

QPL 45: MASH APPROVED ROADSIDE SAFETY HARDWARE

GENERAL

The current TDOT-adopted guidance to evaluate the safety and performance of roadside safety hardware is AASHTO's "Manual for Assessing Safety Hardware" (MASH). Roadside safety hardware selection and placement guidance can be found in the AASHTO "A Policy on Geometric Design of Highways and Streets and Roadside Design Guide". Roadside safety hardware installed on all TDOT owned and maintained roadways shall be crashworthy. This document provides guidance in regards to TDOT's evaluation process to determine crashworthiness of roadside safety hardware.

Beginning January 1, 2020, FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully tested to the 2016 edition of MASH. Evaluation and documentation of roadside safety hardware shall follow MASH evaluation criteria. TDOT process for the determination of crashworthiness follows:

New and Proprietary Products

Per the Joint MASH Implementation Agreement (dated January 7, 2016 and amended June 26, 2018) between FHWA and AASHTO, all new hardware shall be evaluated by the crash matrix for different hardware categories as provided by the current addition of MASH (currently 2016 version). If the new hardware has been developed using a previously tested device and/or component, a "Test Requirements and Evaluation Criteria" section of the report shall provide all related background information.

Existing and Proprietary (In-Service) Hardware Modifications

Modifications to NCHRP 350 evaluated existing products shall follow MASH evaluation processes. Modifications to MASH evaluated products do not require the product to be tested with complete MASH test matrix if an engineering assessment and/or professional judgement is used. If there is any supplemental information available in regards to the in-service performance of a modified device, the data shall be provided to TDOT.

Generic Roadside Safety Hardware

Generic hardware developed by a pooled fund research [Texas Transportation Institute (TTI) at Texas A&M University or Midwest Roadside Safety Facility (MwRSF) at University of Nebraska], other DOTs, NCHRP, or FHWA Research Office will follow the below guidance. Third party review and endorsement, and signed sealed shop drawings are not required since the standard drawings will be developed and distributed by the department.

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SPECIFICATIONS

- AASHTO Manual for Assessing Safety Hardware (MASH)
- AASHTO “A Policy on Geometric Design of Highways and Streets and Roadside Design Guide”
- TDOT Standard Operating Procedure 6-1: Specialty Items, Procedures and Qualifications for Guardrail Manufacturer and Supplier

PROCEDURES

An evaluation package of the proposed roadside hardware must be submitted to TDOT. At a minimum, this package shall contain the following **in digital format**:

1. TDOT Product Evaluation Submittal form
2. Hardware evaluation report, videos, and pictures
3. Third party Professional Evaluation/Endorsement Letter
4. Shop drawings that have been signed and sealed by an engineer registered in Tennessee or a state recognized by the Tennessee Board of Engineers and Architects
5. Hardware installation manual and inspection checklist.

The evaluation package should describe the additional safety benefits of the tested hardware if there are any available. For example, excess capacity beyond the minimum required values, or improved driver safety features such as lowered occupant impact velocities and occupant ride down accelerations data. Other supplemental information such as FHWA Eligibility letter, third party evaluation and endorsement letter, if needed, as well as other state DOT approval letters must be submitted.

HARDWARE EVALUATION REPORT

The report format shall follow *Section 6, Test Documentation* of the current AASHTO MASH.

Test Requirements and Evaluation Criteria

The safety and performance evaluation of a device or a component of a system often requires background review and/or use of existing studies and reports. All additional methods used during the evaluation, pendulum and/or bogie testing, Finite Element Analysis (FEA) to assess the performance of a system or a component of a device during the evaluation shall be cited clearly and be easily accessed on line or a file transfer protocol (FTP) site.

If an *engineering assessment and/or professional judgment* is used to abbreviate the crash test matrix or as rationale not to conduct certain crash tests, it shall be explained clearly in this section of the report.

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All pictures and crash test videos associated with the testing of the hardware as determined by the testing agency shall be submitted with the report.

Crash Test Facility

Testing shall be completed at an accredited crash test facility conforming to International Organization of Standardization (ISO) 17025. If the tested article is developed by the employees of a testing agency or a parent company, then a third-party must conduct an evaluation and provide an endorsement letter. Financial disclosure information showing monetary compensation shall be provided as well. Testing facility plant certification, and/or equipment calibrations may be required.

Third Party Professional Evaluation and Endorsement Letter

Third party professional evaluation and endorsement letter (preferably prepared by TTI or MwRSF) shall be required to demonstrate that the device has been satisfactorily evaluated as described in the Hardware Evaluation Report section. The letter shall disclose financial (monetary compensation) and trade independency from the tested device.

TDOT REVIEW PROCESS

A TDOT committee comprised of representatives from the Design, Maintenance, Materials and Tests, Operations, Construction, Traffic Operations, and Occupational Health and Safety Divisions will review the submitted evaluation package.

The Department will further evaluate a submitted roadside safety device from the performance, installation, and maintenance perspectives—installation difficulties, repair time, parts availability, and use of conventional hardware components. Evaluation may include other considerations such as in-service performance of similar devices.

The generic hardware that is used or will be used by the department may have been developed by a pooled fund study, NCHRP, other DOTs, or the FHWA research center. The department will review the reports to evaluate the crashworthiness of a generic device. Third party professional evaluation, endorsement letters, and signed sealed shop drawings will not be required.

Other Information

Due to complexity and performance, crash cushions are the most complicated and expensive roadside safety devices. In addition to MASH crash test performance, these devices will be further evaluated and categorized by TDOT, using criteria such as self-restoring vs. low maintenance.

While TDOT's intention is to allow all developed hardware to be evaluated and available for use, TDOT assumes the right to refuse to review any device submitted, or to decline approval of a

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hardware device with no further explanation. TDOT may request additional tests beyond the minimum required by MASH. TDOT assumes all referenced documents in a submittal package are the best engineering practices represented by the state-of-the-art research agencies and testing laboratories. All legal litigations must be disclosed and justified.

Hardware and products determined acceptable for use will be placed in the appropriate Qualified Products List (QPL). TDOT retains the right to remove any hardware or product from the QPL at any time.

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Product Categories

TDOT QPL 45 product sections are outlined in the table on the following page entitled QPL SECTIONS AND MASH REFERENCES. These sections generally follow MASH 2016, but the sections for work zone devices generally follow the four categories used in the National Cooperative Highway Research Program (NCHRP)-350 and supported by the American Traffic Safety Services Association (ATSSA).

Longitudinal Barriers (and associated items), **Guardrail End Terminals**, and **Crash Cushions** must be tested to the full matrix of MASH 2016 requirements. If products in a category that meet MASH 2016 requirements do not exist, NCHRP-350 devices on QPL 34 may be used. Additionally, if there are no products in a MASH category that meet the Department's requirements, then NCHRP-350 devices on QPL 34 may be used.

The following **Category I through Category IV 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 the normal service life of the product and not after 2030.

Category I Work Zone Devices, which include cones, tubular markers, plastic drums and STOP/SLOW paddles, are not required to be tested to MASH standards. Rather, as under NCHRP Report 350, the manufacturer must submit a self-certification that the device meets MASH 2016 standards.

Category II and III Work Zone Devices must be tested to the full matrix of MASH 2016 requirements. Subsequent modifications to a tested device will be evaluated on a case-by-case basis by the TDOT MASH Committee to determine if additional crash testing is needed.

No crash testing will be required for **Category IV Work Zone Devices** (except for truck- and trailer-mounted attenuators) until a testing matrix is developed and TDOT can evaluate the crashworthiness of the portable work zone control trailers that carry devices such as variable message signs, variable speed limit signs, speed feedback devices, arrow boards, temporary signals, and work zone lights. Once testing matrices are developed for this category of products, the TDOT MASH Committee will evaluate products submitted for approval and approve those that meet the full matrix of MASH 2016 requirements. Subsequent modifications to a tested device will be evaluated on a case-by-case basis by the TDOT MASH Committee to determine if additional crash testing is needed.

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QPL SECTIONS AND MASH REFERENCES

TDOT PRODUCT CATEGORY	MATERIAL CODE	UNIT	MASH 2016			
			SECTION	PAGE	TEST MATRIX TABLE(S)	PAGE(S)
QPL 45 Section A: Longitudinal Barriers						
W-Beam Guardrail	QPL.45.001	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Thrie Beam Guardrail	QPL.45.002	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Cable Barrier Systems	QPL.45.003	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Bridge Parapets, Concrete	QPL.45.004	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Bridge Parapets, Combination	QPL.45.005	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Bridge Parapets, Metal	QPL.45.006	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Alt. Systems: Roller barriers	QPL.45.007	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Alt.: TL-5 Median barrier systems	QPL.45.008	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Alt.: Aesthetic systems	QPL.45.010	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Other (Attachments): Glare protection	QPL.45.011	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Others (Attachments): Fence attachments (generic system for motorcycle safety or WZ access control)	QPL.45.012	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
Anchors for Longitudinal Barriers	QPL.45.013	EACH	2.2.1	13	2-2A, 2-2B	15, 16
QPL 45 Section B: Guardrail End Terminals						
Tangential	QPL.45.014	EACH	2.2.2	25	2-3	27-29
Flared	QPL.45.015	EACH	2.2.2	25	2-3	27-29
Median Guardrail End Terminals	QPL.45.016	EACH	2.2.2	25	2-3	27-29
QPL 45 Section C: Crash Cushions (Redirective Only)						
Reusable	QPL.45.017	EACH	2.2.2	25	2-3	27-29
Low Maintenance	QPL.45.018	EACH	2.2.2	25	2-3	27-29
Self-Restoring	QPL.45.019	EACH	2.2.2	25	2-3	27-29
QPL 45 Section D: Category I Work Zone Devices						
Plastic or Rubber Cones	--	LS	Products are self-certified per project IAW Standard Specifications			
Flexible Delineator Posts/Tubular Markers (surface and ground-mounted)	916.08.027	EACH	Products are self-certified. Refer to QPL List 1 for these items			
Work Zone Traffic Drums	QPL.01.005	EACH				
Lights for Work Zone Traffic Drums	QPL.45.024	EACH	Products are self-certified. Under review.			
Pedestrian Channelizers (< 100 lbs.)	QPL.45.009	--	As required in accordance with MASH 2016 and/or self-certification			
QPL 45 Section E: Category II Work Zone Devices						
Longitudinal Channelizers for Traffic Control (gating devices with more than 5 foot deflection)	QPL.45.025	L.F.	2.2.4	39	2-5	42
Mobile WZ Devices: Movable barriers (quick change)	QPL.45.026	L.F.	As required in accordance with MASH 2016 and/or self-certification			
Mobile WZ Devices: Mobile barriers	QPL.45.027	L.F.				
Other Lightweight TCDs	QPL.45.028	--				
QPL 45 Section F: Category III Work Zone Devices						
WZ Barriers: Portable precast concrete, free-standing	QPL.45.029	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
WZ Barriers: Portable precast concrete, anchored	QPL.45.030	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
WZ Barriers: Steel, anchored	QPL.45.031	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
WZ Barriers: Steel, free-standing	QPL.45.032	L.F.	2.2.1	13	2-2A, 2-2B	15, 16
WZ Crash Cushions: Non-gating (permanent devices, may not need foundation)	QPL.45.034	EACH	2.2.2	25	2-3	27-29
Other TCDs (≥ 100 lbs.)	QPL.45.041	--	Determined by product type			
QPL 45 Section G: Category IV Work Zone/Traffic Control Devices						
Attenuators: Truck-mounted	QPL.45.035	EACH	2.2.3	36	2-4	37
Attenuators: Trailer-mounted	QPL.45.036	EACH	2.2.3	36	2-4	37
WZ/TCD: Variable message signs	QPL.45.037	EACH	MASH test matrices have not yet been developed for these categories of products. These products must be delineated and/or shielded with a MASH-approved positive protection device.			
WZ/TCD: Arrow board trailers	QPL.45.038	EACH				
WZ/TCD: Temporary signals	QPL.45.039	EACH				
WZ/TCD: Work zone lights	QPL.45.040	EACH				
WZ/TCD: Other trailer-mounted devices (AFAD, SAWS, DAD, etc.)	QPL.45.033	EACH				