Mr. Tekeste Amare  
Maryland Transportation Authority  
300 Authority Drive  
Baltimore MD 21222  
USA

Dear Mr. Amare:

This letter is in response to your April 1, 2021 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-359 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:

- MDTA Chesapeake Bay Bridge Steel Rail System

**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: MDTA Chesapeake Bay Bridge Steel Rail System
  - Type of system: Longitudinal Barrier
  - Test Level: Test Level 5
  - Testing conducted by: Texas A&M Transportation Institute (TTI)
  - Date of request: April 1, 2021

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

In accordance with FHWA's Memo "Federal-aid Reimbursement Eligibility Process for Safety Hardware Devices" dated November 12, 2015, FHWA will make note of any reported damage to a test vehicle's fuel tank, oil pan, or other feature that might serve as a surrogate of the fuel tank. AASHTO's MASH states "Although not a specific factor in assessing test results, integrity of a test vehicle's fuel tank is a potential concern. It is preferable that the fuel tank remains intact and not be punctured. Damage or rupture of the fuel tank, oil pan, or other feature that might serve as a surrogate of the fuel tank should be reported". A test report included in with the submittal documents that Test 5-12 shows the right fuel tank was damaged.

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-359 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

<table>
<thead>
<tr>
<th>Submitter</th>
<th>Name: Tekeste Amare</th>
<th>Company: Maryland Transportation Authority</th>
<th>Address: 300 Authority Drive, Baltimore, MD 21222</th>
<th>Country: United States of America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Request:</td>
<td>April 01, 2021</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To:</td>
<td>Michael S. Griffith, Director</td>
<td>FHWA, Office of Safety Technologies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<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 (Roadside, Median, Bridge Railings)</td>
<td>Physical Crash Testing</td>
<td>MDTA Chesapeake Bay Bridge Steel Rail System</td>
<td>AASHTO MASH</td>
<td>TLS</td>
</tr>
<tr>
<td></td>
<td>Engineering Analysis</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:**

<table>
<thead>
<tr>
<th>Contact Name:</th>
<th>Tekeste Amare</th>
<th>Same as Submitter ✗</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Name:</td>
<td>Maryland Transportation Authority</td>
<td>Same as Submitter ✗</td>
</tr>
<tr>
<td>Address:</td>
<td>300 Authority Drive, Baltimore, MD 21222</td>
<td>Same as Submitter ✗</td>
</tr>
<tr>
<td>Country:</td>
<td>United States of America</td>
<td>Same as Submitter ✗</td>
</tr>
</tbody>
</table>

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 Modjeski and Masters, Inc. (M&M) vis-a-vis the Maryland Transportation Authority (MDTA) to perform full-scale crash testing of the MDTA Chesapeake Bay Bridge Steel Rail System. There are no shared financial interests in the MDTA Chesapeake Bay Bridge Steel Rail System by TTI, or between/among M&M / MDTA and TTI, other than costs involved in the actual crash tests and reports for this submission to FHWA.

612861-02
PRODUCT DESCRIPTION

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: 1254 Avenue A, Bldg 7091, Bryan, Texas 77807

Country: United States of America

A brief description of each crash test and its result:

New Hardware or Significant Modification

Modification to Existing Hardware

The MDTA Chesapeake Bay Bridge Steel Rail system consists of four 40-ft 8-inch long and one 42-3/16-inch long steel parapet assembly sections, which are supported and anchored to the bridge floor system by nine floor beam assemblies, evenly spaced at 20-ft-5-inches. The parapet assembly is anchored to the floor beam 7¾ inches below grade and extends up to 32 inches above grade. A steel rail system is mounted on top of the parapet; it consists of an 8-inch x 4½-inch elliptical tube and intermediate short posts, with the top of the tube located 50 inches above grade. Both the parapet and rail contain 2-inch-wide longitudinal expansion joints between each assembly section.
<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-10 (1100C)</td>
<td>Test 5-10 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 right corner of the front bumper was 3.6 ft upstream of the centerline of the steel rail joint between posts 6 &amp; 7. The results of the test conducted on May 26, 2020, are found in TTI Test Report No. 612861-02. The test vehicle was traveling at an impact speed of 62.6 mi/h as it made contact with the MDTA Chesapeake Bay Bridge Steel Rail System 3.9 ft upstream of the centerline of the steel rail joint between posts 6 &amp; 7 and at an impact angle of 25.0°. After loss of contact with the barrier, the vehicle came to rest 174 ft downstream of the impact point and in line with the bridge rail. The MDTA Chesapeake Bay Bridge Steel Rail System 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 during the test was 1.5 inches. Maximum permanent deformation was 0.25 inch. Working width was 25.0 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 18° and 14°, respectively. Longitudinal OIV was 20.3 ft/s and lateral OIV was 29.2 ft/s. Maximum longitudinal occupant ridedown acceleration was 4.8 g, and maximum lateral occupant ridedown acceleration was 6.5 g. Occupant risk factors were within the preferred limits specified in MASH. Maximum exterior crush to the vehicle was 10.0 inches in the front plane at the right front corner at bumper height. Maximum occupant compartment deformations were 6.5 inches in the right-side kick panel; 6.5 inches in the right-side diagonal direction of the windshield; 3.0 inches in the right-side firewall; and 2.0 inches in the floor pan. No fuel tank damage was observed. The MDTA Chesapeake Bay Bridge Steel Rail System performed acceptably for MASH test 5-10.</td>
<td>PASS</td>
</tr>
</tbody>
</table>

PASS
<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-11 (2270P)</td>
<td>Test 5-11 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 right corner of the front bumper was 4.3 ft upstream of the centerline of the joint in the steel rail between posts 6 &amp; 7. The results of the test conducted on May 21, 2020, are found in TTI Test Report No. 612861-02. The test vehicle was traveling at an impact speed of 62.2 mi/h as it made contact with the MDTA Chesapeake Bay Bridge Steel Rail System 5.1 ft upstream of the centerline of the joint in the steel rail between posts 6 &amp; 7 and at an impact angle of 25.0°. After loss of contact with the barrier, the vehicle came to rest 151 ft downstream of the impact point and 4 ft toward the field side. The MDTA Chesapeake Bay Bridge Steel Rail System 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 2.6 inches. Maximum permanent deformation was 1.1 inches. Working width was 20.1 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 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 16° and 10°, respectively. Longitudinal OIV was 21.0 ft/s and lateral OIV was 31.2 ft/s. Maximum longitudinal occupant ridedown acceleration was 6.1 g and maximum lateral occupant ridedown acceleration was 9.8 g. Occupant risk factors were within the preferred limits specified in MASH. Maximum exterior crush to the vehicle was 12.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 2.5 inches in the right front firewall area. No fuel tank damage was observed. The MOTA Chesapeake Bay Bridge Steel Rail System performed acceptably for MASH test 5-11.</td>
<td>PASS</td>
</tr>
</tbody>
</table>
Test 5-12 involves a 36000V vehicle impacting the test article at a target impact speed of 50 mi/h and target angle of 15°. The target CIP for the right corner of the cab's front bumper was 7.0 ft upstream of the centerline of post 3.

The results of the test conducted on May 29, 2020, are found in TTI Test Report No. 612861-02. The test vehicle was traveling at an impact speed of 49.9 mi/h as it made contact with the MDTA Chesapeake Bay Bridge Steel Rail System 6.9 ft upstream of the centerline of post 3 and at an impact angle of 15.0°. After loss of contact with the barrier, the vehicle came to rest 309 ft downstream of the impact point and 104 ft toward the field side.

The MDTA Chesapeake Bay Bridge Steel Rail System contained and redirected the 36000V 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 3.0 inches. Permanent deformation was unmeasurable due to rail separation. Working width was 60.9 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 36000V vehicle remained upright during and after the collision event, although the trailer severed 5 feet behind the bulkhead.

Maximum roll and pitch angles were 6° and 4°, respectively.

Longitudinal OIV was 3.3 ft/s, and lateral OIV was 14.8 ft/s.

Maximum longitudinal occupant ridedown acceleration was 12.4 g, and maximum lateral occupant ridedown acceleration was 12.5 g.

Maximum exterior crush to the vehicle cab was 19.0 inches in the front plane at the right front corner of the cab at bumper height. Maximum occupant compartment deformation was 4.5 inches in the right floor pan.

The MDTA Chesapeake Bay Bridge Steel Rail System performed acceptably for MASH test 5-12.

5-20 (1100C) Test for transition is not applicable for this bridge barrier system

Non-Relevant Test, not conducted
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 A&amp;M Transportation Institute Proving Ground</th>
</tr>
</thead>
</table>
| Laboratory Signature: | Digitally signed by Darrell L. Kuhn  
'Date: 2021.03.29 16:36:35 -05'00  
Signature: D~ |
| Address: | 1254 Avenue A, Bldg 7091, Bryan, Texas 77807  
Same as Submitter □ |
| Country: | United States of America  
Same as Submitter □ |
| Accreditation Certificate Number and Dates of current Accreditation period: | ISO 17025-2017 Laboratory  
A2LA Certificate Number: 2821.01  
Valid To: April 30, 2021  
| Submitter Signature: | Digitally signed by Tekeste Amare, P.E.  
'Date: 2021.04.08 12:18:34 -04'00' |

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:

| Eligibility Letter |  |
| Number | Date | Key Words |
|        |      |           |
Figure 7.6. Summary of Results for MASH Test 5-10 on MDTA Chesapeake Bay Bridge Steel Rail System.
Figure 6.6. Summary of Results for MASH Test 5-11 on MDTA Chesapeake Bay Bridge Steel Rail System.
General Information
Test Agency ........................................ Texas A&M Transportation Institute (TTI)
Test Standard Test No. .................. MASH Test 5-12
TTI Test No. ................................. 612861-02-4
Test Date ....................... 2020-05-29

Test Article
Type.......................... Longitudinal Barrier—Bridge Rail
Name ................................ MDTA Chesapeake Bay Bridge Steel Rail System
Installation Length .............. 171 ft 7 inches × 22 2/13 inches
Material or Key Elements ... Four 40-ft 8-inch parapet assembly sections with rail assembly of 8-inch × 4 1/2-inch elliptical tube held by short posts 50% inches above the pavement

Soil Type and Condition ....
Test Vehicle
Type/Designation ............... Concrete bridge deck, dry
Make and Model ................. 36000V
2013 International 8600 SBA6X4 with 1983 Lufkin 7FV-IPST trailer
Curb .............................................. N/A
Test Inertial ...................... 30,370 lb
Dummy .............................. 79,510 lb
Gross Static ......................... 79,510 lb

Impact Conditions
Speed ........................................ 49.9 mi/h
Angle ........................................ 15.0°
Location/Orientation .......... 6.9 ft upstream of post 3

Impact Severity ................. 443 kip-ft
Exit Conditions
Speed ........................................ Not attainable
Trajectory/Heading Angle ... Along bridge rail

Occupant Risk Values
Longitudinal OIV ...................... 3.3 ft/s
Lateral OIV ............................... 14.8 ft/s
Longitudinal Ridedown ............ 12.4 g
Lateral Ridedown ................. 12.5 g
THIV .......................................... 4.6 m/s
ASI ............................................. 1.0
Max. 0.050-s Average
Longitudinal ......................... -5.8 g
Lateral ..................................... -6.8 g
Vertical ................................. 10.0 g

Vehicle Stability
Maximum Yaw Angle .............. 20°
Maximum Pitch Angle .......... Not measurable
Maximum Roll Angle ............. 6°
Vehicle Snagging ................. No
Vehicle Pocketing ................. No

Test Article Deflections
Dynamic ...................................... 3.0 inches
Permanent .............................. None measurable
Working Width ...................... 60.9 inches
Height of Working Width ....... 138.3 inches

Vehicle Damage
VDS .............................................. N/A
CDC .............................................. N/A
Max. Exterior Deformation ...... 19.0 inches
OCDI ........................................... N/A
Max. Occupant Compartment
Deformation ......................... 4.5 inches

Figure 8.8. Summary of Results for MASH Test 5-12 on MDTA Chesapeake Bay Bridge Steel Rail System.
Top Fill Plate, 5/8" 2 per Floorbeam
Support Angle L 8 x 4 x 1/2 A572 grade 50 2 per Floorbeam (1 mirrored)
Bolt, 7/8 x 3 1/4" hex, A325 7/8" Hardened Washer (2), Lock Washer, Heavy Hex Nut 16 per Floorbeam
HAS-E Threaded Rod 1" x 10" Long
1" USS Flat Washer, (7 5/8" embedment, minimum) Lockwasher and heavy hex nut 8 per Floorbeam 3" center spacing
See note 2c
Bolt, 7/8 x 3 1/4" hex, A325 7/8" Hardened Washer (2), Lock Washer, Heavy Hex Nut 42 per Floorbeam
HAS-E Threaded Rod 1" x 14" Long (11 5/8" embedment, minimum) 1" USS Flat Washer, Lockwasher and heavy hex nut 8 per Floorbeam 6" center spacing
See note 2b

Detail C
Floorbeam, 9 required

10" typ

2a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted
2b. All Anchors in concrete to be epoxied in using HIT-RE 500 V3, with Hilti instructions.
3a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
4a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
5a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
6a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
Stringer Detail

7a. All steel shall be ASTM A572 Grade 50, unless otherwise noted.
8a. All Rebar is Grade 60
8b. All concrete is TxDOT Class S (4000 psi)
Concrete Dimensional Details

9a. All Rebar is Grade 60
9b. All concrete is TxDOT Class S (4000 psi)
**Support Block Detail**

**Detail E**
Support Block Detail
Typical 9 locations

**10a.** All Rebar is Grade 60
**10b.** All concrete is TxDOT Class S (4000 psi)
Rebar Detail

- 15-1/8" Wall to Base
- 8" 3/4" Ø1/2" Lower Transverse L
- 45" Ø3" 5/8" Ø3-3/4" Upper Transverse L
- 42" 46"

Tie Bar
- 6-1/4" Ø5/8" 3-3/4" Ø1/2"
- 25" 8-1/2" Typ 1-3/4" Typ
- 7-3/8" 25-1/4" 6-7/8" Typ

11a. All Rebar is Grade 60
12a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
13a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
13b. Paint the traffic side of the barrier plate (front and top face) in accordance with Maryland State Highway Administration (MDHSA) System B paint system. The top coat shall be grey in color in accordance with Federal Standard 26493.
15a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted

15b. See Diaphragm at Post for Dimensional details
16a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
17a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
Section L-L
Scale 1:5

18a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
18b. All Rail Assembly parts to be galvanized unless otherwise noted.
19a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.

19b. All Rail Assembly parts to be galvanized unless otherwise noted.
20a. All steel shall be ASTM A 709 Grade 50, unless otherwise noted.
Instrument Orientation

Detail M
Scale 1:45

Strain Gauge Placement
Typical traffic and field side flanges

Roadside Safety and Physical Security Division
Proving Ground

Project #612861 MM/ Bridge Rail 2020-11-03
Drawn by BG/ GS/ WS Scale 1:10 Sheet 22 of 22 Instrument Orientation