

MASH Requirements for Safety Hardware

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Outline

- What is “MASH”?
- When is Implementation needed?
- Why is Implementation needed?

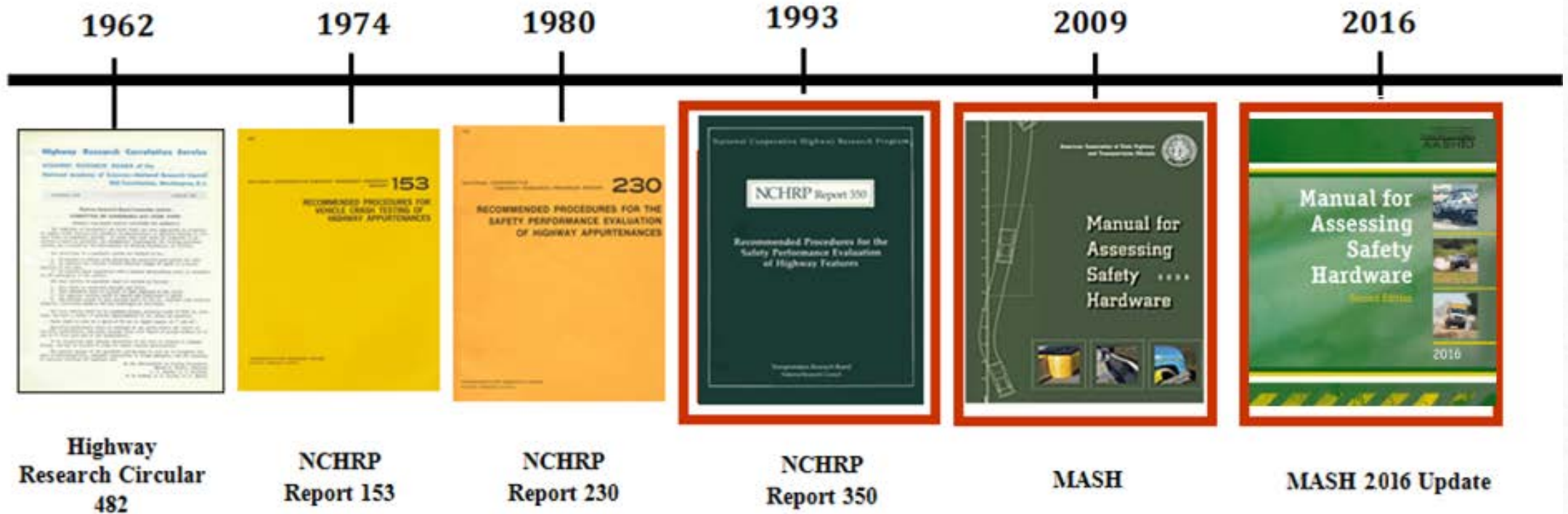
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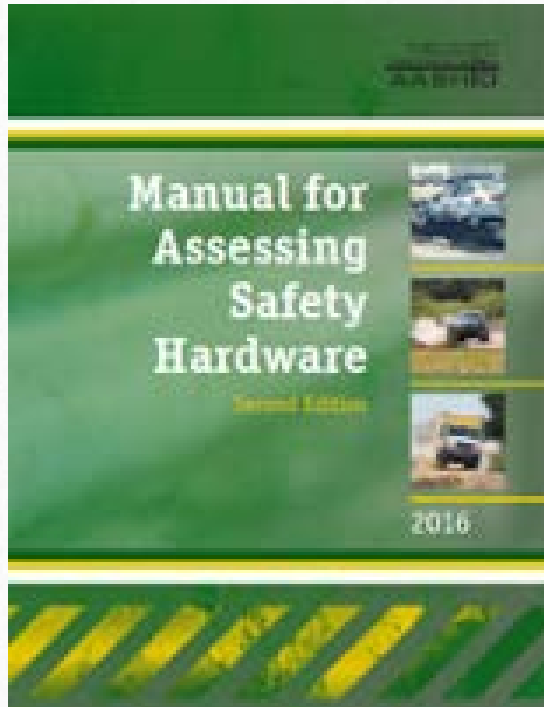
Crash Testing Guidance

- Uniform guidance for testing roadside safety features
 - Test matrices
 - Vehicle type, impact speed, impact angle, impact location
 - Evaluation criteria

Guideline Evolution



Manual for Assessing Safety Hardware (MASH16)



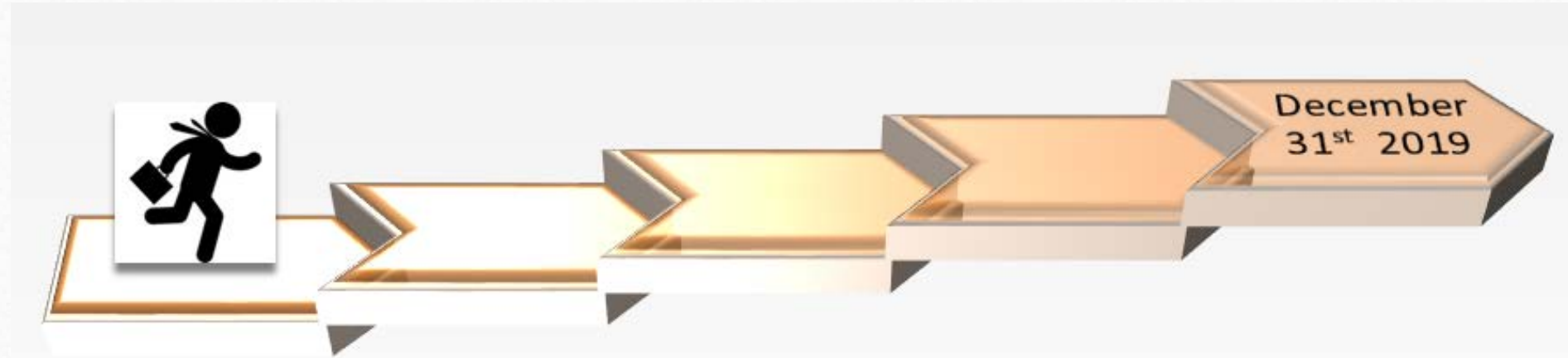
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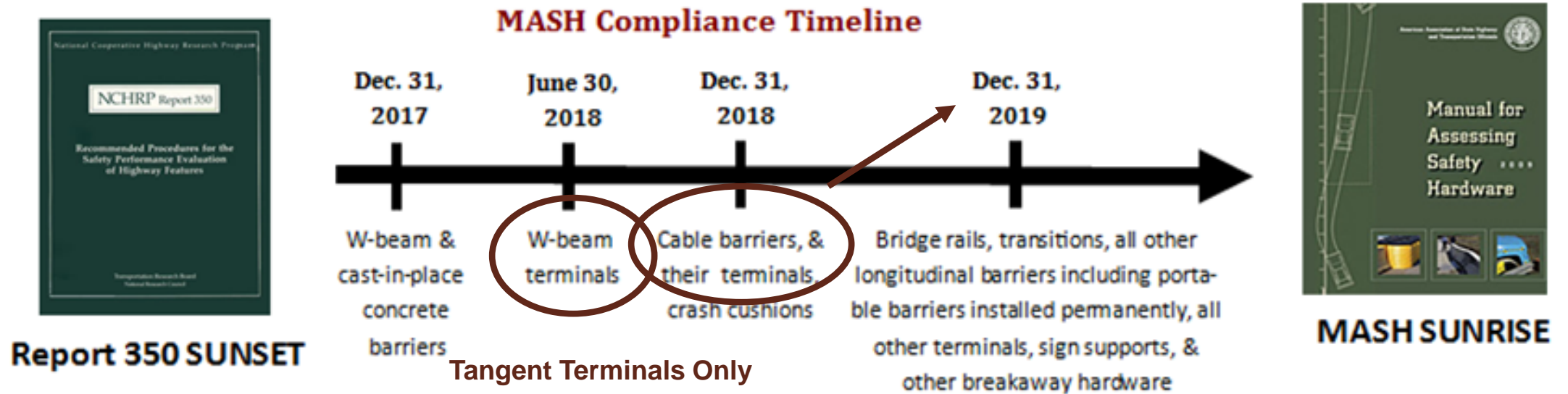
MASH Implementation Plan

2016: AASHTO Technical Committee on Roadside Safety (TCRS) and Federal Highway Administration (FHWA) have adopted a new **MASH implementation plan**

For contracts on the National Highway System:
after December 31, 2019, only safety hardware evaluated using MASH 2016 are allowed
for new permanent installations



MASH Implementation Timeline



TxDOT

Crashworthiness of Roadside Safety Hardware

(Memo June 2018)

- May 21, 2012, FHWA Memo: “**States can certify** that roadside safety hardware has been tested by an accredited crash test laboratory and meets MASH criteria, and can thus be **eligible for reimbursement**”
- April 9, 2018, FHWA Memo: “it is the **State’s responsibility** to determine crashworthiness and **provides guidance** on the process the State can use”

TxDOT

Crashworthiness of Roadside Safety Hardware

(Memo June 2018)

- Hardware approved for use on TxDOT projects:
 - Successfully crash tested per MASH16
 - Approved for specific uses by FHWA
 - Evaluated by TxDOT and identified as similar in strength and geometry to another rail successfully crash tested per MASH16
- TxDOT to assess in-service performance of hardware initially determined crashworthy under MASH
- Divisions and Districts will be surveyed annually for feedback on installing, maintaining, and repairing hardware

TxDOT

Crashworthiness of Roadside Safety Hardware

(Memo June 2018)

Division of Record has records of the basis of acceptance
(available to FHWA upon request):

- **Bridge Division**
<http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/bridgee.htm#RAILINGSTANDARDS>
- **Design Division**
<http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/rdwylse.htm>
- **Maintenance Division**
<https://www.txdot.gov/insdtdot/orgchart/cmd/cserve/standard/maintcad.htm>
- **Traffic Division**
<https://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/standard/toc.htm>

Outline

- What is “MASH”?
- When is Implementation needed?
- **Why is Implementation needed?**

Manual for Assessing Safety Hardware (MASH)

- Next step in advancement & evolution of testing & evaluation
- Addresses changes in vehicle fleet & highway network
- Reflects advancements in knowledge & technology
- Will result in:
 - Improved roadside safety hardware
 - Enhanced safety for motorists

Key Changes in MASH

- Small Design Test Vehicle
 - Weight increased from 1800 lb to 2425 lb
 - 2nd percentile lightest vehicle (i.e., 98% of vehicles sold weigh more than 2425 lbs)
- Large Design Test Vehicle
 - Changed from $\frac{3}{4}$ -ton, 2-door to $\frac{1}{2}$ -ton, 4-door pickup
 - Better represents SUVs
 - Weight increased from 4410 lb to 5000 lb
 - Minimum c.g. height = 28 in



Examples

**W-Beam
Guardrail
(MASH TL-3)**



**TL-4 Barrier
Height & Design
Load**



**Sign Supports
(Roof Crush &
2270P Testing)**

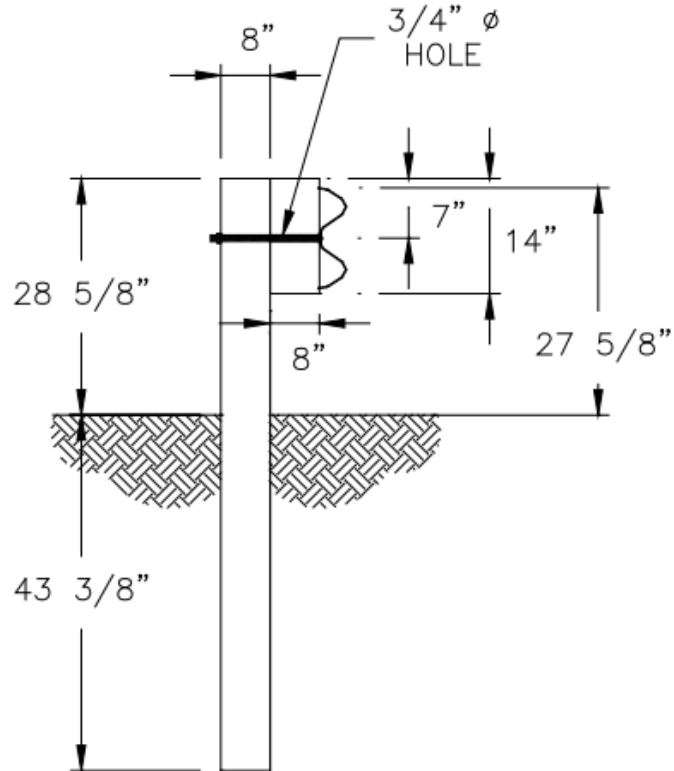


Example #1

G4(2W) W-Beam Guardrail

MASH TL-3 Testing

Example #1 – G4(2W) Guardrail



■ Test Vehicles

	NCHRP 350	MASH
Small car	1,800 lb	2,420 lb
Pickup truck	4,400 lb	5,000 lb
SUT	17,600 lb	22,000 lb



NCHRP Report
350 – TL3

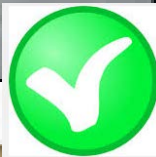
27 5/8" W-Beam Guardrail MASH Test 3-11



MASH

31" W-Beam Guardrail

MASH Test 3-11



MASH

Example #2

Test Level 4 (TL-4) Barrier

Barrier Height and Design Load Requirements

Example #2 – TL-4 Barrier

- **Test Matrices**

	NCHRP 350	MASH
Small car impact angle	20 ⁰	25 ⁰
SUT impact speed	50 mi/h	56 mi/h

- **Test Vehicles**

	NCHRP 350	MASH
Small car	1,800 lb	2,420 lb
Pickup truck	4,400 lb	5,000 lb
SUT	17,600 lb	22,000 lb

- **Impact Severity**

Test	NCHRP 350	MASH
3-10	-	+206 %
3-11	-	+13 %
4-12	-	+56 %

Example #2 – TL-4 Barrier

MASH Test 4-12

32-in N.J. safety shape
barrier



MASH



Example #2 – TL-4 Barrier

Sheikh and Bligh (2011) “**Determination of Minimum Height and Lateral Design Load for MASH Test Level 4 Bridge Rail**”



- Minimum rail height for MASH TL-4 barriers = **36 inches**
- Lateral impact load for MASH TL-4 significantly greater than NCHRP Report 350 TL-4

36-inch tall barrier -- design impact load = 68 kips

42-inch tall barrier -- design impact load = 80 kips

Example #2 – TL-4 Barrier

MASH Test 4-12
36-in single slope
concrete barrier



MASH



Example #3

Sign Supports

**Roof Crush and Pickup Truck
Vehicle Testing**

Example #3 – Slip Base Sign Support



NCHRP Report 350

5.6" Roof Crush (> 4" MASH Criteria)



MASH

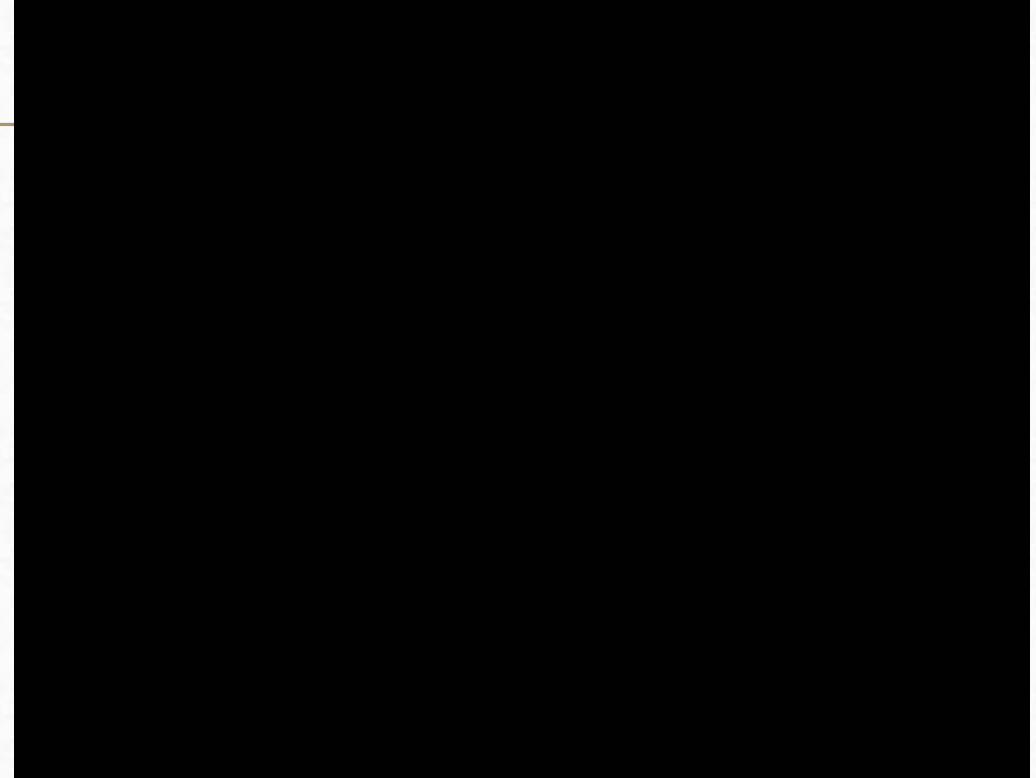
Example #3 – Slip Base Sign Support

TxDOT Research Study 0-6363

Minimum Sign Area for Slip Base Supports

Sign Area (ft ²)	System	Nominal Diameter (in)	Post Type
0 - 14	Wedge & Socket	2	BWG-13
14 – 24	Slip Base	2.5	BWG-10
24 – 36	Slip Base	2.5	Sch-80

Example #3 – Slip Base Sign Support

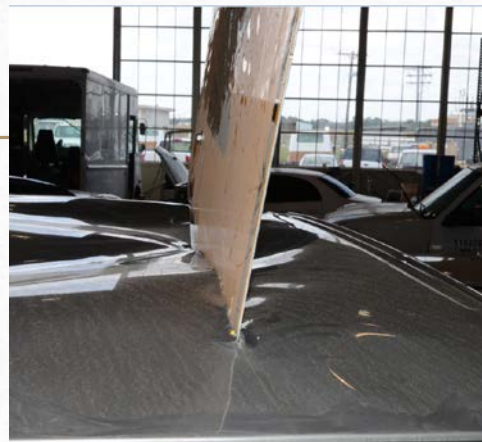


2.5" Roof Crush



MASH

Example #3 – Temporary Sign Support



 MASH

Example #3 – Temporary Sign Support



Design 1



Design 2



MASH

MASH Implementation Progress - TxDOT

- TxDOT research project 0-6968
 - Three year project
 - Evaluate most roadside safety devices used in Texas
 - Wade Odell at Wade.Odell@txdot.gov (RTI) or Dr. Bligh at R-Bligh@tti.tamu.edu (TTI)
- Roadside Safety Pooled Fund (TxDOT is a member)

TxDOT research project 0-6968

Device	TxDOT Standard	Test Level	MASH Compliant	Comments
36" vertical parapet	N.A.	TL-4	Yes	Modified 32-inch tall T221 rail by increasing height and adding additional reinforcement.
1" ACP lateral support for concrete barrier	SSCB(1F)-10	TL-4	Yes	75-ft minimum segment length
Pinning pattern for concrete barrier in concrete	CSB(7)-10	TL-3	Yes	F-shape portable concrete barrier segments with J-J Hooks connection placed at edge of concrete deck and restrained with four 1-1/4 inch angled pins per 30-ft segment.
Direct embedded wood sign support	BC(5)-14 (single)	TL-3	No	Failed pickup truck test at 90 degrees due to penetration of windshield by sign and segment of wood sign support. Modification being developed under Project 0-6968.
	BC(5)-14 (dual)	TL-3	No	Failed small car test at 0 degrees due to hole in windshield caused by contact with a fragment of the fractured wood support. Modification being developed under Project 0-6968.
Pedestal pole with beacon (drilled shaft foundation)	RFBA-13 (without solar assembly)	TL-3	Yes	Pedestal pole with sign and flashing beacons
	SPRFBA-13 (with solar assembly)	TL-3	Yes	Pedestal pole with sign, flashing beacons, solar panel, and battery cabinet
Mailbox Type 1 foundation (multi) 56" hanger	MB-15(1)	TL-3	Yes	Multiple (four) mailboxes on "hanger" style support in wedge and socket foundation system
Mailbox Type 2 foundation (double)-thin walled galvanized tubing	MB-15(1)	TL-3	Yes	Two mailboxes on single thin-wall steel tube support in wedge and socket foundation system
Mailbox Type 3 foundation (double)-winged channel post	MB-15(1)	TL-3	Yes	Two mailboxes on direct embedded 2 lb/ft U-channel support

Contact Dr. Bligh (R-Bligh@tti.tamu.edu)

TxDOT research project 0-6968

Device	Standard	Test Level	MASH Compliant	Comments
C402 bridge rail	C402	TL-4	Yes	Elliptical steel rail on concrete parapet
C412 bridge rail	C412	TL-5	Yes	Aesthetic TL-5 concrete bridge rail with windows
C411 bridge rail	C411	TL-2	Yes	Aesthetic concrete baluster style rail
T1W bridge rail	T1W	TL-3	Yes	Two tubular steel rails on concrete curb
W-beam guardrail with round wood posts	GF(31)-14	TL-3	No	Wood posts fractured rather than deflecting through soil and vehicle penetrated system. Modification being developed under Project 0-6968.
Modified W-beam guardrail with round wood posts		TL-3	Yes	Round wood posts with 36-inch embedment (tested under Project 0-6968)
W-beam guardrail with steel posts in rocky terrain	GF(31)-14 (note 9)	TL-3	Yes	Steel posts embedded 24 inches in simulated rocky terrain.
W-beam guardrail with round wood posts in rocky terrain	GF(31)-14 (note 9)	TL-3	No	Round wood posts embedded 24 inches in simulated rocky terrain. Numerous posts fractured. Rail ruptured. Vehicle penetrated system and rolled over.
Modified W-beam guardrail with round wood posts in concrete mow strip	GF(31)-14 (note 9)	TL-3	Pending	Round wood posts with 36-inch embedment installed in concrete mow strip with grout filled leave outs.
Concrete barrier at light post	SSCB(4)-10 & RIP-11	TL-4	Yes	Add 10' long cast-in-place barrier section for light pole onto single slope barrier constructed in 2017 for evaluation of 1" ACP lateral barrier support.
Single post perforated square metal tubing skid	BC(5)-14	TL-3	Yes	Temporary, free-standing single sign support system for small signs
Dual wood post temporary sign support system on skids	BC(5)-14	TL-3	Yes	Temporary, free-standing sign support system with dual wood supports
Mailbox Type 4 foundation (single)-recycled rubber post	MB-15(1)	TL-3	Yes	Single mailbox on recycled rubber post in wedge and socket foundation system.
Mailbox Type 4 foundation (double)-thin walled white post	MB-15(1)	TL-3	Yes	Two mailboxes on single thin-wall steel tube support in wedge and socket foundation system
Mailbox Type 4 foundation (multi)-Shurtite Multi Hanger	MB-15(1)	TL-3	Yes	Multiple (four) mailboxes on semi-circular style support in wedge and socket foundation system
Mailbox Type 5 foundation (single)-timber post	MB-15(1)	TL-3	Yes	Molded plastic mailbox system mounted to direct embedded timber post

Contact Dr. Bligh (R-Bligh@tti.tamu.edu)

TxDOT research project 0-6968

Device	Standard	Test Level	Comments
C1W bridge rail	C1W	TL-4	Four tubular steel rails on concrete curb.
C66 bridge rail	C66	TL-3	Concrete beam and post bridge rail.
Low profile concrete barrier	LPCB-13	TL-2	20-inch tall, portable, low-profile concrete barrier
F-shape to low profile barrier transition	FSLP(TR)-10	TL-2	Precast concrete transition section to transition from 20-inch TL-2 low-profile barrier to 32-inch TL-3 F-shape precast concrete barrier
TL-3 Thrie Beam transition downstream end without end shoe block	GF(31)TR-14	TL-3	Thrie beam transition to 36-inch single slope bridge parapet without tapered block behind end terminal connector
Single post wood skid	BC(5)-14	TL-3	Soil embedded perforated square steel tube support for temporary small signs
Single embedded perforated square metal tube	BC(5)-14	TL-3	Foundation Option 1 is considered most critical and will achieve MASH compliance for foundation options 2 and 3. MASH requires testing of signs at 90 degrees if they are used at intersections.
Burn ban sign attached to sign support below primary sign	SMD(SLIP-1)-08 (slip base)	TL-3	County burn ban sign attached to slip base sign support system below primary sign.
	SMD(TWT)-08 (wedge anchor)	TL-3	County burn ban sign attached to thin-wall steel tube in wedge and socket foundation system below primary sign
Mailbox Type 6 foundation (single) construction barrel	MB-15(1)	TL-3	Temporary mailbox attached to plastic drum
Mailbox Type 7 foundation (double)-thin walled white post	MB-15(1)	TL-3	Two mailboxes on single thin-wall steel tube support in wedge and socket foundation system
Mailbox Type 7 foundation (multi)-50" hanger	MB-15(1)	TL-3	Multiple (four) mailboxes on triangular-shaped steel support in wedge and socket foundation system

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Roadside Safety Pooled Fund

MASH Database

[ABOUT](#)[PROJECTS](#)[MASH](#)[NEWS](#)[Implementation Dates](#)[General Information](#)[Research Needs List](#)[Testing Needs List](#)[FHWA MASH
Implementation
Agreement Q&A](#)

Hardware Tested

The information provided in this database is for reference only. It is the responsibility of the user/designer to verify that the selected system meets current Federal eligibility and safety requirements. To filter available hardware devices, select the type of device, test level, eligibility letter, and if the device is proprietary/non-proprietary. If there are options available for the device selected they will appear to the right. Results are displayed below and can be selected for more information.

Device Types

All

Test Level

All

FHWA Eligibility Letter

All

Proprietary/Non-
proprietary

All

Implementation Dates

General Information

Research Needs List

Testing Needs List

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Device Types

-Guardrails ▼

Test Level

All ▼

FHWA Eligibility Letter

All ▼

Proprietary/Non-proprietary

All ▼

Guardrail Options

Rail Type:

☐ Box-Beam ☐ Thrie Beam ☐ W-Beam

Post Material:

☐ Steel ☐ Wood ☐ Wood and Steel

Blockout Type:

☐ Composite ☐ Steel ☐ Wood ☐ None

	Title	Description	Proprietary/ Non proprietary	FHWA Eligibility Letter
	WSDOT Guardrail on Slope ↗	12 gauge W-beam with 8" blockout, face of post 1ft onto 1V:2H slope	Non-proprietary	B261
	Ezy-Guard High Containment (HC) Barrier ↗	Narrow guardrail barrier system comprising standard thrie-beam rail supported by steel posts and sliding carriages	Proprietary	B273

Questions?

“MASH Requirements for Safety Hardware”

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