U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **ACTION:** AASHTO Roadside Design Guide 4th Edition

Date: JUN 26 2012

From: Tony Furst
Associate Administrator

In Reply Refer To:
HSST

To: Division Administrators
Safety Field
Federal Lands Division Engineers

The AASHTO Roadside Design Guide (RDG) 4th edition was published in October 2011. The Office of Safety is distributing one copy to most FHWA field offices, with larger offices receiving two copies. The purpose of this memo is three-fold:

- Reiterate the status of the RDG for FHWA
- Summarize significant changes in the RDG 4th edition
- Add Frequently Asked Questions to our website

Status of the RDG for FHWA

Plans and specifications for projects on the National Highway System (NHS) must provide for facilities, including the roadsides that are conducive to safety. The RDG is included in the FHWA Policy and Guidance Center (PGC) as "guidance" for use when designing highway projects and addressing roadside issues on the NHS. The first edition of the RDG was adopted by the FHWA through the Federal Register, effective July 25, 1990, and recommended as the document States should use to develop roadside safety design policies. This memorandum supersedes the FHWA memorandum dated July 19, 1990 on the RDG adoption.

Each State highway agency should have a written policy for designing roadsides that incorporates wide clear zones, traversable drainage structures, and breakaway sign and lighting support structures in new construction and reconstruction and, to the extent practicable, in 3R-type projects. The roadside policy should also describe how other hazards may be relocated, modified, shielded, or delineated. The provisions of the AASHTO RDG should be used by each State to develop their roadside policy document.

Action

Each Division Office should: 1) encourage their State highway agency to have a written roadside policy, and 2) review their State's conformance with the RDG 4th edition. Where substantial differences are found, the State should be encouraged to update their practices to be in line with the current RDG.

cc: Directors of Field Services
John R. Baxter, Associate Administrator for Infrastructure, (HIF-1)
Jeffrey A. Lindley, Associate Administrator for Operations, (HOP-l)
Fred R. Wagner, Chief Counsel. (HCC- 1)

Attachments

Attachment No. 1 is a summary of major changes between the 4th edition and earlier editions.
Attachment No. 2 is a compilation of questions and answers.

Attachment #1

Significant changes in the RDG 4th edition

This section presents a brief outline of changes from the 3rd edition, plus provides additional detail on certain significant issues that may affect State design standards.

Chapter 1 – An Introduction to Roadside Safety

- Roadside crash statistics are updated.
- AASHTO Strategic Plan for Highway Safety and the NCHRP Report 500 Series of guides are referenced to help States in their efforts to reduce crash injuries and fatalities.
- References FHWA hardware eligibility letter Web Site for additional information on the eligibility of crash tested hardware for reimbursement under the Federal-aid Highway program.

Chapter 2 – Economic Evaluation of Roadside Safety

- Editorial updating only. The Roadside Safety Analysis Program (RSAP) is being re-written under NCHRP Project 22-27 "Roadside Safety Analysis Program Update" and will be available on-line when completed.

Chapter 3 – Roadside Topography and Drainage Features

- "Clear-Zone" terminology coordinated with AASHTO Green Book.
- Clear-Zone for auxiliary lanes defined.
- Curb discussion moved to Chapter 5.

Chapter 4 – Sign, Signal, and Luminaire Supports, Utility Poles, Trees, and Similar Roadside Features

- Update breakaway discussion re: AASHTO Manual for Assessing Safety Hardware (MASH) – pickup test, windshield damage, roof crush. Under NCHRP Report 350 the vehicle velocity change, the stub height, and the occupant risk numbers were the only "pass-fail" criteria, with incidental vehicle damage being subjective. Now, the MASH provides thresholds for deflection and penetration of the windshield and the occupant compartment of the test vehicle.
- Cites MUTCD breakaway requirement. The MUTCD requires all signs within the clear zone of all roads open to public travel in the United States to be mounted on breakaway/yielding structures, or be shielded with a crashworthy barrier. All new installations of signs on any road must be breakaway or shielded if located within the clear zone. Retrofits of non-breakaway supports are required by January 17, 2013, on roads with posted speed limits of 50 mph or greater.
- Recommends breakaway devices in urban areas as run-off-road crashes tend to occur at times of reduced pedestrian traffic.
- Notes that MUTCD requires that breakaway supports housing electrical components utilize electrical disconnects to reduce the risk of fire and electrical hazards after impact by a vehicle.

- Emphasizes the need for omni-directional supports at intersections and other locations where traffic approaches from various directions.
- Discusses high mast lighting supports and traffic signal supports. These are generally not considered for breakaway hardware but there are certain situations on high-speed roads where relocation of hardware or shielding should be considered.
- Refers to NCHRP Report 500, Volume 8 for dealing with utility poles.

Chapter 5 – Roadside Barriers

- References MASH and AASHTO FHWA Joint Implementation Plan. For details on the Implementation Plan, please see the AASHTO website: https://bookstore.transportation.org/imageview.aspx?id=709&DB=3
- Discusses motorcycles and barrier design. While various treatments are used in Europe, the U.S. is studying the extent and nature of motorcycle crashes into barriers. If U.S. crash experience shows that the European treatments can have a significant effect on the reduction of crash severity, then the treatments will need to be evaluated to see if they will adversely affect barrier performance under current MASH criteria.
- Links to Task Force 13 'A Guide to Standardized Highway Barrier Hardware' (Barrier Hardware Guide) and FHWA Eligibility Letters. The Barrier Hardware Guide is available at: https://www.aashtotf13.org/guide_display.php
- New W-beam systems, including MGS and the proprietary 31-inch systems. These are covered in detail in our May 17, 2010, memorandum, available here: http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/policy_memo/memo051710.
- Zone of Intrusion (ZOI) concept. The ZOI is the region measured above and beyond the face of a barrier system where an impacting vehicle or any major part of the system may extend during an impact. The amount of intrusion is related to the height and profile of the barrier, as well as the vehicle size, speed, and angle of impact. For Test Level 4 and higher, the designer should try to accommodate this additional clearance for ZOI.
- Revised discussion of guardrail behind curbs. Two designs of 31-inch tall guardrail have been successfully crash tested behind curbs.
- Runout lengths reduced for barrier design. This results in generally shorter "length of need" for barriers.
- Guardrail posts in rock or mow strips. Strong-post guardrail systems require the posts to be able to push through the soil upon impact. The RDG offers designs for leave-outs when placing posts in pavement or rock.
- Upgrading existing systems revised. The old RDG three inch +/- tolerance allowed guardrail that was much too low to remain in place. W-beam guardrail that is less than 26 ½ inches high after an overlay should be raised, reset, or reconstructed. While new installations must be at least 27 ¾ inches high, this guidance recognizes that it is not cost effective to raise an existing barrier if it is slightly lower. See the FAQs for guidance on raising guardrail.

Chapter 6 – Median Barriers

- 50 foot width for barrier warrant. This was introduced in the 2006 update to Chapter 6 and is incorporated into the 2011 4th Edition. Please note that Figure 6-1 in early printed

editions of the 2011 RDG show the incorrect graphics. Download the errata from the AASHTO Bookstore website.

- Details generic low-tension and proprietary high-tension cable barriers.
- Discusses median terrain effects on barrier performance and location. Further information on placing cable barriers on sloping terrain is available in the final report from NCHRP Project 22-25 to be covered in future FHWA guidance.
- All new and existing median barriers can be found in the Hardware Barrier Guide: https://www.aashtotf13.org/guide_display.php.

Chapter 7 – Bridge Railings

- Discusses MASH, and the AASHTO Load, and Resistance Factor Bridge Design Specifications (LRFD). The LRFD require 42-inch or 54-inch tall barriers to shield bridge piers that are not designed to withstand a 400-kip impact. NCHRP Project "Guidelines for Design and Shielding of Bridge Piers" will develop warranting criteria for these barriers, transition, and approach guardrail.
- Incorporates "Protective Screening at Overpasses" which was once a separate AASHTO guide.
- References Task Force 13 Bridge Rail Guide. All new and existing bridge railings can be found in the TF13 Bridge Rail Guide: http://guides.roadsafellc.com/bridgeRailGuide/index.php.

Chapter 8 – End Terminals

- Discusses grading in advance of and behind terminals.
- Lists numerous new terminals and crash cushions. All new and existing end terminals can be found in the Barrier Hardware Guide: https://www.aashtotf13.org/guide_display.php.
- Includes a table of Comparative Maintenance Requirements.

Chapter 9 – Work Zone Devices

- Generic and Proprietary Portable Concrete Barrier designs enumerated.
- Includes a discussion of how you can reduce deflection by pinning barriers and other treatments.
- Excellent discussion of water filled barriers vs. longitudinal channelizers and why it is important to distinguish the two.

Chapter 10 – Roadside Safety in Urban or Restricted Environments

- Describes "enhanced lateral offset" for use in urban areas where conventional clear zone widths are impractical. Research into cashes show that an enhanced lateral offset of 4 feet minimum, 6 feet desirable, will address most crashes in urban areas.
- Urban control zone concept: keep obstacles away from intersections, driveways, speed change lanes.
- Emphasizes 1.5 foot min lateral offset to obstructions is not a clear zone. This is a critical point to get across to designers. The 1.5 foot minimum distance behind a curb is and operational offset intended to accommodate truck mirrors and open car doors. It should not be used as a "clear zone."

Chapter 11 - Mailboxes

- Includes a discussion of heavy and hazardous mailboxes including vandal proof boxes and secure, locked mailboxes where they should not be placed.
- Advocates the use of lightweight plastic designs.
- Includes strategies for getting homeowners to allow replacement of hazardous rural mailboxes.

Chapter 12 - Roadside Safety on Low-volume Roads and Streets

- New chapter to the RDG addressing roads where the majority of fatal run-off-road crashes occur, but rarely have high accident locations that can be addressed with major improvements in a cost-effective manner.
- Emphasizes low cost systemic strategies of signing, pavement markings, and delineation to reduce run-off-road incidents.
- Provide as much clear zone as is practical to address crashes involving trees, utility poles, and rollovers on embankments.

Attachment #2

FHWA Frequently Asked Questions

The following questions and answers offer clarification on certain roadside issues not covered by FHWA policy or topics that simply need additional explanation.

Roadside Design Guide:

Q1.) What if my state challenges all or part of the Roadside Design Guide?

A1.) The Roadside Design Guide is neither a standard nor a design policy. It is intended to be used as a resource document offering guidance 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.

Guardrail:

Q1.) Is it appropriate to use re-galvanized or salvaged guardrail posts and rail in longitudinal barriers for new construction and/or maintenance repair projects?

A1.) No, only new posts and rails that are accompanied by a material certification should be allowed on Federal-Aid projects or on NHS routes. FHWA also recommends that State DOTs should not use salvaged or reconditioned guardrail material on State projects off the NHS because w-beam guardrails are at performance limits when all the materials used conform to specifications. Non-documented components should not be used.

New steel guardrail posts should conform to AASHTO M270 / ASTM A-36 steel and AASHTO M111 / ASTM A-123 for the galvanizing. New W-beam rails should conform to AASHTO M-180 specifications. When delivered to construction sites, these components are typically accompanied by mill certifications. Salvaged material is often an assortment of varying ages, bolt-hole locations, steel grades, etc. State highway agency should be able to track and verify the source of these materials to ensure the barrier will perform as designed because it is difficult to establish that salvaged guardrail material meets proper specifications. The use of new material is recommended.

An exception exists where "remove and reset" conditions apply. If the highway agency approves the condition of the in-situ barrier components, then it may be adjusted to current specifications within the limits of the project.

Concerns about the environmental aspects of old guardrails may be reduced because most salvaged posts and rails are recycled and used to produce new steel. FHWA's general guidance on salvage credit is located at:
http://www.fhwa.dot.gov/programadmin/contracts/core02.cfm#s2C06

Q2.) Is it appropriate to use re-straightened guardrail w-beam panel?

A2.) No. W-beam rail is placed under significant tensile loading when the barrier is impacted. A minimum 27 ¾ inch high w-beam rail is at its performance limit when tested to the AASHTO Manual for Assessing Safety Hardware (MASH) Test 3-31 using the quad cab pickup truck at 25 degrees and 100 km/hr. Any potential alteration of the strength of the rail by deformation during an impact or by re-straightening could compromise its performance.

Useful FHWA links:

W-Beam Guardrail Repair Guide
http://safety.fhwa.dot.gov/local_rural/training/fhwasa08002

Criteria for Restoration of Longitudinal Barriers
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_656.pdf

Task Force 13 Guide to Standardized Highway Barrier Rail Hardware:
http://www.aashtotf13.org/Barrier-Hardware.php

Q3.) How do you handle guardrail posts when using in expanded polystyrene (EPS) fill, the geofoam, lightweight fill since it won't create the support needed for proper resistance of the guardrail when hit? Can you simply extend the posts?

A3.) There are a few ways to do this: 1) bury the EPS deep enough and cover with conventional soil that develops the length needed, 2) construct as a moment slab and barrier (similar to Mechanically Stabilized Earth walls), or 3) use a load distribution slab (a reinforced concrete slab overlying the EPS) an anchor the guardrail in it.

Q4.) Would drilling a new hole in the Midwest Guardrail System (MGS) guardrail weaken the system?

A4.) FHWA does not recommend altering a conventional w-beam rail by drilling new holes to accommodate the MGS. If the rail does not come with slots pre-punched at the 3' 1 1/2" mark, attempting to drill a new hole may compromise the performance of the rail or constrain its lateral movement. The cross section of all w-beam rail is already reduced at the splices, and there is a hole at the mid-span location. Providing additional factory-punched holes or slots at the 3' 1 1/2" marks does not reduce the effective cross-section.

Q5.) Are there other products (w-beam guardrail systems and terminal sections) currently being tested?

A5.) Yes, research sponsored by the NCHRP and pooled fund studies at the Midwest Roadside Safety Facility (Lincoln, NE) and the Texas Transportation Institute (College Station, TX.) is underway. Placement next to slope break points, transitions, terminals, etc., will be tested and/or evaluated. Proprietary terminals are also being developed and tested under MASH criteria.

Guardrail Height:

Q6.) Have terminal sections for 31" w-beam guardrail been found eligible without blockouts or do all systems have either 8" or 12" blockouts? Can they be used with systems without blockouts?

A6.) Currently eligible terminals for 31" guardrail were listed in Appendix C of our May 17, 2010 memo: http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/policy_memo/memo051710. Appropriate terminals are also listed in Chapter 8 of the RDG. Alternatively, a 27 or 27 ¾ inch terminal may be installed and transitioned to 29 inches or 31 inches when you reach 25 feet beyond the downstream end of the terminal. The terminal manufacturer should be consulted for current design details.

Q7.) What about the national trend to go greener and the growing preference for smaller, lower profile vehicles? Is a higher rail needed for the future?

A7.) "Green" vehicles such as battery powered cars are larger and heavier than the 820C test vehicle of NCHRP Report 350, so the additional rail height should not be detrimental when considering the future vehicle fleet.

Q8.) Will there be similar new height requirements for box beam rail?

A8.) No. The metric version of the box beam is 27 1/6 inches tall, and that is the height at which it was tested. The difference from a 27" high box is negligible, especially since the box beam is a weak post system where the box separates quickly from the post and stays in contact with the vehicle.

Q9.) Have there been a statistically significant number of crashes and/or fatalities with the lower height rail that is driving the increase in height or is it all based on crash testing and simulation?

A9.) The recommendations for increased w-beam height are based on crash testing and an increase in the number of high center-of-gravity vehicles currently traveling on highways and roads compared to the 1960's when the 27-inch standard was set.

Q10.) Would a nominal height of 29" +/- 1" with an 8" blockout be acceptable? At what height is a 12" blockout recommended? Can you adjust the simulation to test heights between 27-3/4 and 31"?

A10.) Conventional G4 (1S) strong-post guardrail at 29 inches to the top of the rail should have 8-inch blockouts. The size of the blockout is not simply a factor of the height of the guardrail. When the 30- inch maximum height of the G4(1S) guardrail is exceeded an entirely different system is encountered. The generic MGS system with a nominal height of 31" has a blockout that is 12 inches deep, and splices between the posts. The MGS and some of the proprietary 31" systems have the advantage that they will also meet crash test criteria at lower heights, but

should be installed at 31" (or slightly higher to accommodate forthcoming overlays). This is also discussed in Chapter 5 of the RDG.

Q11.) How was the 31" height selected? Did small car performance, testing, or simulation play a role?

A11.) In the early 2000's the Midwest Roadside Safety Facility (MWRSF) conducted a study to develop a better-performing roadside barrier. That research indicated that the performance of the G4 (1S) strong steel post guardrail improved when the splices were moved to mid-span. Increasing the blockout depth also improved crash test performance, as did raising the height of the rail from 27 3/4" to 31" which reduced the embedment of the post. The MGS represents the combination of these factors. The MGS has also been crash tested with 8" blockouts and Texas DOT is currently (June 2012) preparing to submit a Request for Eligibility.) Other systems were subsequently developed that also have a 31-inch mounting height.

Q12.) When do you need to raise the guardrail when an overlay has reduced the height?

A12.) The AASHTO Roadside Design Guide, 4th Edition, states that guardrail that is at least 26 ½ inches high after an overly may remain in place. (See RDG p. 5-17)

Q13.) How high do you need to raise guardrail that is lower than 26 ½ inches? What are the best ways to do that?

A13.) The guardrail should be raised to 29 inches, which represents the target height for new installations of strong post w-beam systems. If the pavement work requires the barrier to be moved, then the posts should be carefully extracted and, if in good condition, re-driven at the new location so that the rail will be at 29 inches. If the barrier does not need to be moved, then raising the blockout up to three inches is a common practice. This will require field drilling or punching of a new hole in the guardrail post.

Guardrail Terminals:

Q14.) I thought a non-gating terminal captured everything that hit it?

A14.) Under the criteria of NCHRP 350, capturing every vehicle that impacts the nose of the terminal was not a requirement for a non-gating system. The test with a 2000P vehicle impacting at an angle of 15 degrees on the nose of the system (Test 3-33 for 100 kph) can have the vehicle penetrate the system and proceed a considerable distance behind it. However, under the new MASH criteria, there is a specific requirement for non-gating systems that any hit on the nose or near the nose "should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate . . . ." Therefore, the criteria being used, (NCHRP Report 350 or MASH) dictates whether a system should be called "gating" or "non-gating." So, it is important to know how a system performs and where the impacting vehicle will end up under each of the required impact tests on the nose - zero degrees, at an angle (5-15 degrees depending on the criteria), or on the side.

Regardless of the type of system being used, a safe runout distance is needed beyond the beginning of the system, either for the situation where the vehicle passes through the system, or where the vehicle just misses the end of the system and continues behind it. Likewise, proper grading providing an essentially flat pad and traversable side slopes to ensure stability of the vehicle is needed, regardless of the type of system. The terminal is only re-directive beyond the point of length of need, which should be specified by the manufacturer.

Concrete barriers and bridge rails:

Q15.) May a decorative texture or graphic design be added to the face of a crashworthy concrete barrier?

A15) Yes, but the relief of that texture is subject to certain limitations. These limitations are detailed in the NCHRP Report 554 "Aesthetic Concrete Barrier Design." http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_554.pdf

Miscellaneous:

Q16.) May computer modeling be used as a substitute for full-scale crash testing of new devices?

A16.) No. FHWA determination of Federal-aid reimbursement eligibility of roadside hardware is performance-based, which means full-scale crash testing under the AASHTO Manual for Assessing Safety Hardware is needed to establish such eligibility. Manufacturers developing new hardware are encouraged to use Finite Element Analysis (ie: LS-DYNA) to develop their device using the Verification and Validation process as detailed in NCHRP Web-Only Document 179 (Procedures for Verification and Validation of Computer Simulations Used for Roadside Safety Applications (V&V)) procedures in efforts to refine their designs and reduce the cost of developmental crash testing. For existing devices that have already demonstrated that they comply with NCHRP Report 350, certain minor modifications to the system may be evaluated using Finite Element Analysis. In addition, any Finite Element Analyses that are submitted to FHWA as part of the documentation package for determining eligibility for reimbursement under the Federal-aid highway program should be accompanied by a Verification and Validation Report as detailed in NCHRP Report 22-24.

Q17.) Do we need to have the vertical devices (road tubes, vertical panels, etc.) in place when crash testing a "curbing" system as a work zone device in Category II.

A17.) Yes. MASH section 3.4.1 states "The test article should be constructed and erected in a manner representative of in-service installations and should conform to specifications and drawings of the manufacturer or designer." The FHWA has issued several letters for curbing systems since 2002 and the tests themselves have evolved to incorporate vertical elements starting in 2004. Over the next several years, more and more tests incorporated "delineator" style vertical elements as this became the in service condition of nearly all curbing systems utilized in this country.

In an attempt to improve roadway safety and to evaluate systems that are reflective of in service conditions, all future test documentation should include the vertical elements that the manufacturers market with the curbing systems.

Q18.) Is it OK to add a decorative shell or casting to a breakaway light pole to make it more aesthetic?

A18.) Adding decorative hardware to a breakaway luminaire support might affect proper performance. Thus, aesthetic or decorative modifications should be crash tested.