Mr. Jeff Jeffers  
State of Alaska Department of Transportation and Public Facilities  
3132 Channel Drive  
Juneau, AK 99811-2500  
USA  

Dear Mr. Jeffers:

This letter is in response to your April 17, 2020 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number B-350 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

**Decision**

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- 2019 MASH 2-Tube Bridge Rail Transition

**Scope of this Letter**

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials’ (AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
Eligibility for Reimbursement

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the AASHTO’s MASH. Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system: 2019 MASH 2-Tube Bridge Rail Transition
Type of system: Longitudinal Barrier Transition
Test Level: Test Level 3 (TL3)
Testing conducted by: Texas A&M Transportation Institute (TTI)
Date of request: April 17, 2020

FHWA concurs with the recommendation of the accredited crash testing laboratory on the attached form

Full Description of the Eligible Device

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

Notice

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO’s MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.
**Standard Provisions**

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-350 shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed upon request.

- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

Sincerely,

Michael S. Griffith  
Director, Office of Safety Technologies  
Office of Safety

Enclosures
Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Date of Request: April 17, 2020

Name: Jeff Jeffers
Company: State of Alaska Department of Transportation and Public Facilities
Address: 3132 Channel Drive, Juneau, AK 99811-2500
Country: United States of America

To: Michael S. Griffith, Director
FHWA, Office of Safety Technologies

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

**Device & Testing Criterion** - Enter from right to left starting with Test Level L - L - L

<table>
<thead>
<tr>
<th>System Type</th>
<th>Submission Type</th>
<th>Device Name / Variant</th>
<th>Testing Criterion</th>
<th>Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>B': Rigid/Semi-Rigid Barriers</td>
<td>Physical Crash Testing</td>
<td>2019 MASH 2-Tube</td>
<td>AASHTO MASH</td>
<td>TL3</td>
</tr>
<tr>
<td>(Roadside, Median, Bridge</td>
<td>Engineering Analysis</td>
<td>Bridge Rail Transition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Railings)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

**Individual or Organization responsible for the product:**

Contact Name: Jeff Jeffers
Company Name: State of Alaska Department of Transportation and Public Facilities
Address: 3132 Channel Drive, Juneau, AK 99811-2500
Country: United States of America

Enter below all disclosures of financial interests as required by the FHWA "Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices" document.

Texas A&M Transportation Institute (TTI) was contracted by the State of Alaska Department of Transportation and Public Facilities and the North Dakota Department of Transportation to perform full-scale crash testing of the 2019 MASH2-Tube Bridge Rail Transition. There are no shared financial interests in the 2019 MASH2-Tube Bridge Rail Transition by TTI, or between the State of Alaska Department of Transportation and Public Facilities and/or the North Dakota Department of Transportation, and TTI, other than costs involved in the actual crash tests and reports for this submission to FHWA.

608331-4, 5, 6
A brief description of each crash test and its result:

**PRODUCT DESCRIPTION**

- **New Hardware or Modification to**
  - [ ] Significant Modification
  - [ ] Existing Hardware

The 2019 MASH 2-Tube Bridge Rail Transition test installation was comprised of a 154-ft long section of reinforced concrete bridge deck that incorporated two steel rails, a 12½-ft long (nominal) section of two nested thrie beams (RTM08a) attached to the bridge rails with a thrie beam terminal connector (RTE01b) and unique guardrail connector, a standard symmetrical 75 inch long (nominal) thrie-beam-to-W-beam transition rail section (RWT01b), 25 ft of W beam guardrail (in length of need), and a standard 9 ft-4½ inch long TxDOT DAT terminal (posts 1 and 2) at the end.

The total length of the installation was approximately 207 ft-3½ inches (53 ft-3½ inches transition + 154 ft bridge deck). The top edges of the DAT rail and W-beam were located 31 inches above grade. The top edge of the nested thrie beam was 34¾ inches above grade, and the tops of the bridge rails were located 24 inches and 38 inches above the bridge deck.

Transition section Posts 3 through 6 were 72 inches long (embedded 40 inches), posts 7 and 8 were 72 inches long, and posts 9 through 15 were 78 inches long. Posts 1 through 6 were spaced at 75 inches; posts 7 through 10 were at 37⅜ inches; and posts 10 through 15 were at 18⅜ inches. Timber blockouts, 8-inches deep, were installed on posts 2 through 6. Posts 7 and 8 were fitted with 12-inch deep, short (14 inches) steel hollow structural section (HSS) tubing blockouts, and posts 9 through 15 were fitted with 12-inch deep, long (21 ⅛ inches) steel HSS blockouts.

The bridge deck’s curb was 10 inches tall, with a 4-inch thick lift of grout, yielding a 6-inch tall traffic side face. The curb was 18 inches wide at the base, and 17 inches wide at the top, with the traffic side face sloping 1-inch toward the field side.

Sixteen fabricated steel posts were longitudinally spaced on 10 ft centers, beginning at 24 inches from each end of the concrete curb. Two steel rectangular HSS rail elements spanned the posts and extended past them at each end of the installation.

**CRASH TESTING**

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash tests are necessary to determine the device meets the MASH criteria.

Engineer Name: William F. Williams

Engineer Signature: William Williams

Address: TTI, TAMU 3135 College Station, TX 77843-3135

Country: United States of America

A brief description of each crash test and its result: Help
<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-20 (1100C)</td>
<td>Test 3-20 involves an 1100C vehicle impacting the test article at a target impact speed of 62 mi/h and target angle of 25°. The target CIP for the left corner of the front bumper was 5.1 ft upstream of the end of the concrete curb/deck. The results of the test conducted on September 2, 2019, are found in TTI Test Report No. 608331-4-6 as Test #4. The test vehicle was traveling at a speed of 60.9 mi/h as it made contact with the 2019 MASH2-Tube Bridge Rail Transition 6.06 ft upstream of the end of the concrete curb/deck at impact angle of 26.5°. After loss of contact with the transition, the vehicle came to rest 145 ft downstream of the impact point and 137 ft toward the traffic side. The 2019 MASH2-Tube Bridge Rail Transition contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection of the rail during the test was 3.5 inches. Maximum permanent deformation was 1.25 inches. Working width was 26.1 inches. No detached elements, fragments, or other debris were present to penetrate, or to show potential for penetrating, the occupant compartment, or to present undue hazard for others in the area. The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 12° and 3°, respectively. Longitudinal OIV was 22.6 ft/s and lateral OIV was 30.5 ft/s. Maximum longitudinal occupant ridedown acceleration was 14.5 g, and maximum lateral occupant ridedown acceleration was 9.2 g. Occupant risk factors were within the maximum limits specified in MASH. Maximum exterior crush to the vehicle was 14.0 inches in the side plane in the front plane at the left front corner at bumper height. Maximum occupant compartment deformation was 3.5 inches in the left kick panel area. No damage to the fuel tank was observed. The 2019 MASH2-Tube Bridge Rail Transition performed acceptably for MASH test 3-20.</td>
<td>PASS</td>
</tr>
</tbody>
</table>
Test 3-21 involves a 2270P vehicle impacting the test article at a target impact speed of 62 mi/h and target angle of 25°. The target CIP for the left corner of the front bumper was 7.0 ft upstream of the end of the concrete curb/deck.

The results of the test conducted on September 5, 2019, are found in TTI Test Report No. 608331-4-6 as Test #5. The test vehicle was traveling at a speed of 61.9 mi/h as it made contact with the 2019 MASH2-Tube Bridge Rail Transition 6.52 ft upstream of the end of the concrete curb/deck and at an impact angle of 25.3°. After loss of contact with the transition, the vehicle came to rest 174 ft downstream of the impact point and in-line with the rail.

The 2019 MASH2-Tube Bridge Rail Transition contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection during the test was 6.1 inches. Maximum permanent deformation was 3.75 inches. Working width was 26.9 inches.

No detached elements, fragments, or other debris were present to penetrate, or to show potential for penetrating, the occupant compartment, or to present undue hazard for others in the area. The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 8° and 11°, respectively.

Longitudinal OIV was 20.3 ft/s and lateral OIV was 23.6 ft/s.

Maximum longitudinal occupant ridedown acceleration was 7.4 g and maximum lateral occupant ridedown acceleration was 13.0 g. Occupant risk factors were within the preferred limitsspecified in MASH. Maximum exterior crush to the vehicle was 15.0 inches in the side plane at the left front corner at bumper height. Maximum occupant compartment deformation was 4 inches in the left side kick panel. No damage to the fuel tank was observed.

The 2019 MASH2-Tube Bridge Rail Transition performed acceptably for MASH test 3-21.
| 3-10, 3-11 | The reported tests were for the Transition section. Tests 3-10 & 3-11 pertain to Length-of-Need. The Length-of-Need Tests 4-10, 4-11, & 4-12 were performed in December 2018, and are found in TTI Test Report No. 608331-1A, 2, 3. | Non-Relevant Test, not conducted |

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>>>>> Continued on Page 7 of 8 <<<<<<
Test 3-21 involves a 2270P vehicle impacting the test article at a target impact speed of 62 mi/h and target angle of 25°. The target CIP for the left corner of the front bumper was 7.3 ft upstream of centerline of Post #7.

The results of the test conducted on December 19, 2019, are found in TTI Test Report No. 608331-4-6 as Test #6. The test vehicle was traveling at a speed of 62.6 mi/h as it made contact with the 2019 MASH2-Tube Bridge Rail Transition 7.5 ft upstream of the centerline of Post #7 and at an impact angle of 24.9°. After loss of contact with the barrier, the vehicle came to rest 133 ft downstream of the impact point and 2 ft toward the traffic side.

The 2019 MASH2-Tube Bridge Rail Transition contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The vehicle exited within the exit box criteria defined in MASH. Maximum dynamic deflection during the test was 33.6 inches. Maximum permanent deformation was 28.0 inches. Working width was 44.7 inches.

No detached elements, fragments, or other debris were present to penetrate or to show potential for penetrating the occupant compartment, or to present undue hazard for others in the area. The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 15° and 14°, respectively. Longitudinal OIV was 24.9 ft/s and lateral OIV was 16.4 ft/s. Maximum longitudinal occupant ridedown acceleration was 10.7 g and maximum lateral occupant ridedown acceleration was 9.8 g. Occupant risk factors were within the preferred limitsspecified in MASH.

Maximum exterior crush to the vehicle was 20.0 inches in the side plane at the left front corner at bumper height. No occupant compartment deformation or intrusion was observed. No damage to the fuel tank was observed.

The 2019 MASH2-Tube Bridge Rail Transition performed acceptably for MASH test 3-21.
Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory’s accreditation status as noted in the crash test reports):

<table>
<thead>
<tr>
<th>Laboratory Name:</th>
<th>Texas AM Transportation Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Signature:</td>
<td>Digitally signed by Darrell L. Kuhn Date: 2020.09.28 14:02:31-05'00</td>
</tr>
<tr>
<td>Address:</td>
<td>TTI, TAMU 3135 College Station, TX 77843-3135</td>
</tr>
<tr>
<td>Country:</td>
<td>United States of America</td>
</tr>
<tr>
<td>Accreditation Certificate Number and Dates of current Accreditation period:</td>
<td>ISO 17025-2017 Laboratory A2LA Certificate Number: 2821.01 Valid To: April 30, 2021</td>
</tr>
</tbody>
</table>

Submitter Signature*: Jeff. C Jeffers Digitally signed by Jeff. C Jeffers Date: 2020.09.28 13:32:31-08'00

**ATTACHMENTS**

Attach to this form:

1) Additional disclosures of related financial interest as indicated above.
2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

**FHWA Official Business Only:**

<table>
<thead>
<tr>
<th>Eligibility Letter</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Date</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 5.6. Summary of Results for MASH Test 3-20 on 2019 MASH 2-Tube Bridge Rail Thrie Beam Transition.
Texas A&M Transportation Institute (TTI)  
MASH Test 3-21  
608331-01-5  
2019-09-05

2019 MASH 2-Tube Bridge Rail Thrie Beam Transition  
AASHTO M147 Grading B Soil (crushed limestone), Damp

2270P  
2013 RAM 1500 Pickup  
5168 lb  
5050 lb  
165 lb  
5215 lb

20.3 ft/s  
23.6 ft/s  
7.4 g  
13.0 g  
33.5 km/h  
1.51  
11LFQ5  
11FLEW4

6.1 inches  
3.75 inches  
26.9 inches  
34.75 inches

11LFQ5  
11FLEW4

15.0 inches  
4.0 inches

Figure 6.6. Summary of Results for MASH Test 3-21 on 2019 MASH 2-Tube Transition from Thrie Beam to Bridge Rail.
Texas A&M Transportation Institute (TTI)
MASH Test 3-21
608331-01-6
2019-12-19

Transition
2019 MASH 2-Tube Bridge Rail Thrie Beam Transition
Beam Transition
207 ft 3½ inches (incl 154 ft of deck)
Thrie beam guardrail terminal to 38-inch tall 2-tube bridge rail, 34½ inch tall thrie beam guardrail section, symmetrical W-beam to thrie beam terminal, 25 ft of W-beam guardrail

AASHTO M147 Grading B Soil (crushed limestone), Damp

62.6 mi/h
24.9°
7.5 ft upstream of post 7
117 kip-ft
31.8 mi/h
23.3° / 24.7°
24.9 ft/s
16.4 ft/s
10.7 g
9.8 g
8.6 m/s
1.02

-9.1 g
-4.6 g

133 ft downstream
2 ft twd traffic
53°
14°
15°
No
No

33.6 inches
28.0 inches
44.7 inches
61.8 inches

11LFQ5
11FLEW4

61.8 inches

LF0000000

None

Figure 7.8. Summary of Results for MASH Test 3-21 2019 MASH 2-Tube Transition from W-Beam to Thrie Beam.

1b. Bolts are ASTM A307 unless otherwise indicated. Recessed Guardrail Nuts on all 5/8" Bolts unless otherwise indicated.

1c. All steel components, including hardware, shall be galvanized.

2b. Recessed Guardrail Nuts on all 5/8" Bolts unless otherwise indicated.

2c. All steel components, including hardware, shall be galvanized.
Bridge Rail Details

Concrete Dimensions

154'-0"
115'-7"
115'-5"
75'-7"
75'-5"

Plan View

150'-0" Post to Post

10'-0" Typ

Elevation View

38"
24"
0"
6"
4"

Asphalt

Existing Concrete

30"
1"
42"

Detail G

Scale 1:20
Typ each Rail joint (7)
and Deck and Curb joint (2)

Detail F

Scale 1:5

Nut, 7/8 A563 heavy hex
ASTM A563

Nut, 3/4 F563 heavy hex

Plate Washer (turn to cover slot)

Nut, 7/8 A563 heavy hex

Washer, 7/8 F436

1-1/2" non-shrink grout

Section E-E

Scale 1:20
Hardware is x 4 at each Post

Roadside Safety and Physical Security Division - Proving Ground

Project #608331 4-6 Alaska Bridge Transition 2019-07-03

Drawn by GES Scale 1:250 Sheet 3 of 13 Bridge Rail Details
Concrete Details, Elevation

Section J-J
Scale 1 : 15

4a. Concrete Strength is 5000psi for the Wall and Deck, 3000 psi for the Working Slab, and 4000 psi for the Curb.

4b. Chamfer Field Side edges of Deck, and field side and top edges at end of Curb 3/4" each way as shown.
5a. Place the Anchor Bars @ maximum 18" spacing and secure to existing rebar protruding from the runway with minimum 3" weld. (Existing rebar not shown here.)

5b. Minimum rebar lap is 24" for #4 bars and 30" for #5 bars.

5c. Place one mat of Ø1/2 (4) bars in Working Slab @ 12" each way with ≈1-1/2" cover at top. These bars are not shown here.

5d. Field bend traffic side longitudinal bar and turn Hoop Bars at ends of Curb to maintain cover.

5e. The Anchor Bars will be bare steel, and the bars in the Working Slab may be bare steel. All other bars shall be epoxy coated, and all bars are grade 60.
**6a.** Concrete Strength is 5000psi for the Wall and Deck, 3000 psi for the Working Slab, and 4000 psi for the Curb.

**6b.** Chamfer Field Side edges of Deck, and field side and top edges at end of Curb 3/4" each way as shown.

**6c.** Rebar placement shown in Detail View at joint is typical each joint. Adjust spacing and Hook Bar direction as needed at location shown.

---

**Offset Hook Bars as needed to avoid interference.**

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**Detail K**
Scale 1 : 20
Typ each Joint

---

**Detail L**
Scale 1 : 20
Typ each Joint

---

**Details, Plan**
7a. All bent bars, and all longitudinal bars in the Curb, Deck and Wall shall be epoxy coated. All bars are grade 60.
Post

Plan View

Plate, 12" x 1" x 13"
ASTM A709 Grade 50
See Anchor Plate detail for hole locations

Isometric View

Anchor Plate

Plan View

Plate, 12" x 3/8" x 13"
ASTM A709 Grade 50

Elevation Views

Slot, 1" x 1-1/2"
Typ x 4

W8x24
ASTM A709 Grade 50

1-1/8" Typ x 4

13-1/2"

17-1/2"

29-1/2"

12"

10-1/2"

12"

15/16" Typ x 4

6"

1-1/2"
Bridge Rail

Plan View

HSS 7" x 5" x 3/8"
ASTM A500 Grade B

HSS 6" x 4" x 1/2" x 20"
ASTM A500 Grade B

Elevation View

Ø3/4" x 2"
Reduced Weld Base Stud
ASTM A108 Grade 1010

Detail N

Plate Washer
Plate, 2" x 1/4" x 2 1/8"
ASTM A709 Grade 36

Section M-M

Scale 1 : 5

Roadside Safety and Physical Security Division - Proving Ground

Project #608331 4-6 Alaska Bridge Transition
2019-07-03

Drawn by GES | Scale 1:30 | Sheet 9 of 13 Rail and Plate Washer
Transition Rail
See previous sheet for details not shown here.

Plan View
- HSS 7" x 5" x 3/8"
  - ASTM A500 Grade B
- HSS 6" x 4" x 1/2" x 20"
  - ASTM A500 Grade B

Elevation View
- Plate, 4 3/4" x 3/16" x 6 3/4"
  - ASTM A709 Grade 36
- Ø3/4" x 2" Reduced Weld Base Stud (x 2)
  - ASTM A108 Grade 1010

Section O-O
- Scale 1:5

Detail P
- Scale 1:5
11a. All welding must be performed by certified welders using industry standard practices.

11b. Galvanize all components after fabrication is complete.
12a. Galvanize after fabrication is complete.
Posts and Blockouts

Transition Post
W6x8.5 x 78"
ASTM A992 Steel
(at 9 - 15)

Posts 7 and 8
W6x8.5 x 72"
ASTM A992

Long Tubing Blockout
HSS 12" x 6" x 1/4"
ASTM A500 Grade B

Short Tubing Blockout
HSS 12" x 6" x 1/4"
ASTM A500 Grade B

Roadside Safety and Physical Security Division - Proving Ground

Drawn by GES
Scale 1:10
Sheet 13 of 13 Posts and Blockouts