

Please note that the information contained in this presentation consists of technical recommendations and time/cost estimates from the scoping study research team. Decisions regarding these recommendations will be made by the appropriate AASHTO committees/councils later this fall.

Scoping Study for Conversion of the AASHTO Manual for Assessing Safety Hardware (MASH) to a Specification

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Project Team

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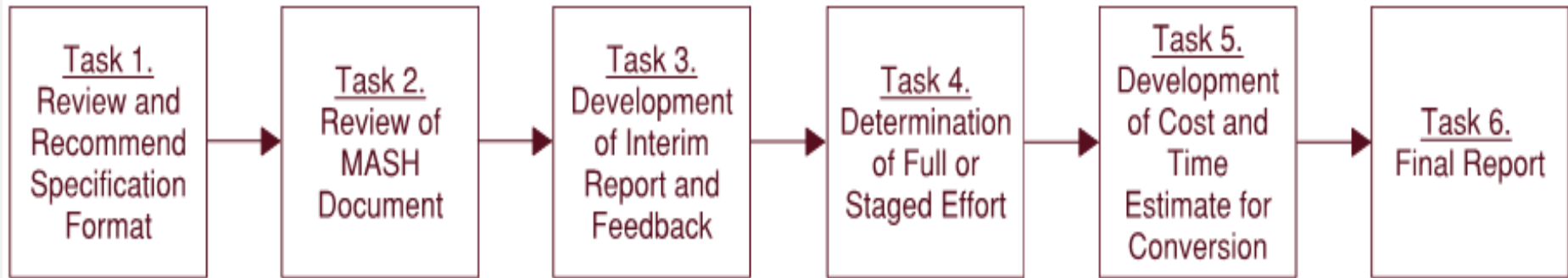
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Objective

- Determine level of effort required to convert MASH-16 to a set of performance specifications



Research Approach



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Task 1 - Review and Recommend Specification Format

- Reviewed various specifications and test methods
 - AASHTO LRFD Bridge Design Specifications
 - AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals
 - AASHTO Specifications for Transportation Materials and Methods of Sampling and Testing
 - ASTM F2656 Standard Test Method for Crash Testing of Vehicle Security Barriers
 - EN 1317 Road Restraint Systems
 - FMVSS 208 Occupant crash protection
 - SAE J1526 Fuel Consumption Test Procedure

Task 1 - Review and Recommend Specification Format

- Recommend appropriate format for MASH crash testing specification
 - Device-based organization
 - Longitudinal barriers, cable barriers, terminals/crash cushions, support structures, work zone devices, TMAs and trailers
 - Common information separated and referenced
 - Test vehicle specifications, evaluation criteria, test documentation
 - Concise, easy to interpret language
 - Address uncertainties and subjectivity
 - Much of existing text moved to commentary in appendix

Task 2 - Review MASH Document

- Review MASH-16 to determine required tasks and level of effort to convert it into a specification
 - Entire document reviewed
 - Summary tables developed to present level of effort and recommendations for each section

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Task 2 - Review MASH Document

- Categorized sections and chapters of MASH
 - S → Simple conversion into specification format
 - 2 examples provided
 - E → Expert opinion required to convert into a specification
 - 3 examples provided
 - R → Research needed prior to incorporation into a specification
 - 2 examples provided
- Categories E & R reviewed by team

Summary Table

Section	Title	Pages	Description/ Purpose	Conversion Category*	Key Issues/Comments
2.2.4.2	<i>TESTS 70, 71, and 72-Work-Zone Traffic Control Devices</i>	43	Description & purpose of Tests 70, 71, and 72	S	Move to Commentary
		43	Discussion regarding placement of work-zone traffic control devices on pavement or compacted gravel or sod	S	Remove subjectivity regarding placement of devices on pavement surface
		43	Comment regarding utilization of sand bags or other weights in testing	S	Replace “should” with “shall”
3.4.4	TEST INSTALLATION DISPOSAL	80	Timeline on disposal	E	Specify when test labs can dispose of test articles. Current language recommends retention until FHWA Eligibility Letter issue, but this can be overly burdensome to test lab.
2.2.2.3	<i>Other Terminals and Crash Cushion System</i>	35-36	Very generic for non-listed devices	E(x3)	Need to develop test matrices for special applications including <i>short radius guardrail, bullnose treatment, and buried-in-backslope terminals.</i>
2.2.4.2	<i>TESTS 90 and 91-Longitudinal Channelizers</i>	44	Description of impact angle condition	E	Specify CIAs for longitudinal channelizers.

Expert Opinion Needed

- **MASH Section:** 3.4.2.3 *Support Structures, Work-Zone Traffic Control Devices, Breakaway Utility Poles*
- Conversion Category: E (Expert Opinion)
 - Specify when to test road closure gates in an open or closed configuration

“Road closure gates are typically tested with the gate arm in the up position. Nevertheless, an assessment should be made as to whether the test is more critical with the gate arm in the up or down position, and test accordingly.”

Research Required

- **MASH Section:** 2.2.4.1 *Support Structures, Work-Zone Traffic Control Devices, Breakaway Utility Poles, and Longitudinal Channelizers*
- **Conversion Category:** R (Research)
 - Determination of Critical Impact Angle (CIA) for systems within these categories
 - Potential to include CIA addressing reverse-side impacts

“...A critical impact angle (CIA) should be determined for each test recommended (...) Features that are designed to be used along the outside of divided highways need only be evaluated for impact angles of 0 to 25 degrees. However, if the same feature can be used in locations where it could be subjected to reverse-side impacts, 0-to-25-degree and 155-to-180-degree impact envelopes should be considered (...)”

Research Required

- Research needed to convert section to specification
 - Investigate CIA guidelines for breakaway support structures, evaluated at flat level ground.
 - Inclusion of variety of categories (including small /large sign supports, chevrons (on curves), mailboxes, luminaires)
 - Investigation to consider potential for these systems to be impacted in a reverse direction.
- \$800,000 funding need
- 36 months

Other Research Needs

- **MASH Section:** 3.4.2.1 *Longitudinal Barriers*
- **Conversion Category:** S (simple)
 - Require largest and smallest post spacings to be tested
 - Move rest of language to commentary

“...a cable barrier is ~~encouraged~~ **required** to be tested with both the largest and smallest recommended post spacings if a range of post spacings is desired. ~~Testing with the largest post spacing allows for assessment of maximum barrier deflection as well as its greatest working width. Testing with the smallest post spacing allows for assessment of vehicle instability. Barrier deflection and working width associated with intermediate post spacings may be estimated from computer simulation or supplemental crash tests.~~”

Other Research Needs

- Simple effort required to convert section to specification
- Additional research would be beneficial to MASH
 - Evaluate which cable barrier post spacing (min. or max.) is most critical for each specific test
 - Determine a critical matrix to reduce number of tests required for evaluation
- Research team identified other research that could be conducted to improve/update MASH
 - Not strictly needed to convert MASH to a specification
 - Not necessarily a comprehensive list

Modification Process

- Considered modification process for incorporation of new/revised content into MASH specification
 - Different models/processes exist
 - AASHTO balloting process must be utilized
- Periodic updates will be driven by research addressing identified needs
 - New design test vehicles, new test conditions (e.g., side impact), updated CIPs or CIAs
- Differentiate between major and minor modification cycles

Modification Process

- Modularity of device-specific chapters permits revision a single chapter without revision of entire document.
 - Chapters can be updated on an interim basis, as needed, between less frequent revisions to entire document
 - Similar to approach used by AASHTO *LRFD Bridge Design Specification*
- TCRS could establish MASH canvassing committee
 - Draws upon outside expertise
 - Charged with developing revisions to the MASH specification during a specified cycle

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Task 4 - Determination of Full or Staged Conversion Effort

- Develop recommendation regarding multi-staged conversion or one complete conversion for MASH document



Staged Conversion

- Potentially shorter implementation time for parts of MASH
 - Chapters requiring minimal conversion effort would not be delayed by chapters that require more research
- Not practical if MASH converted in current form
 - Every chapter of MASH has to be referenced to conduct, evaluate, and document a crash test
 - Want to avoid cross-referencing multiple documents
- Recommended device-specific format would have merit
 - Device-specific chapter could be standalone
 - Would require conversion of supporting chapters to avoid referencing multiple documents

Staged Conversion

- Industry Consideration
 - Anything less than standalone chapter conversion would likely result in industry delaying product development and testing
 - Industry does not want to be “penalized” for being an early adopter
- Potentially increases questions and confusion in the short term due to use of two or more different documents for testing
- How would multi-stage conversion process be funded?

Full Conversion

- Simpler, more straightforward process
 - Prevents interim confusion associated with need to cross-reference two documents.
- Less prone to introducing errors, inconsistencies, and questions
 - Different chapters may be developed at different times by potentially different persons
- Time required to complete needed research could be substantial
- Industry would prefer full conversion to eliminate uncertainty and risk of developing products under incomplete specification.
- More straightforward funding model

Hybrid Conversion

- Potentially addresses uncertainties of staged conversion and lengthy time of full conversion
- Convert everything possible to specification at one time without waiting for completion of research
- MASH-16 language carried over in areas that require further research
 - Rewritten consistent with language in specification

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Hybrid Conversion

- Numerous areas of uncertainty and subjectivity addressed through expert opinion
- Research results easily implemented through interim updates
- Reduced development time for majority of specification
- Single document will reduce questions and confusion
- More efficient funding model

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General Considerations

- Perception of continuous change
- Will industry and user agencies grow weary
- Important to communicate purpose, schedule, and implementation plan
 - Will retesting of any products be required?
 - Will there be an implementation agreement that accompanies a new MASH specification?
- MASH specification will be ultimately benefit both industry and user agencies
 - Positive that uncertainty and subjectivity is reduced

Task 5 - Develop Cost and Time Estimates for Conversion

- Developed cost estimate for full conversion
 - Conversion cost of basic chapter content (S)
 - Added cost to develop expert opinions (E)
- Developed time estimate to convert MASH into specification
 - Defined tasks required for conversion effort
 - Added time for review periods
- Separate time and cost estimates for additional research
 - High-level estimates at problem statement level

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Chapter Organization

1. *Scope*
2. *Purpose*
3. *References* (to other documents or chapters)
4. *Definitions or Glossary of Terms*
5. *Test Matrix*
 - specifying number of tests with vehicle type, impact speed, impact angle, and impact location for each
6. *Test Installation*
7. *Evaluation Criteria* (relevant criteria for the device category)
8. *Test Documentation* (device specific considerations, including photography and reporting requirements)
9. *Commentary* (included as an appendix)

Chapter Conversion Tasks

1. Identify applicable MASH content
2. Extract information from relevant sections in MASH and incorporate into new chapter template
3. Revise language to specification format and remove unnecessary commentary
4. Prepare new commentary for chapter sections
5. Conduct internal technical review of draft chapter and commentary and revise document as needed
6. Coordinate external review by project panel
7. Address comments received from panel and other external reviewers, and revise chapter and commentary accordingly

Device-Specific Chapters

- Longitudinal Barriers
- Cable Barrier
- Crash Cushions and Terminals
- Support Structures
- Work Zone Traffic Control Devices & Longitudinal Channelizers
- Truck and Trailer Attenuators and Portable Work Zone Trailers

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Other Supporting Chapters

- Test Vehicle Specifications
- Evaluation Criteria
- Test Documentation



ISPE

- MASH Chapter 7 *In-Service Performance Evaluation*
 - Very general in nature; lacks sufficient detail to support inclusion in a specification
 - References older research (NCHRP Report 490)
 - Conceptual framework and flow chart
 - Indicates adaptation needed to fit needs and resources of particular agency
- Would constitute major rewrite if retained
 - Much more specificity needed for ISPE methods
 - Difficult due to the differences in available data among states

ISPE (cont.)

- Recommend removing chapter from MASH specification
- No reflection on importance and need for ISPEs
- Discuss in introductory scope of MASH specification
 - Reference other documents to guide practitioners
- If ISPE retained in the MASH specification, level of effort for conversion will increase

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Expert Opinions Needed

Device Category	MASH Section	MASH Page No.	Issue	Standard/Involved
General	2.1.2	12	Determination of which tests impact speed above tolerance is acceptable	Standard
	3.2	67	Quantify and specify flatness requirement for vehicle run up and runout areas	Standard
	3.4.4	80	Update when test labs can dispose of test articles	Standard
Longitudinal Barriers	2.1.2	12	Impact point tolerance for Test 4-12	Standard
	3.4.2.1	74-76	Update required lengths for test installations	Standard
	3.4.2.1	75	Determine specific slope rounding radii and tolerance for ditches constructed for testing cable barriers.	Standard
Terminals & Crash Cushions	2.2.2.2	34	Need more specificity on selecting the CIP for non-gating crash cushions.	Standard
	2.2.2.3	34	Develop test matrix for short radius guardrail	Involved
	2.2.2.3	34	Develop test matrix for bullnose treatment	Involved
	2.2.2.3	34	Develop test matrix for buried-in-backslope terminals	Involved
	3.4.2.2	76	Update required lengths for test installations	Standard
Support Structures	3.4.2.3	76-77	Specify what devices require testing at both 0° and 90°	Standard
	3.4.2.3	77	Specify when to test road closure gates in an open configuration or a closed configuration	Standard
Work Zone Devices	3.4.2.3	77	Specify which products require testing in “out-of-service” configurations and which to evaluate	Standard
	2.2.4.2	44	Determine Critical Impact Angles (CIAs) for longitudinal channelizers	Involved

Expert Opinion Tasks

1. Identify experts for subject matter
2. Prepare documentation of issue to share with experts
3. Coordinate development of consensus opinion (conduct meetings, etc.)
4. Prepare summary of issue, decisions, and draft specification language and commentary
5. Coordinate external review by panel
6. Address comments received from panel and revise language and commentary accordingly

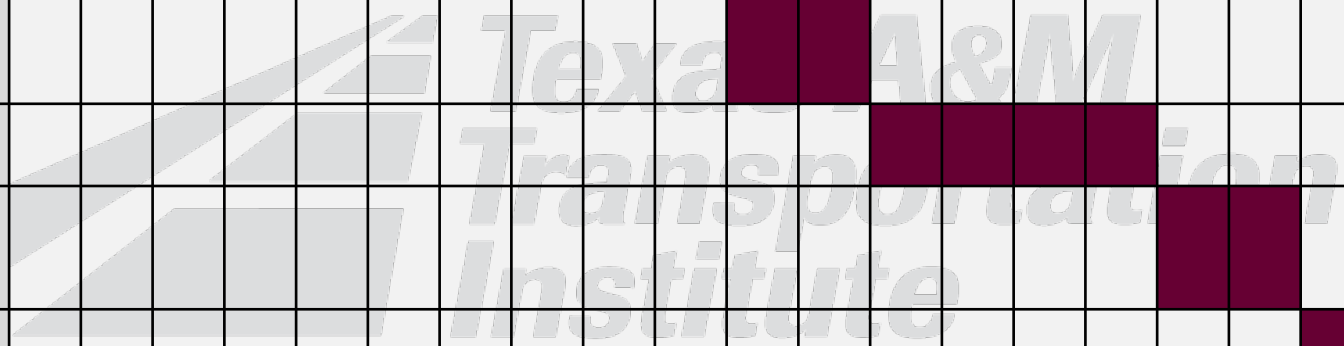
Estimated Cost

- Basic Chapter Conversion
 - \$26,000
- Expert Opinion Development
 - Standard: \$10,000
 - Involved: \$18,000
- Total Cost (9 chapters + 15 expert opinions)
 - \$416,000

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Estimated Conversion Schedule

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Task 1: Initial Chapter Development																				
Task 2: Panel Review and Revision of Initial Chapter																				
Task 3: Develop Remaining Device-Specific Chapters																				
Task 4: Panel Review and Revision of Remaining Device-Specific Chapters																				
Task 5: Development of Other Supporting Chapters																				
Task 6: Panel Review and Revision of Other Supporting Chapters																				
Task 7: Deliver MASH Specification and Present to Community																				



Research Needs

Device Category	MASH Section	MASH Page No.	Issue	Cost (\$)	Time (months)
General	2.4	65-66	Implement side impact procedures into MASH (NCHRP Project 22-32 canceled; Additional research being programmed under Project 22-32A)	\$530,000	30
Terminals & Crash Cushions	2.3.3.1	63	Critical Impact Point (CIP) guidance for Test 34 for both terminals and non-gating crash cushions	\$600,000 (combined)	33
	2.3.3.2	64	CIP guidance for Test 36 for transition between crash cushion and backup structure		
	2.3.3.3	64	CIP guidance for Test 37 for reverse direction evaluation of both terminals and crash cushions		
Support Structures	2.2.4.1	41	Critical Impact Angle (CIA) guidelines for breakaway support structures	\$800,000	36
	3.4.2.3	77	Guidance on which sign materials, sizes, and mounting heights to be used during testing (i.e., <i>evaluation of family of products also affects Work Zone Devices</i>) (Should be addressed by NCHRP Project 22-43)	\$500,000	33

Task 6 - Final Report

- Submitted April 2021
 - Documents all tasks
 - Includes NCHRP problem statement for funding conversion effort



Questions/Discussion

