Mash Implementation Plan
AZ State & Local agencies

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ITE-IMSA Spring Conference
Feb 27th, 2019
M*A*S*H
What is MASH?

MASH:  *Manual for Assessing Safety Hardware*
Published: 2009
Revised: 2016 (2nd Edition)
Published by: AASHTO

- MASH is an update to and supersedes *NCHRP Report 350*
- Provide uniform guidelines for
  1. Conducting crash tests for all highway safety features for the purposes of evaluating new safety hardware devices.
  3. Criteria based on changes to vehicle fleet (Test vehicles were updated to what’s being produced and sold today.)
MASH Implementation Plan
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 with a letting date after December 31, 2019, only safety hardware evaluated using MASH 2016 will be allowed for new permanent installations.
Memorandum

Subject: INFORMATION: AASHTO/FHWA Joint Implementation Agreement for Manual for Assessing Safety Hardware (MASH)

Date: JAN - 7 2016

From: Thomas Everett
Director, Office of Program Administration

Michael S. Griffith
Director, Office of Safety Technologies

In Reply Refer To: HSST

To: Division Administrators
Directors of Field Services
Federal Lands Highway Division Directors

Purpose

The purpose of this memorandum is to share information regarding the American Association of State Highway and Transportation Officials (AASHTO)/FHWA Joint Implementation Agreement for the AASHTO Manual for Assessing Safety Hardware (MASH). Recently, the agreement was successfully balloted by AASHTO’s Standing Committee on Highways and approved by FHWA.

Information

On November 12th, 2015, FHWA issued a memorandum indicating that all modifications to NCHRP 350-tested devices will require testing under MASH in order to receive a Federal-aid eligibility letter from FHWA. In addition, a Federal Register Notice was also issued regarding this action. This action provided a significant step forward to the implementation of MASH.

Through the AASHTO/FHWA partnership, the agreement was executed to define actions needed for full implementation of MASH over the course of several years. Per the agreement, the implementation of the forthcoming edition (anticipated Spring 2016) of the AASHTO Manual for Assessing Safety Hardware (MASH) will be as follows:

- The AASHTO Technical Committee on Roadside Safety will continue to be responsible for developing and maintaining the evaluation criteria as adopted by AASHTO. FHWA will continue its role in issuing letters of eligibility of roadside safety hardware for federal-aid reimbursement.

- Agencies are urged to establish a process to replace existing highway safety hardware that has not been successfully tested to NCHRP Report 350 or later criteria.

- Agencies are encouraged to upgrade existing highway safety hardware to comply with the 2016 edition of MASH either when it becomes damaged beyond repair, or when an individual agency’s policies require an upgrade to the safety hardware.

- For contracts on the National Highway System with a letting date after the dates below, only safety hardware evaluated using the 2016 edition of MASH criteria will be allowed for new permanent installations and full replacements:
  - December 31, 2017: w-beam barriers and cast-in-place concrete barriers
  - June 30, 2018: w-beam terminals
  - December 31, 2018: cable barriers, cable barrier terminals, and crash cushions
  - December 31, 2019: bridge rails, transitions, all other longitudinal barriers (including portable barriers installed permanently), all other terminals, sign supports, and all other breakaway hardware

- 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.

- Regarding the federal-aid eligibility of highway safety hardware, after December 31, 2016:
  - FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully crash tested to the 2016 edition of MASH.
  - Modifications of eligible highway safety hardware must utilize criteria in the 2016 edition of MASH for re-evaluation and/or retesting.
  - Non-significant modifications of eligible hardware that have a positive or inconsequential effect on safety performance may continue to be evaluated using finite element analysis.

Division Offices should discuss the MASH implementation agreement with state transportation agency partners and monitor the actions taken and progress towards the dates established in the agreement.

If you have any questions or comments, please contact Brian Fouche in the Office of Safety at (202) 366-0744.
Overview - Agreement Details

• Agencies are encouraged to upgrade existing highway safety hardware to comply with the 2016 edition of MASH either when it becomes damaged beyond repair, or when an individual agency’s policies require an upgrade to the safety hardware.

• For contracts on the National Highway System with a letting date after the sunset dates, only safety hardware evaluated using the 2016 edition of MASH criteria will be allowed for new permanent installations and full replacements.
MASH Implementation Timeline

**MASH Compliance Timeline**

- **Dec. 31, 2017**: W-beam & cast-in-place concrete barriers
- **June 30, 2018**: W-beam terminals
- **Dec. 31, 2018**: Cable barriers, & their terminals, crash cushions
- **Dec. 31, 2019**: Bridge rails, transitions, all other longitudinal barriers including portable barriers installed permanently, all other terminals, sign supports, & other breakaway hardware
What are the new crash testing changes/requirements for the MASH products?
## NCHRP 350 vs. MASH Vehicles

<table>
<thead>
<tr>
<th>Vehicle Class</th>
<th>NCHRP 350</th>
<th>MASH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small car</td>
<td>820C</td>
<td>1100C</td>
</tr>
<tr>
<td>Weight: 1,809 lb</td>
<td>Weight: 2,420 lb</td>
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</tr>
<tr>
<td>Pickup Truck</td>
<td>2000P</td>
<td>2270P</td>
</tr>
<tr>
<td>Weight: 4,409 lb</td>
<td>Weight: 5,000 lb</td>
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</tr>
<tr>
<td>Single Unit Truck</td>
<td>8000S</td>
<td>10000S</td>
</tr>
<tr>
<td>Weight: 17,636 lb</td>
<td>Weight: 22,000 lb</td>
<td></td>
</tr>
<tr>
<td>Tractor Trailer</td>
<td>36000V</td>
<td>36000V</td>
</tr>
<tr>
<td>Weight: 79,366 lb</td>
<td>Weight: 79,300 lb</td>
<td></td>
</tr>
</tbody>
</table>
Pickup Truck

- The 2000P Pickup specified in Report 350 has not been manufactured since 2001
- Quad cab reflects the 90th percentile vehicle. (More Cargo space)
- MASH vehicle is a 2270P Quad cab Pickup (5000 lbs)
- Quad cab Pickup has a higher center of gravity and more closely represents the large SUV’s
Why has the standard changed

- **Test Vehicles** – Update to what’s being produced and sold.

- **Impact Condition Criteria** – Correct for inconsistencies & common conditions.

- **Evaluation Criteria** – Correct existing subjective criteria & better define other criteria.
Crash Testing
The crash performance

The crash performance is judged on:

• **Structural adequacy criteria** *(The vehicle did not penetrate, underride, or override the tested barrier.)*

• Vehicle trajectory, redirection of the vehicle in a controlled manner.

• Vehicle remained upright during and after collision with minor roll and pitch

• Verify Occupant risk by inspecting for intrusion into the occupant compartment.

• Vehicle did not intrude into adjacent lanes
Test Level Designation

- TL2 system is when tested at 70 km/h (43.5 m/h) impact speed. If passed to be used for posted speed less than 45 mph.

- TL3 system is when tested at 100 km/h (62 m/h) impact speed. If passed to be used for posted speed of 45 mph and higher.
ADOT Approach to Mash implementation
Recent crash testing and evaluation criteria were published in 1993 as NCHRP Report 350.

In 2009, the Manual for Assessing Safety Hardware (MASH) was published by AASHTO. It was adopted by FHWA as the testing standard for all new products.

In 2016, an update to MASH was adopted and a timetable for implementation of new installations complying with this edition was signed between FHWA and AASHTO.
MASH Implementation Timeline (January 1, 2009 – January 1, 2020)

- W-Beam Barriers
- Cast-in-place Concrete Barriers

2009
MASH Published

2016
MASH 2016 Published

2018
W-Beam Terminals

2019
- Bridge Rails
- Transitions
- All Other Barriers/Portable
- All Other Terminals
- Sign Supports
- Other Breakaway Hardware

2020

June 30, 2018

2018
- Cable Barriers
- Cable Terminals
- Crash Cushions

11 years
10 years
9 1/2 years
7 years
2 years
**Standard Barrier Systems**

- **Rigid Systems**: (Concrete Barrier) Rigid Barrier Systems have little (between 0 to 1 ft.) deflection under the TL-3 pickup impact. They are generally anchored by some acceptable means. Examples include: F-shape Concrete Barrier which ADOT uses 32” & 42” high, Single Slope Concrete Barrier, Vertical Wall,

- **Semi-Rigid Systems**: Semi-Rigid Barrier Systems have deflections of a few feet (between 2 to 5 ft.) under the TL-3 pickup impact. Consist of beam and post elements W-Beam Guardrail – ADOT PREVIOUS STANDARD (G4 28”) 12” wide W-beam rail section (12-gauge thickness).

  ADOT has adopted the Midwest Guardrail System (MGS)

  31” Height – Tolerance ±1”, the Rail is Spliced at mid-span. Post spacing 6’-3”

  Two post options: Steel posts, W6 x 8.5/9.0 x 6’ & Wood posts, 6” x 8” x 6’

  Blocks: 12” deep wood or composite

- **Flexible Systems**: Flexible Barrier Systems typically have relatively large deflections resulting in a less severe crash. Reducing the post spacing can decrease the deflection (a little).
Flexible Barriers continued

- ADOT APL (Approved Product List) for HTC.
- Proprietary design available systems allowed in Arizona

V-4A – Channelizing Devices – Cable Barriers – Test Level 3 ADOT Specifications: Stored Specification 702ATTN, ADOT Drawings: None

<table>
<thead>
<tr>
<th>ID. No.</th>
<th>Product</th>
<th>Notes:</th>
<th>9/16</th>
<th>12/19</th>
<th>Brifen USA, Inc.</th>
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<tbody>
<tr>
<td>V-4A 06001</td>
<td>Brifen Wire Rope Safety Fence (WRGT End Anchor) NCHRP 350 TL3 compliant</td>
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<td></td>
<td></td>
<td>Oklahoma City OK 73114 405-751-8062</td>
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<td>V-4A 03024</td>
<td>Brifen Wire Rope Safety Fence (WRSF), 4-Wire System NCHRP 350 TL3 compliant</td>
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<td>V-4A 06003</td>
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<td>V-4B 06004</td>
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<td>V-4A 03047</td>
<td>CASS, 3-Wire System NCHRP 350 TL3 compliant Only C-post system is approved</td>
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<td>V-4A 05045</td>
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<tr>
<td>V-4A 07100</td>
<td>Safence 350 4RC NCHRP 350 TL3 compliant</td>
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<tr>
<td>Also approved: Safence Terminal</td>
<td>NCHRP 350 TL3 compliant</td>
<td></td>
<td>12/19</td>
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</tr>
</tbody>
</table>

Each requires a unique proprietary terminal, Somewhat reduced deflections, Generally easier maintenance, Can retain effectiveness after most impacts.

- Used to separate opposing traffic on a divided highway or to separate through traffic from local traffic.
- Many barriers approved for roadside applications can be modified for use in the median. Width of the median is an important consideration.
  Also must consider the dynamic deflection of the barrier to avoid intrusion into opposing traffic.
- There are terminals designed specifically to shield the ends of median barriers.

**Barriers in the Median – Warrant**

- Median barriers shall be installed on high-speed fully controlled-access highways having traversable medians under the following conditions:
  a) Median widths 50 ft and less.
  b) Median widths 75 ft and less when there are three or more through lanes in each direction.
- In addition to the above criteria, median areas may require protection with barriers as warranted for other conditions such as steep slopes or fixed objects within the clear zone. Ref: ADOT Roadway Design Policy, 2012, 304.4
# Guardrail and End Treatments Per District

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Guardrail Length</th>
<th>End Treatments</th>
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<tbody>
<tr>
<td></td>
<td>Linear Feet</td>
<td>Miles</td>
</tr>
<tr>
<td>Central</td>
<td>560,308.54</td>
<td>106.12</td>
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<tr>
<td>Southcentral</td>
<td>1,146,764.01</td>
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<tr>
<td>Southeast</td>
<td>1,148,534.89</td>
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<tr>
<td>Southwest</td>
<td>565,185.36</td>
<td>107.04</td>
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<tr>
<td>NorthCentral</td>
<td>1,426,054.79</td>
<td>270.09</td>
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<tr>
<td>Northeast</td>
<td>897,432.31</td>
<td>169.97</td>
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<tr>
<td>Northwest</td>
<td>1,717,421.98</td>
<td>325.27</td>
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<tr>
<td><strong>Total</strong></td>
<td>7,461,701.88</td>
<td>1,413.20</td>
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</table>
Cable Barrier Length Per District

<table>
<thead>
<tr>
<th>District</th>
<th>Linear Feet</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>365,480.04</td>
<td>69.22</td>
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<tr>
<td>Southcentral</td>
<td>97,658.23</td>
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<tr>
<td>Southeast</td>
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<tr>
<td>Southwest</td>
<td>6,213.76</td>
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<td>NorthCentral</td>
<td>1,691.00</td>
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<tr>
<td>Northeast</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Northwest</td>
<td>87,674.57</td>
<td>16.61</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>558,717.60</strong></td>
<td><strong>105.83</strong></td>
</tr>
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</table>
Traffic Barrier systems include:
Longitudinal Barriers

Flexible Barriers

Rigid barriers
Transitions

End Terminals
Crash Cushions

Truck mounted attenuators

Cable barrier
MCDOT MASH Implementation Plan
Inventory / Data Collection

Department of Transportation Maintained Roads

- NW Maintenance District
- NE Maintenance District
- S Maintenance District
## Existing Guard Rail Quantity

<table>
<thead>
<tr>
<th></th>
<th>Barrier Length (LF.)</th>
<th>End Terminal (Each)</th>
<th>Barrier Length (Mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE Maintenance District</td>
<td>83,584</td>
<td>263</td>
<td>15.8</td>
</tr>
<tr>
<td>NW Maintenance District</td>
<td>40,092</td>
<td>24</td>
<td>7.6</td>
</tr>
<tr>
<td>S Maintenance District</td>
<td>7,985</td>
<td>24</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td><strong>131,661</strong></td>
<td><strong>311</strong></td>
<td><strong>24.9</strong></td>
</tr>
</tbody>
</table>
What are the design changes/requirements to the new MASH Installations?
I. W-Beam height is now 31” vs 28” measured from finished grade to top of the rail.

II. Post height used is 72” vs 64”.

III. W-Beam sections are spliced at mid span. (Detail 3101 & 3103)

IV. Long span is replacing nested guardrail. (Detail 3108)

V. Selection of End Terminals (Types/Brands) for Bid projects including Federal Funding projects will be subject to competitive bidding. Bidders are requested to select from approved MASH tested terminals that qualify for FHWA eligibility letter. (MCDOT AML should be referenced in the Plans allowing the contractor to choose one of the three available products)

VI. NCHRP 350 compliance End Terminals ET-Plus TL2 & TL3 are not MASH compliance and will no longer be used as part of MGS guardrail installation. New MASH compliance End Terminals have been approved by MCDOT and listed in AML
W-BEAM GUARDRAIL G4(1W) AND G4 (2W) BLOCKED OUT TIMBER POST

MIDWEST GUARDRAIL SYSTEM BLOCKED OUT TIMBER POST
New Approved Mash Compliant End Terminal
Soft Stop MASH End Treatment by Trinity Highway product
MASH SKT End Treatment by RSI Road Systems, Inc.
MAX-Tension MASH End Treatment
What design documents should be used when designing guardrail?

- MCDOT Supplement to MAG Uniform Standard specifications and Details for Public Works Construction. (2019 edition)
- MCDOT Approved Material List
- MAG Specifications and Details
What Does Implementation Mean To YOU?

• Manufacturer?
• DOT’s?
• FHWA?
• Contractor?
• Test Laboratories?
Manufacturer - Design/Test products/Production
- Provide information, demos & training

FHWA – Issue eligibility letters

DOT’s – Oversee MASH implementation, sign off on schedule
 Design - Inventory, Update standards & Details
- Approve MASH products
- Update AML (Approved Materials List)

Maintenance – In house training, stock piling

Contractor/Suppliers - Learn about new products, supply & install material

Test House - Business is good...
Manufacturers Product Approval Process

Concept/Development

1 - 2 years

Crash Testing

1 - 2 years

FHWA Letter

6 mo. - 1 year??

U.S. Department of Transportation
Federal Highway Administration
Questions?

Or maybe just fix the guardrail?