

Clarifications on Implementing the AASHTO Manual for Assessing Safety Hardware, 2016

May 2018

The following Q&A document has been developed for the purpose of clarifying and implementing the *Manual for Assessing Safety Hardware* (MASH), which is published by the American Association of State Highway and Transportation Officials (AASHTO). This document has been approved by AASHTO and FHWA for dissemination to the roadside safety hardware community. The responses below were developed by a joint AASHTO/FHWA technical working group of representatives from state transportation departments, the Federal Highway Administration, and accredited crash testing laboratories.

For answers to specific questions about the federal-aid eligibility process, please see FHWA's [Roadside Hardware Policy Memoranda and Guidance](#).

IMPLEMENTATION

What is included in the December 31, 2017, sunset date in the AASHTO/FHWA Joint Implementation Agreement?

The AASHTO/FHWA Joint Implementation Agreement states that for contracts on the National Highway System with a letting date after December 31, 2017, new permanent installations and full replacements of w-beam barrier and cast-in-place concrete barrier must be MASH 2016-compliant. This sunset date is intended to cover standard installations. Special applications of these devices, such as barriers utilizing reduced post spacing, barriers installed on a flare, barriers mounted behind curbs, and barriers located at bridge ends in restricted areas, are included in the December 31, 2019, sunset date for "transitions" and "all other longitudinal barriers."

For additional information on system configurations that are planned for crash testing, see [A Synthesis of MASH Tested 31-in. Tall, Non-Proprietary, W-Beam Guardrail Systems](#), dated February 27, 2017.

What is the definition of "letting date"?

The letting date is equivalent to the owner-agency's definition of "bid opening date" for traditional design-bid-build projects. For design-build projects, the date on which the funding is obligated may be used.

How is it determined whether a modification to a device is significant or non-significant?

A significant modification to a device is a modification that adversely affects the crashworthy performance of the device based on the crash testing criteria in MASH. Owner-agencies may make determinations as to whether a modification is significant and what additional testing and/or engineering analysis is required for them to approve a modified device.

TEST VEHICLES

What is an acceptable model year for a test vehicle?

MASH 2016, Section 4.2.1, p 147, is clarified as follows: Passenger vehicles used for crash testing should

be 6 years old (or less) when the test occurs. Regardless of age, test vehicles should adhere to the properties specified in MASH. For situations where the vehicle is more than six years old, the test facility must document and certify that all other stipulations regarding the condition and configuration of the vehicle provided in MASH 4.2.1 and MASH A4.2.1 are met and address all properties that are outside of tolerances set in MASH Table 4-1.

Note that the 6-year limit is not a requirement for heavy trucks. MASH 2016, Section 4.2.1, states, "Although it is cost-prohibitive to apply the 6-year limit to heavy truck test vehicles, it is desirable to utilize vehicles of recent vintage. Heavy truck test vehicles should be representative of widely used designs." In addition, MASH 2016, Section A4.2.1, states that, "Whenever possible, it is recommended that heavy trucks not be more than 12 model years old." Thus, for heavy truck test vehicles that are older than 12 years, the test facility must document and certify that all other stipulations regarding the condition and configuration of the vehicle provided in MASH 4.2.1 and MASH A4.2.1 are met and address all properties that are outside of tolerances set in MASH Table 4-2.

May NCHRP Report 350 small car tests be used to determine MASH crashworthiness for breakaway devices (e.g., small sign supports)?

The crashworthiness of breakaway devices under MASH cannot be determined using NCHRP Report 350 small car tests (820C), as the small car properties in MASH, including mass and dimensions, are different from NCHRP 350. In addition, the use of a MASH-compliant test vehicle enables test results to be used as a baseline on which to justify the crashworthiness of any future modifications to a device.

Are cab-over-engine trucks acceptable for use in crash testing?

Cab-behind-engine models are encouraged, but not required, for testing at TL-4, TL-5, and TL-6, as stated in MASH 2016, Section 4.2, p 82: "All heavy truck test vehicles should incorporate a cab-behind-engine configuration, not a cab-over-engine design."

Can surrogate testing be used for low-speed performance evaluation of small sign supports in lieu of full-scale testing under MASH?

All sign supports should be evaluated to MASH criteria. MASH 2016, Section 4.2.2, p 96, states that "Surrogate test vehicles, including pendulums and bogie vehicles, may be used to evaluate the impact performance of breakaway systems and work-zone traffic control devices." However, no MASH-compliant bogie vehicle currently exists for testing.

TEMPORARY TRAFFIC CONTROL DEVICES

Must all variations of a given device (such as a work zone device) be crash tested?

Owner-agencies may accept modifications made to or variations of a tested device based on engineering analysis and/or additional crash testing in accordance with MASH.

May "Category 1" devices (i.e., drums, cones, road tubes) be self-certified by the manufacturer as crashworthy?

Low-mass, single-piece traffic cones, tubular markers, single-piece drums, and delineators (known as Category 1 devices under NCHRP 350) may be manufacturer-certified as MASH-compliant as long as

there are no attachments to the device. If there are attachments, crash testing and/or evaluation to MASH criteria is required.

If an attachment to a “Category 1” device, e.g., a warning light attached to a cone, is tested on Manufacturer A’s cone, must it be tested on Manufacturer B’s equivalent cone as well?

Owner-agencies may accept modifications made to a tested device based on engineering analysis and/or additional crash testing in accordance with MASH.

May two temporary work zone signs be tested in one test run?

Two free-standing work-zone traffic control devices of light mass (< 100 kg) may be tested in a single crash test. See MASH 2016, Section A2.2.4, p 136, for additional discussion, which includes the following: "Note that many testing agencies impact two work-zone traffic control devices in a single run. The devices are placed to impact opposite quarter points of the front of the vehicle. Device spacing is selected such that the first device is usually completely disengaged from the test vehicle before it strikes the second device. In some cases, the first device does not disengage or it produces sufficient damage that it is impossible to determine the extent of windshield damage for the second device. In these situations, the second device should be retested."

Is rear window damage (e.g., due to a tall breakaway or work zone device) cause for failure of a test?

Currently, there are no defined criteria for rear window damage in MASH. Until additional research is conducted, no penetration of any element of the test article through the rear window is allowed. Deformation and/or shattering of the rear window is acceptable if within intrusion limits. A detailed description of the events surrounding the deformation and/or shattering event must be provided by the testing facility.

Is floor board penetration or tearing (e.g., from sign stand legs, cable posts, frangible sign supports, etc.) cause for failure of a test?

A separation of floor board seams is allowable under MASH criteria, however because cutting or tearing of the floor board by the test article is evidence of penetration, it is cause for failure. Until additional research is conducted, no penetration of any element of the test article through the floor board is allowed. See MASH 2016, Section 5.2.2, p 106, which states, "...a seam separation by itself is not considered a test failure unless (1) a component of the safety device protrudes through the opening or (2) the deformation limit of 12 in. is exceeded."

May breakaway slip bases, frangible couplings, and similarly-defined breakaway devices that have been successfully tested in strong soil be mounted in or on paved surfaces?

Testing conducted with posts driven into strong soil is considered equivalent to testing conducted with posts driven into a combination of asphalt pavement and strong soil. However, devices securely attached to concrete pavement and devices driven into weak soil must be tested separately.

Are devices known as “Category 4” devices under NCHRP 350 (such as portable, changeable-message sign (PCMS) trailers, temporary traffic signals, and camera trailers) exempt from crash testing?

MASH contains crash testing criteria for devices previously known as “Category 4” devices. See MASH 2016, Section 2.2.3, p 36, “Truck- and Trailer-Mounted Attenuators and Portable Work-Zone Traffic

Control Trailers.” The AASHTO/FHWA Joint Implementation Agreement states that temporary work zone devices manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH.

How long may portable concrete barriers and “Category 4” devices, such as trailer-mounted arrow boards, variable message signs, etc., meeting NCHRP Report 350 crash test criteria remain in use?

As stated in the AASHTO/FHWA Joint Implementation Agreement for MASH, "Temporary work zone devices, including portable barriers, manufactured after December 31, 2019, must have been successfully tested to the 2016 edition of MASH. Such devices manufactured on or before this date, and successfully tested to NCHRP Report 350 or the 2009 edition of MASH, may continue to be used throughout their normal service lives." Temporary work zone devices include, but are not limited to, all devices that were known as “Category 4” devices under NCHRP 350, including truck- and trailer-mounted attenuators. Note that individual transportation agencies/facility owners may opt to specify MASH-compliant devices sooner than stated in the joint implementation agreement.

Who determines the “service life” for NCHRP Report 350-compliant work zone devices?

The owner-agency determines the service life of a work zone device. Decisions may be based on the use of a standard device lifetime, compliance with functional and/or visibility guidelines, or some other method.

Must individual barricade units that have been successfully crash-tested as stand-alone devices be retested if they are to be connected and used as longitudinal channelizers?

Yes. If a device is to be used for a different purpose, it needs to be tested for that purpose. See MASH 2016, Section 2.2.4.1, p 40, which states, "For systems intended to be used as stand-alone barricades, the device should be tested as a barricade. For systems designed as positive barriers, it should be crash tested as a permanent or temporary barrier as presented in Section 2.2.1. For longitudinal channelizers, or any channelizing device incorporating individual elements that are connected to form a continuous unit, these systems are considered a separate class of hardware with different testing and evaluation guidelines, as described in Section 2.2.4.2 under tests 90 and 91."

Do surface and road markers need to be tested to MASH?

There are no criteria for testing surface and road markers in MASH.

TESTING PARAMETERS

If a door opens during a crash test, is that cause for failure of a test?

Until additional research on this topic is conducted, a door opening during a crash test is not considered cause for test failure in and of itself; however, penetration of the test article and/or intrusion limits must be verified. If one or more doors open during a crash test, the test facility must document the level of intrusion and whether it exceeds the appropriate MASH criteria.

How are vehicle override and underride determined?

Override of a barrier is considered to occur if, after traveling over the uppermost element of the barrier, any part of the test vehicle touches down on the far side (i.e., non-traffic side) of the barrier. Regarding

underride, until additional research is conducted, the following guidance may be used: underride is considered to occur if the vehicle comes to rest beyond the initial traffic face of the barrier and no structural member of the barrier remains in contact with a side element of the test vehicle.

BARRIERS

Which MASH 2009-compliant barriers need to be re-evaluated to MASH 2016?

Cable barriers and terminals that were tested successfully to MASH 2009 criteria will require additional review to determine if supplemental testing is required to meet MASH 2016 criteria.

Do MASH-compliant, crashworthy, concrete barriers or concrete bridge railings that are constructed taller, wider, or stronger need to be re-tested?

The geometry and strength of the concrete barrier (and, in the case of bridge rail, its connections) need to be considered to determine its crashworthiness. As barriers get taller, impact loads increase because more of the vehicle is being engaged with the barrier. Thus, if a MASH-compliant, crashworthy, concrete barrier or bridge rail is intended to be constructed taller, then a strength calculation needs to be completed to determine if the higher load anticipated during a crash will be accommodated. If the calculated load cannot be accommodated, then additional internal reinforcement may be necessary. If the same MASH-compliant barrier is constructed wider or stronger, there is no need for a barrier strength calculation. See the *AASHTO LRFD Bridge Design Specifications* and your state's bridge design specifications for additional information on the strength calculation.

Does a crashworthy bridge railing/concrete barrier need to be retested when the rebar details are adjusted to match an agency's typical bridge deck or foundation reinforcement pattern?

If the strength of the barrier and the strength of the connections are the same or greater (determined by a strength calculation) and the shape of the barrier has not changed, then no retesting is required. See the *AASHTO LRFD Bridge Design Specifications* or your state's bridge design specifications for additional information on the strength calculation.

Do safety shape, single slope, constant slope, and vertical concrete barriers or bridge rails meeting NCHRP Report 350 TL-5 and TL-6 crash test criteria also meet MASH TL-5 and TL-6 crash test criteria?

If a solid, cast-in-place concrete barrier or bridge rail (such as a safety shape, single slope, constant slope, or vertical shape), with no potential snagging elements on top, has been successfully tested to NCHRP Report 350 criteria for TL-5 or TL-6, then that barrier may be considered equivalent to MASH 2016 TL-5 or TL-6 criteria. Additional information may be found in the following NCHRP research reports: [MASH Equivalency of NCHRP Report 350-Approved Bridge Railings](#) and [Evaluation of Existing Roadside Safety Hardware Using Updated Criteria](#).

May MASH-compliant, crashworthy w-beam, box beam, and cable barriers be used with reduced post spacing (to reduce design deflection) without the need for additional crash testing?

The crash test matrix in MASH for cable barrier provides guidance on the appropriate range of post spacings for testing (i.e., which tests should use wider or narrower spacing). For semi-rigid barriers, including w-beam and box beam, additional evaluation to MASH criteria is required if post spacing is reduced.

Do MASH TL-3-compliant devices automatically meet MASH TL-1 and TL-2?

Yes. Devices meeting MASH TL-3 crash test criteria can be considered for use as MASH TL-1 and TL-2 devices.

May crash cushions be connected to concrete barriers using previously-crash-tested guardrail-to-bridge-rail transition hardware?

This configuration needs to be evaluated to MASH 2016 criteria. Owner-agencies may approve different combinations based on testing and/or engineering analysis.

How should road closure nets be tested?

There is currently no MASH test matrix for these devices. Until additional research is conducted, owner-agencies may work with researchers and/or test facilities to develop a testing matrix that evaluates the range of a system's parameters, including varying lengths. Any test matrices developed through research will be considered by AASHTO for future inclusion in MASH.