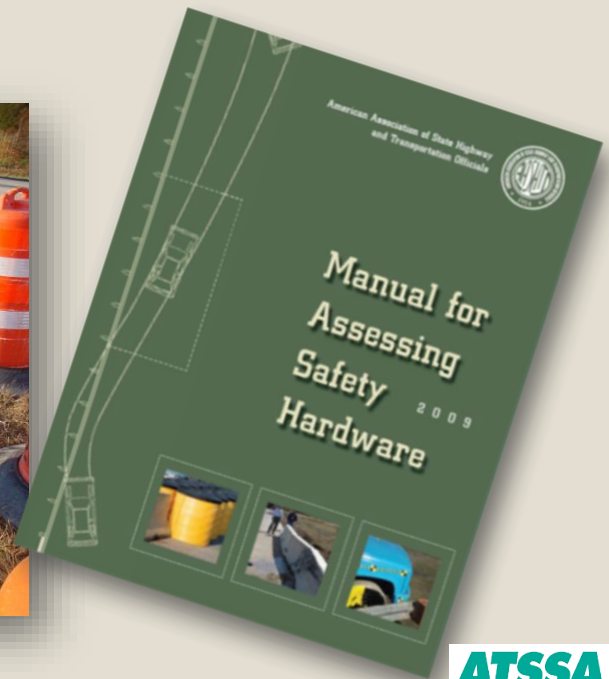
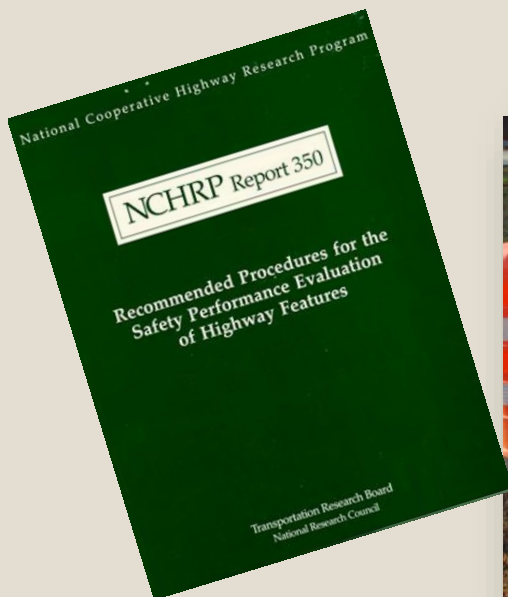


# Delaware's MASH Implementation Plan

CHESAPEAKE AND VIRGINIA CHAPTERS OF ATSSA  
JOINT MEETING  
OCTOBER 13, 2016



**PRESENTED BY:**  
**Adam Weiser, P.E. PTOE**  
**Safety Programs Manager**  
**Delaware Department of Transportation**



# Agenda

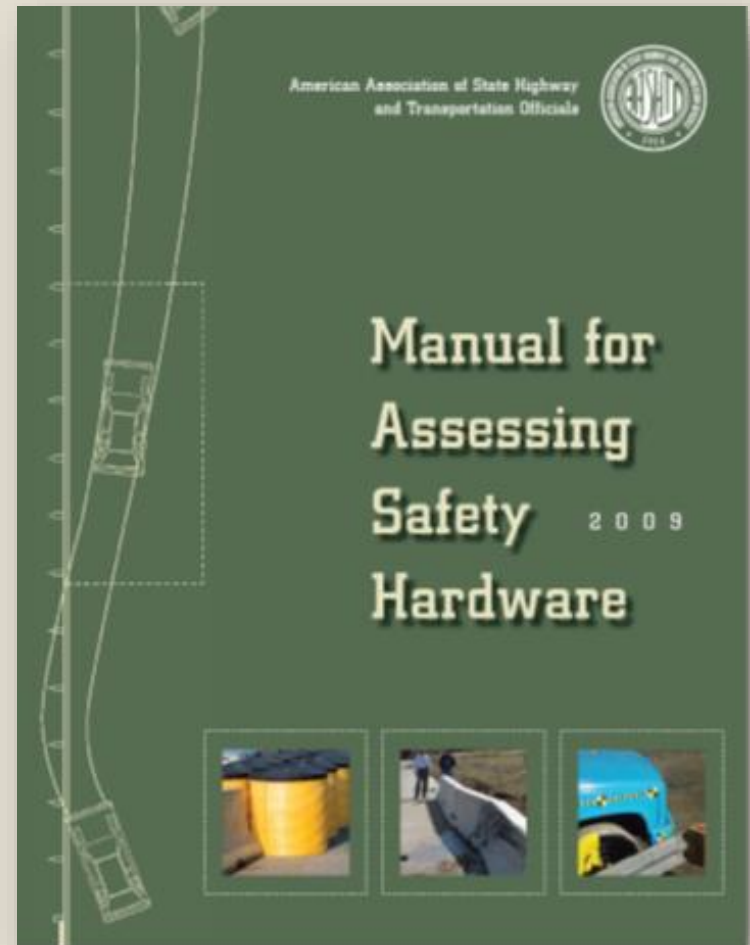
- What is MASH?
- History of Crash Testing
- NCHRP 350 vs. MASH
- MASH Update
- MASH Implementation Plan
- DelDOT's Response
- Questions

# What is MASH?



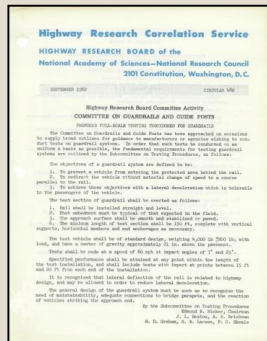
# What is MASH?

## Manual for Assessing Safety Hardware



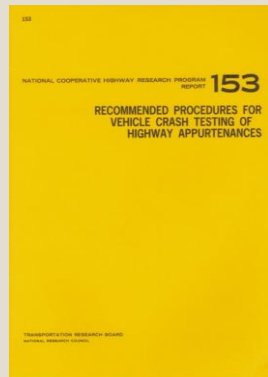
# History of Crash Testing

## ● Evolution of crash test procedures

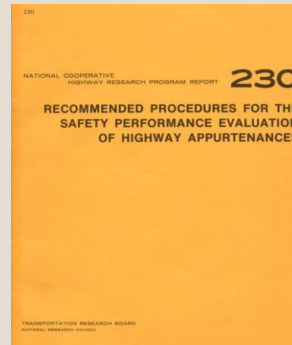


1962

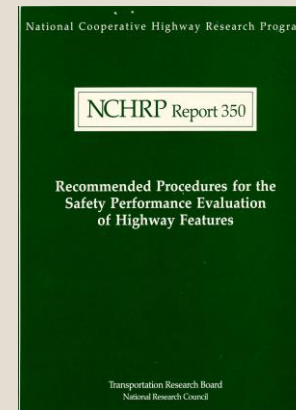
1974



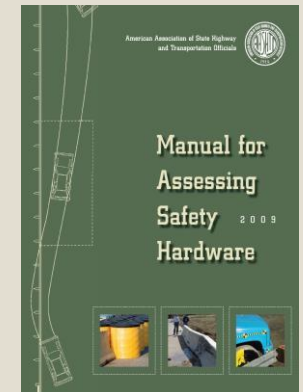
1980



1993

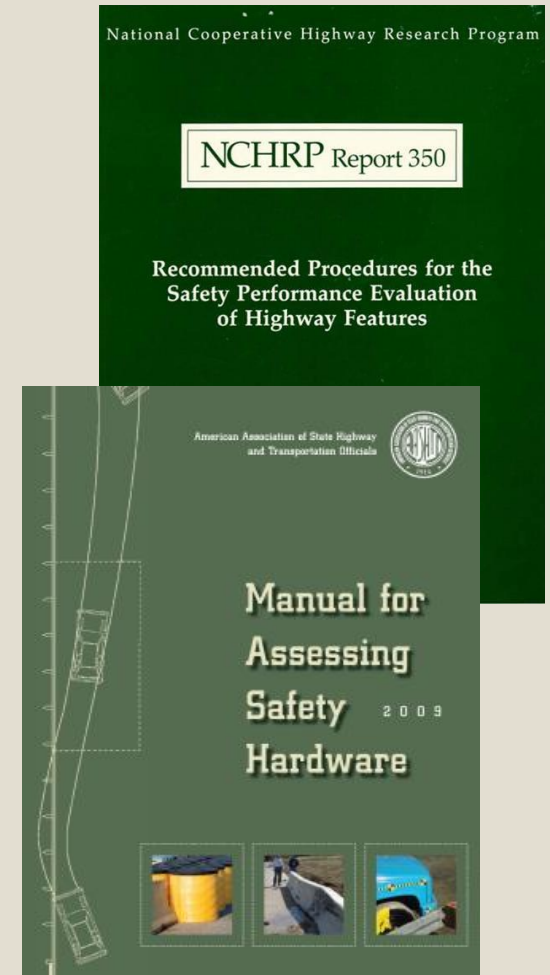


2009



# History of Crash Testing

- **NCHRP Report 350**
  - FHWA adopted in Federal Register
  - Required of all new devices on NHS
  - Existing devices may remain if they met earlier NCHRP Report 230 criteria
- **Manual for Assessing Safety Hardware (MASH)**
  - Update of the evaluation procedures
  - Published as AASHTO document in October, 2009



# NCHRP 350 vs. MASH: Vehicles

Vehicle Class	NCHRP 350	MASH - 2009
Small car 	820C Weight: 1,809 lb	1100C Weight: 2,420 lb
Pickup Truck 	2000P Weight: 4,409 lb	2270P Weight: 5,000 lb Min. c.g. height: 28 in.
Single Unit Truck 	8000S Weight: 17,636 lb	10000S Weight: 22,000 lb
Tractor Trailer 	36000V Weight: 79,366 lb	36000V Weight: 79,300 lb



# Longitudinal Barrier Impact Conditions

Test Level	Test Vehicle	NCHRP 350	MASH - 2009
TL-3	Small Car	Speed: 62 mph Angle: 20°	Speed: 62 mph Angle: 25°
TL-3	Pickup	Speed: 62 mph Angle: 25°	Speed: 62 mph Angle: 25°
TL-4	S.U.T.	Speed: 50 mph Angle: 15°	Speed: 56 mph Angle: 15°
TL-5	Tractor Trailer	Speed: 50 mph Angle: 15°	Speed: 50 mph Angle: 15°



# Other Impact Condition Modifications

Parameter	NCHRP 350	MASH - 2009
Impact Angle for Pickup L.O.N. Test on Terminals and Crash Cushions	Angle: 20°	Angle: 25°
Impact Angle for Gating Terminals and Crash Cushions	Angle: 15°	Angle 5°
Intermediate Test Vehicle	None	1500A Sedan Weight: 3,300 lb
Support Structure and Work Zone Traffic Control Device Testing	Small Car Impacts Only	Small Car and Pickup Truck Impacts

# Modifications to Evaluation Criteria

Parameter	NCHRP 350	MASH - 2009
Maximum Roll/Pitch Angles	No Rollover	<75°
Occupant Compartment Deformation	No deformation greater than 6 in.	Specific limits based on region of the vehicle interior
Test Evaluation	Pass, Fail, or Marginal	Pass or Fail
Windshield Damage Criteria	Subjective/Qualitative	Objective/Quantitative
Vehicle Rebound in Crash Cushion Tests	None	Required
Exit Conditions	Subjective	Exit Box Criteria

# MASH 2009 to MASH 2015

- Soil Strength Testing
- Crash Testing Criteria for Slope
- Measurement Criteria for Vehicle Hood Heights
- Longer Tractor-trailer lengths
- Impact Severity Tolerance for SUT/Tractor-Trailers

# MASH 2009 to MASH 2015

Parameter	MASH 2009	MASH 2015
Hood Height Measurement Reference Point	N/A	Clarification for rounded hoods on new vehicle models
Tractor Trailer <ul style="list-style-type: none"> <li>• Maximum Overall Length</li> <li>• Cargo Bed Height</li> </ul>	<ul style="list-style-type: none"> <li>• 50 ft</li> <li>• 52 in. (+/- 2 in.)</li> </ul>	<ul style="list-style-type: none"> <li>• 53 ft *</li> <li>• 50 in. (+/- 2 in.)*</li> </ul>
Single Unit Truck <ul style="list-style-type: none"> <li>• Cargo Bed Height</li> </ul>	<ul style="list-style-type: none"> <li>• 51 in. (+/- 2 in.)</li> </ul>	<ul style="list-style-type: none"> <li>• 49 in. (+/- 2 in.)*</li> </ul>
Impact Severity Tolerances	TL-3: ±8% TL-4: ±8% TL-5: ±8%	TL-3: ±8% TL-4: ±13% <sup>(1)</sup> TL-5: ±13% <sup>(1)</sup>

\* Proposed to match current fleet based on testing experience and manufacturers survey

<sup>(1)</sup> Allows 1° tolerance on impact angle at target impact speed

# Previous MASH Implementation Agreement

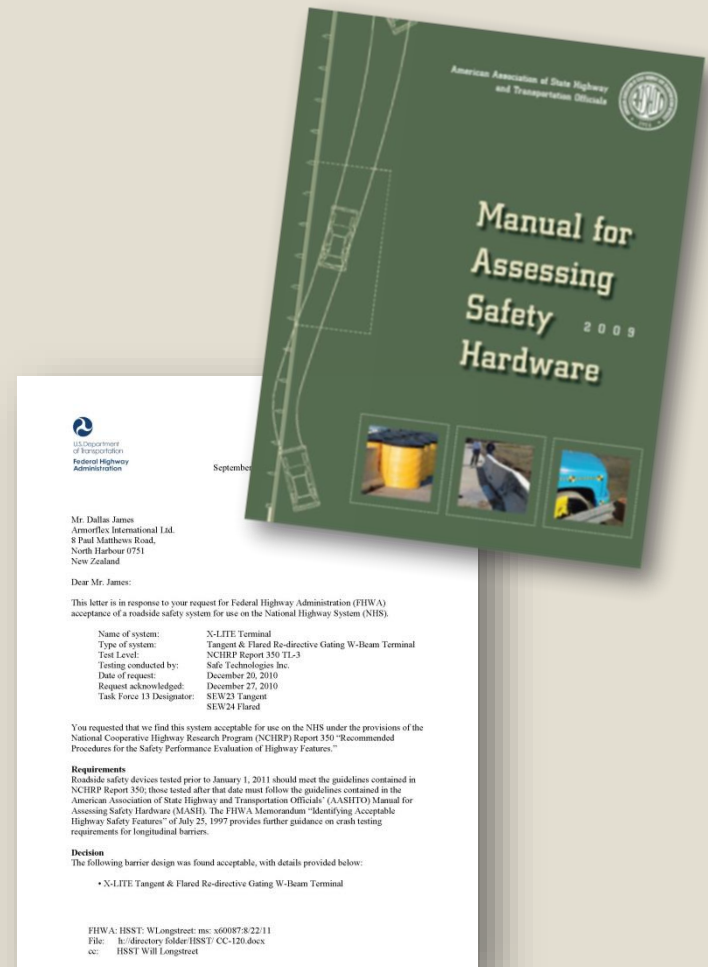
- January 1, 2011 – all newly developed hardware must be tested using MASH
- 350-compliant hardware does not have to be re-tested to MASH
- 350-compliant hardware may remain in-place and continue to be installed
- Non-compliant hardware with no suitable alternatives may be left in place and continue to be installed

# Issues with Previous Implementation Agreement

- “Parallel approach” was supposed to allow manufacturers time to develop new products
- Over four years later, very few proprietary MASH systems exist
- Additional safety benefits of MASH can only be realized if new hardware is developed and installed
- Sunsetting 350 would provide the incentive
- Joint FHWA/AASHTO/TCRS group formed to update agreement

# New MASH Implementation Agreement

- Responsibilities
  - TCRS - responsible for developing and maintaining the evaluation criteria (MASH)
  - FHWA – responsible for issuing letters of eligibility of highway safety hardware for federal-aid reimbursement





# New MASH Implementation Agreement

- Plan urges/encourages agencies to:
  - Replace existing hardware that has not been tested to NCHRP 350 or later criteria
  - **Establish a policy** for upgrading existing hardware to comply with the 2015 edition of MASH
    - ✦ When device becomes **damaged beyond repair**, or
    - ✦ When related project work requires modification to, or removal of, existing hardware



# New MASH Implementation Agreement

- Compliance dates:
  - December 31, 2017: Longitudinal W-beam barriers and cast-in-place concrete barriers
  - December 31, 2018: Cable barriers, transitions, terminals, crash cushions, and bridge railings
  - December 31, 2019: All other longitudinal barriers (including portable barriers installed permanently), sign supports, and other breakaway hardware
- After above dates, only MASH tested devices will be permitted for new permanent installations and full replacements

# New MASH Implementation Agreement

- Compliance dates, cont.:
  - Temporary work zone devices including portable barriers, manufactured after December 31, 2019, must have been successfully tested to the 2015 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.



# New MASH Implementation Agreement

- Regarding the federal-aid eligibility of highway safety hardware, as of January 1, 2017:
  - FHWA will no longer issue eligibility letters for highway safety hardware that has not been successfully crash tested to the 2015 edition of MASH.
  - Modifications of eligible highway safety hardware must utilize criteria in the 2015 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.

# DelDOT's Approach to MASH

- Tasks currently underway:
  - Develop approved products list for end terminals
    - ✦ Recommendation from review of ET-Plus information
    - ✦ Development of list will be undertaken by Guardrail Working Group
  - Develop policy for protection of damaged end terminals
    - ✦ Consultant task approved, but not yet started
    - ✦ Will be led by Guardrail Working Group
  - Incorporated guardrail system upgrades into paving program
    - ✦ Review existing guardrail systems
    - ✦ Upgrade to current standards

# DelDOT's Approach to MASH

- Future tasks:
  - Develop policy/definition for “Damaged Beyond Repair”
    - ✦ Requires coordination with Design and Maintenance Sections
  - Follow FHWA/AASHTO implementation schedule
    - ✦ First compliance date is Dec. 31, 2017
    - ✦ Requires specification updates
      - Full specification update completed in 2016 which included addition of MASH tested devices
      - Future specification updates will eliminate allowance of NCHRP 350 tested devices
  - Develop programmatic upgrade methodology
    - ✦ Address those roads that otherwise will not be affected by a project
    - ✦ Primarily rural local roadways

# DelDOT's Approach to MASH

- Concerns

- Compliance dates and device availability
  - ✦ Bridge railing
  - ✦ Work zone devices
  - ✦ Sign posts/I-beam supports
- Lack of certain types of tested devices
  - ✦ Bridge railing – many systems have not even been tested to NCHRP 350
  - ✦ Curved guardrail sections – no NCHRP 350 devices exist
- Maintenance/replace-in-kind projects
  - ✦ Fine line between damaged beyond repair and replace-in-kind
  - ✦ Replacement is not simply replacing a device
    - Curb work, drainage, etc.
  - ✦ Normal service life



# Evolution



Thank you!

Questions and  
Discussion