes.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

New York

Contact: Robert Winans, Director, Bureau of Maintenance Management, New York State Department of Transportation, bob.winans@dot.ny.us, 518-457-4688.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.

7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

North Dakota

Contact: Craig Faul, Transportation Senior Project Manager, North Dakota Department of Transportation, cfaul@nd.gov, 701-328-2546.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** Yes. A number of years ago we revised our standards to place the gore sign farther back on a two-post assembly with a Type 1 object marker placed at the beginning of the gore to warn drivers of the gore area.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** No.

Ohio

Contact: Jim Roth, Signing Engineer, Ohio Department of Transportation, jim.roth@dot.state.oh.us, 614-752-0438.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** We have moved the exit gore sign farther downstream, up to 75 feet in some cases, from the normal location.

Summary of Follow-up Interview:

Placing exit gore signs farther downstream in the gore has been helpful in limiting exit gore sign knock-downs. However, placing signs farther back in some locations has been problematic if drivers cut across the gore to make a last-minute exit and enter closer to the end of the gore, increasing the possibility of hitting a relocated exit gore sign.

Pennsylvania

Contact: Kenneth Reuther, Senior Civil Engineer, Pennsylvania Department of Transportation, kreuther@pa.gov, 717-787-9508.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** Smaller-width exit gore signs have been used in cases where lateral clearance is a problem.

Rhode Island

Contact: Russell B. Holt, Senior Civil Engineer, Traffic Engineering Unit, Rhode Island Department of Transportation, russell.holt@dot.ri.gov, 401-222-2694, ext. 4046.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** After a knock-down of an exit gore sign, we have in some instances installed same (or a replacement, if knocked-down sign is no longer suitable) at a distance that is farther back from the upstream gore point than the pre-knock-down install location, but the replacement signs are not necessarily appreciably larger, and the distances vary based on site conditions. In some cases, we install other signs along with the exit gore sign to supplement/increase conspicuity (e.g., Type 1 object markers, per MUTCD).
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** Yes. RIDOT has, in a few select freeway locations in recent years, installed lane use markings (arrows, ONLYs, route marker shield logos (or in some cases the exit numbers), etc.) in an exit lane. We have no standard details or other published/formal guidance for doing so, and to date we've simply deferred to the guidance provided in the MUTCD and used engineering judgment at each install site.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** Notes regarding above responses: RE: 1 and 2 above: Many of our exit gore signs use multiple posts (two U-channel posts, typically).

South Carolina

Contact: John (Nick) Boozer, State Traffic Operations Engineer, South Carolina Department of Transportation, boozerjn@scdot.org, 803-737-2086.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** Yes. Currently, the standard in South Carolina is to use exit gore signs (extruded panel) mounted on two I-beam breakaway posts to delineate the point of no return on exit ramps. On loop ramps, we incorporate the ramp advisory speed on the bottom panel. In recent years, we have tried a few single-post systems, such as POZ-LOC [see http://www.nwpipe.com/.docs/pg/400/rid/10067/f/PozLoc_TrafficPosts.pdf for an example of a vendor publication describing POZ-LOC traffic posts], to make sign repair easier for our maintenance guys. The biggest delay in repair is when new I-beams have to be ordered and fabricated. POZ-LOC does solve this problem.

   We are currently looking at a system that will make replacement easier and not require any special equipment. We will use two square tube posts and a two-piece sign blank constructed of Alpolic material [see http://alpolic-usa.com/products/ for additional information about Alpolic's products] supplemented with SignFix channels [see http://www.signfix.co.uk/traffic for more information] and RHS [rectangular hollow section] clamps for mounting. We have not finalized this yet. The plan is to have a lightweight system that is easy for maintenance crews to replace quickly. Hopefully, we will try a few of these in upcoming months. Right now, we do have an on-call contract to repair and replace these signs, but it is pricey. Often the traffic control costs more than the repairs.

   For the record, I do not think they are really necessary when you have a full complement of overhead signs present as described in question 7. Especially if the sign is mounted on a barrier wall or behind a crash attenuator that serves to delineate the gore area.

Summary of Follow-up Interview:

South Carolina DOT's practice is to place the exit gore sign prominently in the gore area. While gore signage may be less critical in urban areas where overhead signs also provide exit information, the agency finds that exit gore signage offers a useful reference point for drivers.

Current Practice

The most significant challenge in replacing exit gore signage is the lack of ready access to a bucket truck or crane needed to lift the heavy signage into place. SCDOT's standard exit gore sign is composed of extruded panels mounted on two S4 x 7.7 steel I-beam posts that are just heavy enough for maintenance personnel to need equipment to lift them into place. A ready supply of replacement posts is not available, and damaged sign-and-post assemblies waiting for new beams to be fabricated can get mislaid in the maintenance yard.

On-Call Contract for Sign Repair

SCDOT is in its third year of an on-call vendor contract to repair signs. The funds available under this

contract are estimated at $1 million per year. While major guide and directional signs are replaced fairly quickly after damage or removal under this contract, it can take up to 90 days for exit signs to be replaced. The agency waits until there are several signs in an area requiring replacement before engaging the contractor. Generally, replacement signs are located immediately behind the sign that was damaged. In a few cases, a replacement sign may be moved farther downstream in the exit gore, but this is not typical.

Alternative Exit Gore Sign Construction
To make sign repair easier, the agency has experimented with replacing the standard I-beam construction with a single-post POZ-LOC system that uses a 2 3/8-inch galvanized steel tube. In addition to eliminating the need to fabricate heavy signs that are difficult to place without the aid of equipment, a sign using one support rather than two could lessen the chance of impact by traffic.
To bridge the time gap between exit gore sign knock-down and replacement, SCDOT's Department of Traffic Engineering is working with the agency's Division of Maintenance on a project to design and build lightweight exit gore signs that can be installed and removed without special equipment. The proposed signs will be patterned after an approach used by SCDOT to provide temporary signage for use by Clemson University that could be installed and removed on days when football games require additional traffic guidance.

The 6' x 6' Clemson signs are fabricated in two pieces using two 2-inch, 12-gauge steel square tube posts and a two-piece sign blank constructed using lightweight Alpolic aluminum composite panels to which the appropriate numbers are applied. The signs are prepared for installation using the SignFix channel and clip system and RHS clamps for mounting rather than using bolts.

It is possible that the new sign type could be adopted as a permanent replacement for the signs now in use if it is found that the new, lightweight signs are cheaper to produce, durable and easier to replace when damaged. Mr. Boozer acknowledged that while replacement of more lightweight signs should take less time than placing heavier signs requiring the use of equipment, maintenance personnel are still exposed to the risks of traffic when completing the repair or replacement.

Other Possible Actions
While SCDOT has considered applying reflective panels on exit gore sign posts, the agency has yet to implement this practice.

Texas

Contact: Howard Holland, Director, Maintenance Division, Texas Department of Transportation, howard.holland@txdot.gov, 512-416-3048.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** Yes. The location of this sign in the gore places our employees in extreme danger, so we are looking at all alternatives to eliminate it.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** Yes. See #1.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** Yes. Have delayed until had lane closures due to extreme danger to employees. We had an employee killed recently and have documented several near misses while reinstalling this sign.

7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.
8. **Other action to address exit gore sign knock-downs?** Yes. Have discussed totally eliminating. We question the value versus the employee risk to install and maintain.

Summary of Follow-up Interview:

Texas has a high incidence of exit gore sign strikes. Drivers appear to be exiting too late, losing control of their vehicles and striking the exit gore sign. Maintenance staff repairing signs are typically protected by their vehicles while they perform the work, but crews are exposed to greater risk when drivers attempt to enter the gore area from the right traffic lane, beyond the typical exit gore access point. Unlike some states, TxDOT has not elected to push signage farther back into the gore area.

In June 2013, a Texas DOT maintenance employee was killed when a vehicle crossed into the gore area from the far right traffic lane, beyond the exit gore access point, and struck the employee as he was working to repair an exit gore sign. Other near misses of maintenance personnel have also been reported at this location. After this recent fatality, TxDOT used traffic control to close the ramp and far right lane on the expressway when repairing this sign to provide a greater cushion for workers in the gore area.

Mr. Holland noted that TxDOT is working to raise awareness of the risks to maintenance staff replacing freeway exit gore signs and would like to see modifications to federal guidance on the use of exit gore signs. The recent fatality has heightened concern about this issue. The agency is interested in finding alternatives that accomplish the same purpose as an exit gore sign, perhaps with the use of advance signs.

Related Resources:

Chapter 2E, Guide Signs—Freeways and Expressways, Texas Manual on Uniform Traffic Control Devices; Revision 1, Texas Department of Transportation, 2011.
http://ftp.dot.state.tx.us/pub/txdot-info/trf/tmutcd/2011_rev1/2e.pdf
See page 230 of the manual (page 42 of the PDF) for Section 2E.37, Exit Gore Signs (E5-1 Series).

Freeway Signing Handbook, Texas Department of Transportation, 2008.
http://onlinemanuals.txdot.gov/txdotmanuals/fsh/fsh.pdf
See page 39 of the PDF for specifications related to exit gore signs.

Washington

Contact: Rick Mowlds, State Sign Engineer, Washington State Department of Transportation, mowldsr@wsdot.wa.gov, 360-705-7988.

1. **Relocate single-post sign to far right-hand edge of freeway off ramp?** No.
2. **Relocate single-post sign farther back into exit gore; place larger two-post sign downstream?** No.
3. **Use overhead sign structures to eliminate need for ground-mounted sign?** No.
4. **Use far right-hand shoulder placement of single- or two-post signs?** No.
5. **Use pavement markings to identify the exit lanes?** No.
6. **Not replace exit gore signs after multiple knock-downs?** No.
7. **Not install exit gore signs for multiple off-ramp or freeway-to-freeway connector exit ramps and where overhead signs provide adequate indication of the exit gore?** No.

8. **Other action to address exit gore sign knock-downs?** This past spring we started placing a three-sided cover with Type IV retroreflective sheeting (green) over the sign post in the vicinity of Seattle on Interstate 5. So far so good.

Summary of Follow-up Interview:

Exit gore sign hits come in spurts for Washington State DOT and appear to be random or weather-related. Placement of the exit gore sign is related to the geometry of the angle and length of the gore area and varies by installation. There appears to be a greater chance of an exit gore sign being hit when the gore area is short. As a general practice, exit gore signs are not moved farther back in the gore area after a sign hit.

Pavement markings are used in the gore area; see Related Resource below for a layout. The agency typically uses perforated square steel tubes with a slip base for its sign posts. A double-post sign is used for exit gore signs that reflect an exit number; single-post signs are used for exit gore signs that do not include an exit number.

To expedite the sign replacement process and limit crews' exposure to the risks of traffic, maintenance crews prepare signs before arriving at the gore area so they can be set quickly. When signs are prepped for placement, they can be set in as little as 15 minutes. Crews repairing or replacing signs on mainline freeways are accompanied by a truck-mounted attenuator to protect them from vehicles in and around the work zone.

Related Resource:

Gore Area Marking Layouts, Standard Plan M-2.20-2, Washington State Department of Transportation, June 3, 2011.
http://www.wsdot.wa.gov/publications/fulltext/Standards/english/PDF/m02.20-02_e.pdf
This plan for gore area pavement markings includes the following notes:

1. Install a minimum of 3 sets of diagonals/chevrons in the gore area. A 50' spacing is standard, however, for gore areas shorter than 150' use a 25' spacing, and for gore areas greater than 400' a spacing of 100' may be used.
2. The acute angle of the diagonals shall always point in the direction of the main line traffic.

Related Research

A search for recent domestic research with regard to alternative exit gore sign placement netted one publication—a 2011 Texas DOT report that investigated the impact of the temporary absence of exit gore signs at two freeway exits and evaluated treatments to reduce the frequency of exit gore sign hits. A 2011 *Transportation Research Record* paper examined the effects of in-line pavement markings in advance of freeway interchanges, finding that drivers made lane changes farther upstream of the exit and that such markings limit unnecessary lane changes. While not specifically addressed in the paper, these changes in driver behavior might lessen the number of vehicles attempting to exit too late and hitting the exit gore sign.

Treatments to Reduce the Frequency of Exit Sign Hits, Geza Pesti, Kwaku Obeng-Boampong, Praprut Songchitruksa, LuAnn Theiss, Texas Department of Transportation, June 2011.
http://tti.tamu.edu/documents/0-6120-1.pdf
Using the period of time between sign hit and reinstallation, researchers collected data to determine the impact of the absence of exit gore signs at two freeway exits in Corpus Christi, TX, where advance warning with overhead exit signs was provided and there were no visibility or sight distance issues. Results indicated that the absence of exit gore signs did not have any negative consequences in terms of vehicle speeds, drivers' deceleration behaviors and erratic maneuvers. In Phase II of the study, researchers ranked and tested countermeasures to address exit gore sign hits using field data collected before and after the treatment.

Related Resource:

0-6120: An Evaluation of the Performance of High Impact Signs, Project Summary, Texas Department of Transportation, undated.
ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/0-6120.pdf
This summary of the 2011 TxDOT research study examining treatments to reduce the frequency of exit sign hits presents factors contributing to frequent exit gore sign hits and potential countermeasures to address these factors. These tables are reproduced on the next page.

Factors Contributing to Frequent Exit Gore Sign Hits*

Category	Factors
Roadway design	• Limited sight distance due to vertical and/or horizontal curve upstream of exit ramp. • Significant weaving between closely spaced ramps. • Shift in horizontal alignment of main lanes. • Constrained right of way. • Significantly lower advisory speed for ramp and/or frontage road. • Drop-lane design coupled with limited sight distance.
Driver behavior	• Inattentive driving (e.g., cell phone use, texting). • Late decision-making. • Excessive speed.
Sign location and/or placement	• Visual clutter with other signs. • Exit gore sign located too close to pavement.
Pavement markings	• Faded/worn out. • Lane delineators broken or uprooted.
Nighttime visibility	Poor nighttime visibility on inadequately lighted roadways.

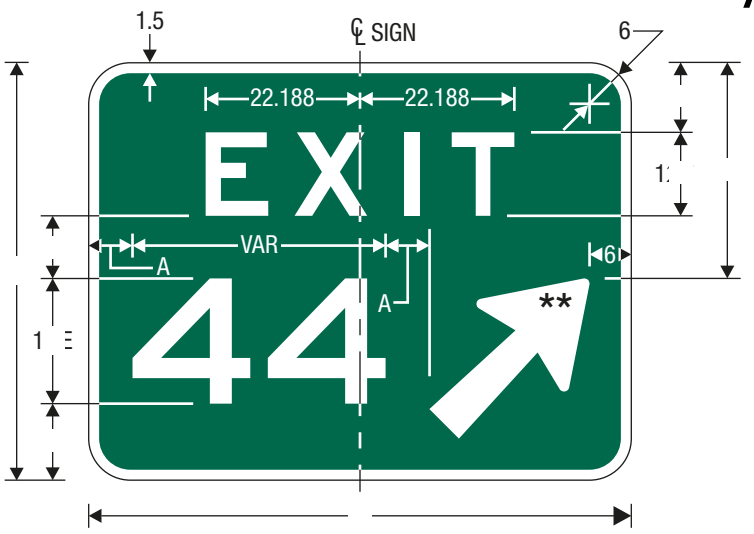
* From page 2 of *0-6120: An Evaluation of the Performance of High Impact Signs.*

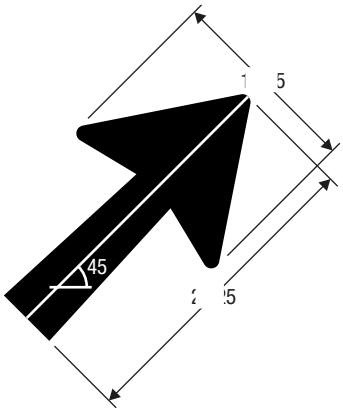
Potential Countermeasures*	
Issues	**Countermeasures**
High operating speeds on approach to exit **Relatively large speed difference between mainline and exit ramp speed**	• Pavement markings as passive speed control devices (converging chevrons, transverse bars, peripheral lines). • Rumble strips on approach lane to exit. • Ramp speed painted on the pavement in the approach lane to the exit. • Advance ramp advisory speed warning sign with flashers.
Vehicle crashes with exit gore sign	• Relocation of exit gore sign farther into gore area.
Late exiting or merging maneuvers **Vehicles crossing gore area**	• Flexible pylons to delineate gore area. • "Escape" lane (on freeway and/or exit ramp).
Poor nighttime visibility	• Retroreflective sheeting on sign posts. • Reflective object markers on sign posts.
Poor delineation and visibility of gore area	• Impact attenuator with large retroreflective bidirectional arrows.

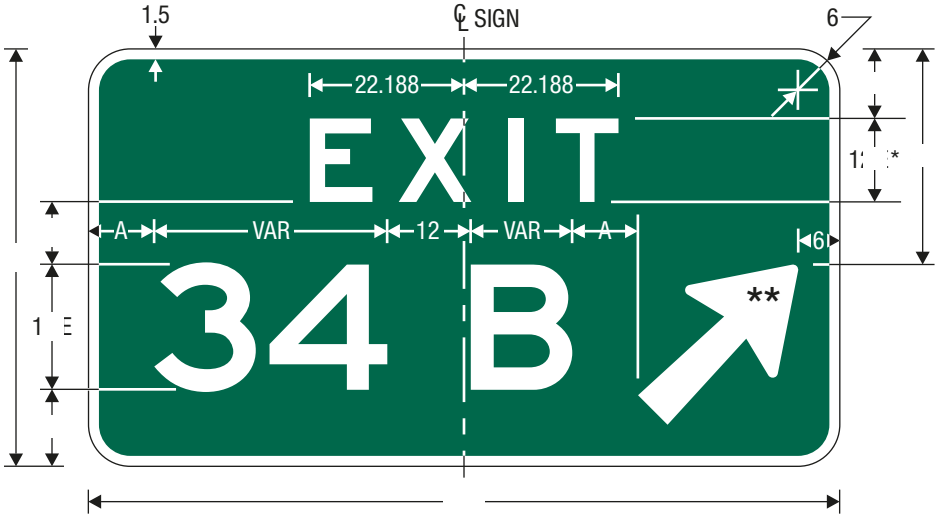
* From page 2 of *0-6120: An Evaluation of the Performance of High Impact Signs.*

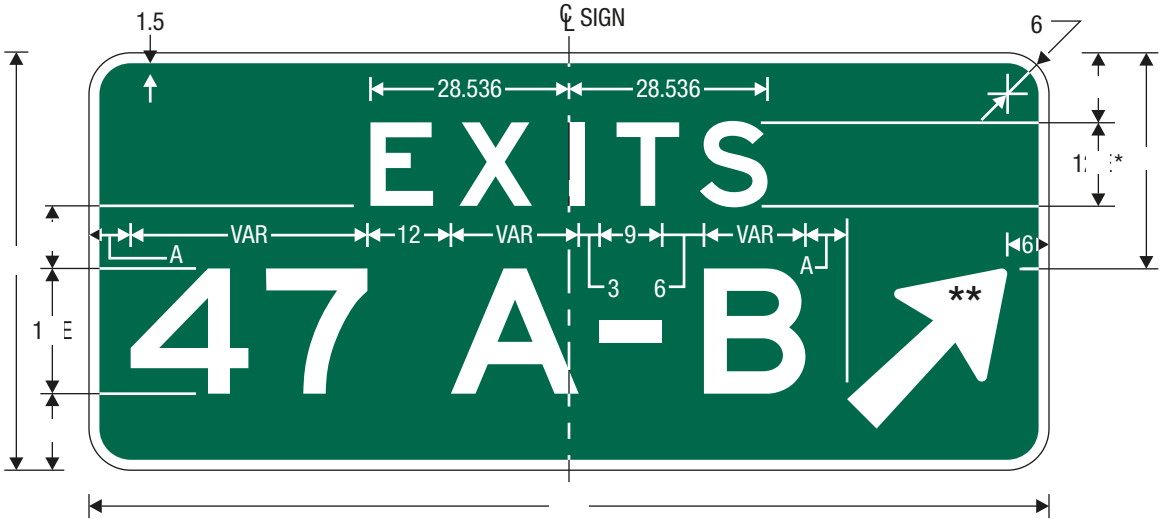
"Field Evaluation of In-Lane Pavement Markings in Advance of Freeway Interchanges," Melisa D. Finley, Brooke R. Ullman, *Transportation Research Record 2250*, pages 32-40, 2011.
Citation at http://trb.metapress.com/content/2h7rg448858m1728/
From the abstract: Freeway interchanges with lane drops, double lane exits with optional lanes, and other unusual geometries violate driver expectations and may result in late lane changes and erratic movements near the exit gore. In-lane pavement markings have the potential to reiterate the information available on overhead signs, which depicts the upcoming interchange geometry. Texas Transportation Institute researchers designed and conducted field studies at freeway interchanges to evaluate the operational impacts of route shield and directional arrow in-lane pavement markings.

The addition of route shields and cardinal directions to existing in-lane directional arrows and "ONLY" text resulted in better utilization of the optional lane. In addition, motorists made lane changes farther upstream of the exit and fewer unnecessary lane changes after the installation of the route shields and cardinal direction markings. Similar positive findings were found where no existing in-lane pavement markings were present and only route shields were installed. While the addition of only directional arrows also positively impacted the lane distributions and lane change rate, the effect on the unnecessary lane changes was not as evident. Overall, researchers concluded that the installation of in-lane pavement markings (either route shields or directional arrows) improved operations, and thus potentially safety, at the interchanges studied. In addition, there is evidence to suggest that using a combination of route shields and directional arrows may be more beneficial to motorists than using only directional arrows.









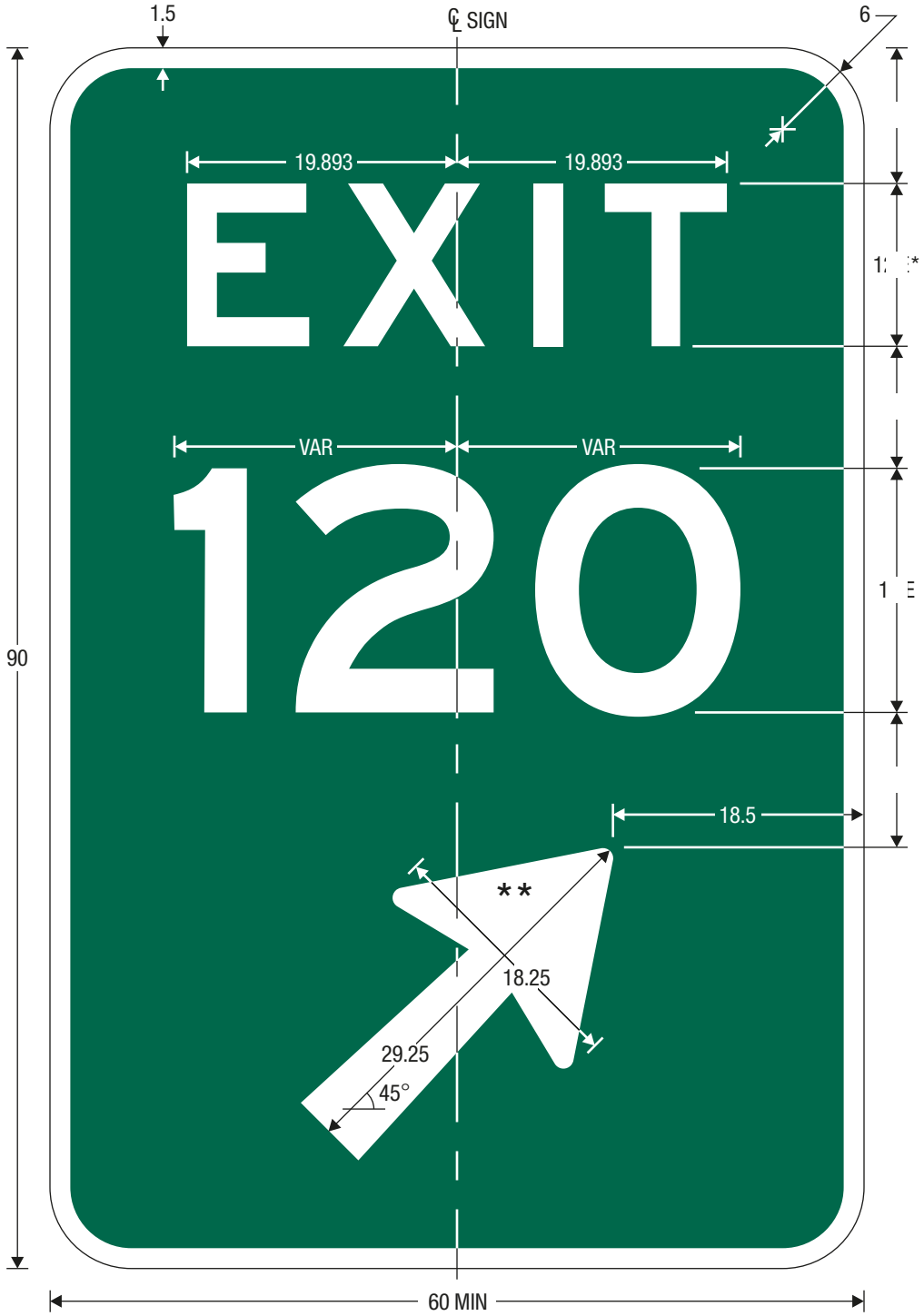
E5-1a

EXIT GORE - NUMBER

* Increase character spacing 225%.

** See page 6-1 for arrow design.

COLORS: LEGEND, BORDER – WHITE (RETROREFLECTIVE)
BACKGROUND – GREEN (RETROREFLECTIVE)



E5-1c

NARROW EXIT GORE

* Increase character spacing 150%.

** See page 6-1 for arrow design.

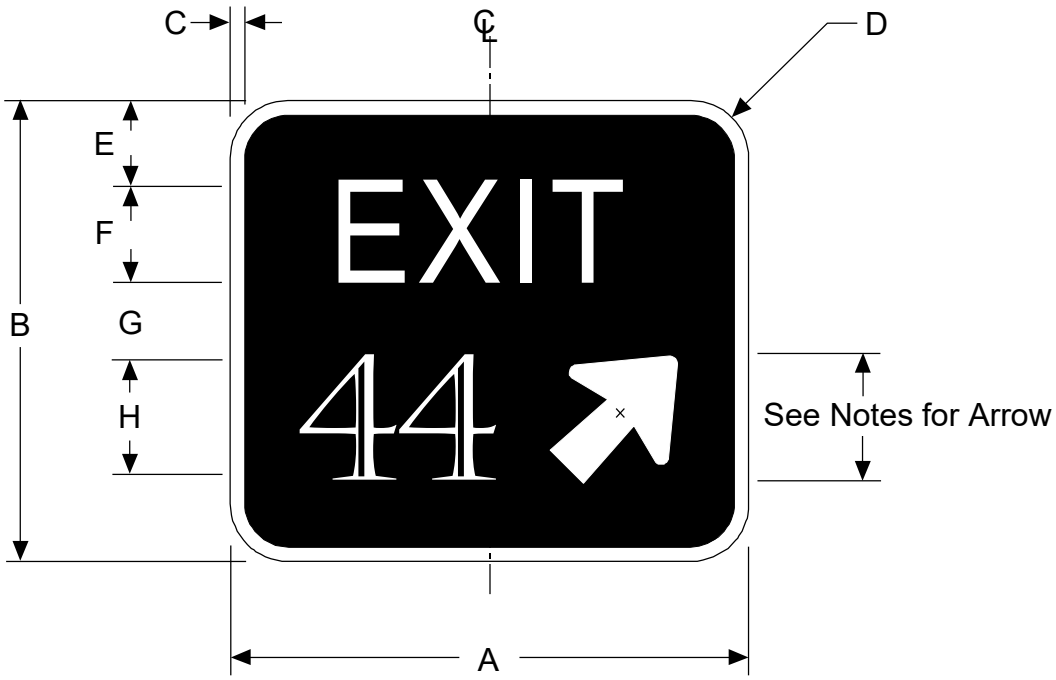
COLORS: LEGEND, BORDER — WHITE (RETROREFLECTIVE)
BACKGROUND — GREEN (RETROREFLECTIVE)

Figure 2E-28. Exit Gore Signs

Figure 2E-28 (CA). Exit Gore Signs

G84-2 (CA) G84-3 (CA)

Use when an Exit Number/Suffix has 1 to 2 numbers or letters.



G84-2 (CA)

NOTES:

For arrow dimensions, see Figure 2D-2 (CA) of the MUTCD 2003 California Supplement.

Arrow is centered on the number/suffix and may be placed on either side. Arrow angle can vary, specify angle or order unapplied.

When the exit number includes a suffix letter, the suffix letter is separated from the number by a space.

ENGLISH UNITS

A	B	C	D	E	F	G	H	J	K
54	48	2	6	9	10E	8	12D	14	16

COLORS: BORDER & LEGEND - WHITE (RETROREFLECTIVE)
BACKGROUND - GREEN (RETROREFLECTIVE)

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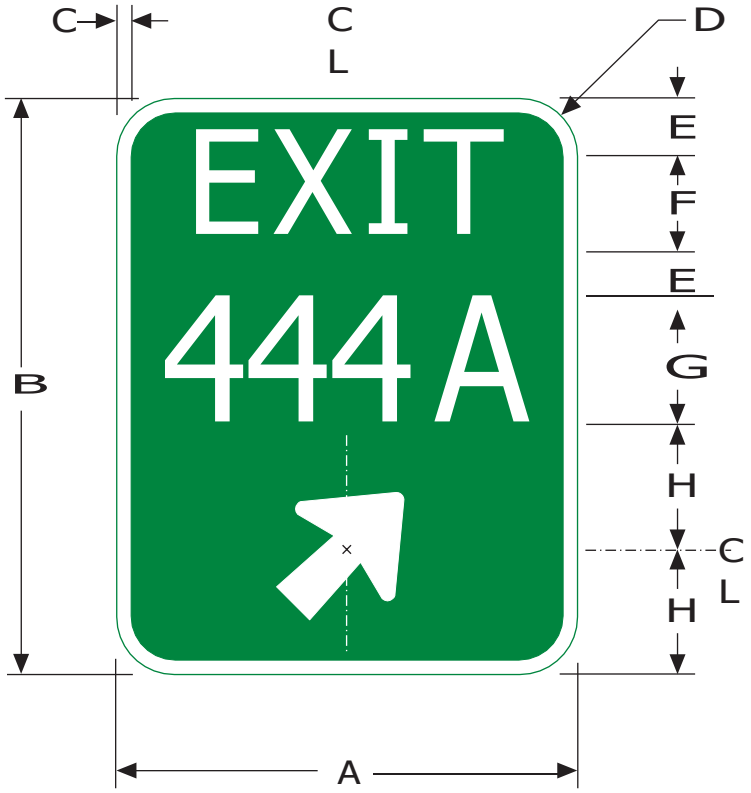
Use when an Exit Number/Suffix
has 3 to 4 numbers or letters.



G84-3 (CA)

NOTES:

For arrow dimensions, see Figure 2D-2 (CA) of the CA MUTCD. Arrow angle can vary, specify angle or order unapplied.

When the exit number includes a suffix letter, the suffix letter is separated from the number by a space (per FHWA Standard Alphabet Spacing standards).

ENGLISH UNITS

A	B	C	D	E	F	G	H	J	K
48	60	2	6	6	10E	12C	13	14	16

COLORS: BORDER & LEGEND - WHITE (RETROREFLECTIVE)
BACKGROUND - GREEN (RETROREFLECTIVE)

3/9/09

Appendix E, Freeway Exit Gore Signage: A Survey of State Practice and Related Research

Excerpt from Figure 2E-28, Exit Gore Signs

E5-1c, Narrow Exit Gore Sign

Image taken from:

Chapter 2E, Guide Signs—Freeways and Expressways, Texas Manual on Uniform Traffic Control Devices, Texas Department of Transportation, 2011 Edition, Revision 1, December 2011. http://ftp.dot.state.tx.us/pub/txdot-info/trf/tmutcd/2011_rev1/2e.pdf