June 23, 2021

Bret R. Eckert
Trinity Highway Products, LLC
3617 Cincinnati Ave.
Rocklin, CA 95765
USA

Dear Mr. Eckert:

This letter is in response to your April 29, 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 CC-169 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:

- REACT M

**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: REACT M
- Type of system: Crash Cushion
- Test Level: Test Level 3
- Testing conducted by: KARCO Engineering, INC
- Date of request: April 29, 2021

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.
Sincerely,

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety
Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

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>'CC': Crash Cushions, Attenuators, &amp; Terminals</td>
<td>Physical Crash Testing</td>
<td>REACT™ M</td>
<td>AASHTO MASH</td>
<td>TL3</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:** Bret R. Eckert, P.E.
- **Company Name:** Trinity Highway Products, LLC
- **Address:** 3617 Cincinnati Ave., Rocklin, CA 95765
- **Country:** USA

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

The REACT™ M system technology is the commercial embodiment of intellectual property that is protected by patents owned by Trinity Highway Products, LLC ("THP"). THP does not pay royalties for sales of the REACT™ M. The REACT™ M system was designed and developed by engineers and employees at THP. The patent holders of record for the REACT™ M system are Michael J. Buehler, P.E. and Aaron J. Cox, P.E.; both of whom are employed by THP. The associated United States patent numbers 8,974,142 (Dated March 10, 2015), 10,006,179 (Dated June 26, 2018), and other patents pending that are assigned to Energy Absorption Systems, Inc., a fully owned subsidiary of THP.

Applus IDIADA KARCO Engineering, LLC (KARCO) conducted the certification tests of the REACT™ M system. KARCO is an internationally accredited third party crash testing laboratory. Physical crash testing of the REACT™ M system was performed in accordance with testing criteria set forth by the American Association of State Highway and Transportation Officials (AASHTO) in the Manual for Assessing Safety Hardware ("MASH") (2016). Other than fees paid to KARCO to conduct the tests and then analyze and report the test results, KARCO and THP do not share financial interests. The fees paid to KARCO were not dependent or contingent on the results of the tests.
PRODUCT DESCRIPTION

The REACT™ M system is a redirective, non-gating, crash cushion that consists of six high density polyethylene (HDPE) cylinders attached to a steel backup and basetrack assembly. The REACT™ M system HDPE cylinders are designed to compress during head-on impacts and redirect vehicles during angled impacts into the side of the system. The system basetrack has parallel rails that control the rearward compressing action and resist lateral movement during side angled impacts. The REACT™ M system includes a self-contained back-up structure that is designed to resist movement during head-on and side impacts. The REACT™ M system has shown self-restoring characteristics when impacted within MASH 16 crash test standards.

The REACT™ M system has an overall length of 22'-2 3/4" and overall height of is 52 3/4". The REACT™ M system is configured with a back-up designed to shield fixed objects up to 30' wide. The system uses two thicknesses of 36" outside diameter HDPE cylinders and HDPE laminates within certain HDPE cylinders. The structural portions of the REACT™ M consist of backup, basetrack and diaphragms that are hot-dipped galvanized steel. These components are manufactured from ASTM A36 or ASTM A500 Grade B steel. The REACT™ M utilizes 3/4" diameter cable assemblies to help provide vehicle redirection.

The REACT™ M may be placed on reinforced concrete pad substrates with approved anchors and adhesive. A lightweight placard with reflective sheeting is attached to the first HDPE cylinder. Lightweight reflector markers are also attached to the sides of the HDPE cylinders. During MASH 2016 Test 3-37a, the REACT™ M was tested with a transition to concrete barrier which is representative of typical concrete barrier in use on the NHS.

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: Steven Matsusaka

Engineer Signature: Steven Matsusaka

Address: 9270 Holly Road, Adelanto, CA 92301

Country: USA

A brief description of each crash test and its result:
<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
</table>
| 3-30 (100C)          | Applus IDIADA KARCO Test No. P39099-01. Test Date February 24, 2020. Crash Test Report No. TR-P39099-01-NC for MASH Test 3-30 Crash Test of Trinity Highway Products TL-3 REACT™ M.  

The crash cushion was impacted by a 2015 Kia Rio 4-door sedan. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 63.06 mph (101.48 km/h) and at an impact angle of 0.1°, and a quarter vehicle width offset. Upon impact the vehicle’s kinetic energy was absorbed by the system as the TL-3 REACT™ M cylinders were compressed. The TL-3 REACT™ M Crash Cushion brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 39.4 ft/s (12.0 m/s) and a maximum ridedown acceleration of -14.9 g. Damage to the vehicle was concentrated at its front end without penetration or significant deformation into the occupant compartment.  

The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-30. | PASS |

The crash cushion was impacted by a 2016 RAM 1500 4-door pick-up truck. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 61.07 mph (98.28 km/h) and at an impact angle of 0.3°. Upon impact the vehicle’s kinetic energy was absorbed by the system as the TL-3 REACT™ M cylinders were compressed. The TL-3 REACT™ M Crash Cushion brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 31.2 ft/s (9.5 m/s) and a maximum ridedown acceleration of -20.1 g. Damage to the vehicle was concentrated at its front end without penetration or significant deformation into the occupant compartment.  

The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-31. | PASS |
<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-32 (1IO0C)</td>
<td>Applus IDIADA KARCO Test No. P39101-01. Test Date January 27, 2020. Crash Test Report No. TR-P39101-01-NC for MASH Test 3-32 Crash Test of Trinity Highway Products TL-3 REACT™ M. The crash cushion was impacted by a 2016 Kia Rio 4-door sedan. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 60.96 mph (98.10 km/h) and at an impact angle of 15.1°. Upon impact the vehicle's kinetic energy was absorbed by the system as the TL-3 REACT™ M cylinders were compressed. The TL-3 REACT™ M Crash Cushion brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 26.9 ft/s (8.2 m/s) and a maximum ridedown acceleration of -12.9 g. Damage to the vehicle was concentrated at its front end without penetration or significant deformation into the occupant compartment. The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-32.</td>
<td>PASS</td>
</tr>
<tr>
<td>3-33 (2270P)</td>
<td>Applus IDIADA KARCO Test No. P39102-02. Test Date March 16, 2020. Crash Test Report No. TR-P39102-02-NC for MASH Test 3-33 Crash Test of Trinity Highway Products TL-3 REACT™ M. The crash cushion was impacted by a 2014 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 62.76 mph (101.00 km/h) and at an impact angle of 14.5°. Upon impact the vehicle's kinetic energy was absorbed by the system as the TL-3 REACT™ M cylinders were compressed. The TL-3 REACT™ M Crash Cushion brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 32.8 ft/s (10.0 m/s) and a maximum ridedown acceleration of -17.4 g. Damage to the vehicle was concentrated at its front end without penetration or significant deformation into the occupant compartment. The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-33.</td>
<td>PASS</td>
</tr>
<tr>
<td>Test No.</td>
<td>Test Date</td>
<td>Crash Test Report</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>P39103-01</td>
<td>March 11, 2020</td>
<td>TR-P39103-01-NC</td>
</tr>
<tr>
<td>P39104-05</td>
<td>December 17, 2019</td>
<td>TR-P39104-05-NC</td>
</tr>
</tbody>
</table>
| 3-36 (2270P) | Applus IDIADA KARCO Test No. P39105-02. Test Date September 30, 2019. Crash Test Report No. TR-P39105-02-NC for MASH Test 3-36 Crash Test of Trinity Highway Products TL-3 REACT™ M.  
The crash cushion was impacted by a 2013 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 62.10 mph (99.94 km/h) and at an impact angle of 24.5°. The TL-3 REACT™ M Crash Cushion contained and redirected the test vehicle with a maximum Occupant Impact Velocity (OIV) of 31.8 ft/s (9.7 mis) and a maximum ridedown acceleration of -9.9 g. Damage to the vehicle was concentrated at its front left quarter without penetration or significant deformation into the occupant compartment.  
The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-36. | PASS |

The transition was impacted by a 2015 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 REACT™ M Transition to Vertical Wall Barrier at a velocity of 62.41 mph (100.44 km/h) and at an impact angle of 25.9°. The transition contained and redirected the test vehicle with a maximum Occupant Impact Velocity (OIV) of 27.6 ft/s (8.4 mis) and a maximum ridedown acceleration of -10.0 g. Damage to the vehicle was concentrated at its front right quarter without penetration or significant deformation into the occupant compartment.  
The Trinity Highway Products TL-3 REACT™ M Transition to Vertical Wall Barrier met all the requirements for MASH 2016 Test 3-37a. | PASS |
Applus IDIADA KARCO Test No. P40248-01, Test Date September 3, 2020. Crash Test Report No. TR-P40248-01-NC for MASH Test 3-38 Crash Test of Trinity Highway Products TL-3 REACT™ M.

The crash cushion was impacted by a 2014 Chevrolet Malibu 4-door sedan. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 61.58 mph (99.10 km/h) and at an impact angle of 0.0°. Upon impact, the vehicle's kinetic energy was absorbed by the system as the REACT™ M Cylinders were compressed. The TL-3 REACT™ M Crash Cushion brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 35.1 ft/s (10.7 m/s) and a maximum ridedown acceleration of -16.1 g. Damage to the vehicle was concentrated at its front end without penetration or significant deformation into the occupant compartment.

The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-38.

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Test Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-38 (1500A)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>PASS</td>
</tr>
<tr>
<td>3-40 (1100C)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>Non- Relevant Test, not conducted</td>
</tr>
<tr>
<td>3-41 (2270P)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>Non- Relevant Test, not conducted</td>
</tr>
<tr>
<td>3-42 (1100C)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>Non- Relevant Test, not conducted</td>
</tr>
<tr>
<td>3-43 (2270P)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>Non- Relevant Test, not conducted</td>
</tr>
<tr>
<td>3-44 (2270P)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>Non- Relevant Test, not conducted</td>
</tr>
<tr>
<td>3-45 (1500A)</td>
<td>Per MASH, this test intended for non-redirective crash cushions.</td>
<td>Non- Relevant Test, not conducted</td>
</tr>
</tbody>
</table>

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>KARCO Engineering, INC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Signature:</td>
<td>Steven Matsusaka</td>
</tr>
<tr>
<td>Address:</td>
<td>9270 Holly Road, Adelanto, CA 92301</td>
</tr>
<tr>
<td>Country:</td>
<td>USA</td>
</tr>
<tr>
<td>Accreditation Certificate Number and Dates of current Accreditation period:</td>
<td>International Accreditation Services (IAS) ISO 17025 Accreditation Certificate #TL-371 Expires July 1, 2022</td>
</tr>
</tbody>
</table>
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>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
MASH 2016 Test 3-30 Summary

Impact Conditions
- Impact Velocity: 63.06 mph (101.48 km/h)
- Impact Angle: 0.1°
- Location/ Orientation: at intended w/4 (430 mm) offset
- Kinetic Energy: 323.1 kip-ft (438.0 kJ)
- Minimum KE Required: 288 kip-ft (390 kJ)

Exit Conditions
- Exit Velocity: N/A
- Exit Angle: N/A
- Final Vehicle Position: 12.5 ft. (3.8 m) upstream, 26.5 ft. (8.1 m) left
- Exit Box Criteria Met: N/A
- Vehicle Snagging: None
- Vehicle Pocketing: None
- Vehicle Stability: Satisfactory
- Maximum Roll Angle: 11.2°
- Maximum Pitch Angle: 13.4°
- Maximum Yaw Angle: 299.2°

Vehicle Snagging: None
Vehicle Pocketing: None
Vehicle Stability: Satisfactory
Maximum Roll Angle: 11.2°
Maximum Pitch Angle: 13.4°
Maximum Yaw Angle: 299.2°

Minimum KE Required: 288 kip-ft (390 kJ)

Occupant Risk
- Longitudinal OIV: 39.4 ft/s (12.0 m/s)
- Lateral OIV: 5.9 ft/s (1.8 m/s)
- Longitudinal RA: 14.9 g
- Lateral RA: 3.4 g
- THIV: 40.0 ft/s (12.2 m/s)
- PHO: 14.9 g
- ASI: 1.34

Test Article Deflections
- Static: 2.7 ft. (0.8 m)
- Dynamic: 11.2 ft. (3.4 m)
- Working Width: N/A
- Debris Field: N/A

Vehicle Damage
- Vehicle Damage Scale: 12-FD-5
- CDC: 12FDEW2
- Maximum Intrusion: 0.2 in. (6 mm) at toepan

Test Article
- Name/ Model: TL-3 REACT M Crash Cushion
- Type: Crash Cushion
- Crash Cushion Length: 22.2 ft. (6.8 m)
- Road Surface: Smooth, clean concrete

Test Vehicle
- Type / Designation: 1100C
- Year, Make, and Model: 2015 Kia Rio
- Curb Mass: 2,620.1 lbs (1,188.5 kg)
- Test Inertial Mass: 2,430.6 lbs (1,102.5 kg)
- Gross Static Mass: 2,593.7 lbs (1,176.5 kg)

General Information
- Test Agency: Applus IDIADA KARCO
- Test No: P39099-01
- Test Designation: 3-30
- Test Date: 02/24/20

Test Designation: 3-30
Test Date: 02/24/20
Figure 2 Summary of Test 3-31

General Information

- Test Agency: Applus IDIADA KARCO
- Test No.: P39100-02
- Test Designation: 3-31
- Test Date: 03/09/20

Test Article

- Name / Model: TL-3 REACT M Crash Cushion
- Type: Crash Cushion
- Crash Cushion Length: 22.2 ft. (6.8 m)
- Road Surface: Smooth, clean concrete

Test Vehicle

- Type / Designation: 2270P
- Year, Make, and Model: 2016 RAM 1500
- Curb Mass: 5,202.8 lbs (2,360.0 kg)
- Test Inertial Mass: 5,004.4 lbs (2,270.0 kg)
- Gross Static Mass: 5,004.4 lbs (2,270.0 kg)

Impact Conditions

- Impact Velocity: 61.07 mph (98.28 km/h)
- Impact Angle: 0.3°
- Location / Orientation: at article centerline
- Kinetic Energy: 623.9 kip-ft (845.9 kJ)
- Minimum KE required: 594 kip-ft (806 kJ)

Exit Conditions

- Exit Velocity: N/A
- Exit Angle: N/A
- Final Vehicle Position: 182.2 ft. (55.5 m) upstream

Occupant Risk

- Longitudinal OIV: 31.2 ft/s (9.5 m/s)
- Lateral OIV: -0.3 ft/s (-0.1 m/s)
- Longitudinal RA.: 20.1 g
- Lateral RA.: 1.2 g
- THIV: 31.2 ft/s (9.5 m/s)
- PHD: 20.1 g
- ASI: 1.55

Test Article Deflections

- Static: 3.6 ft. (1.1 m)
- Dynamic: 13.6 ft. (4.1 m)
- Working Width: N/A
- Debris Field: N/A

Vehicle Damage

- Vehicle Damage Scale: 12-FD-5
- CDC: 12FDEW1
- Maximum Intrusion: 0.3 in. (8 mm) at toepan

Vehicle Stability

- Maximum Roll Angle: 2.5°
- Maximum Pitch Angle: 5.7°
- Maximum Yaw Angle: 0.7°

Test Article

- Name: TL-3 REACT M
- Crash Cushion Type: Crash Cushion
- Crash Cushion Length: 22.2 ft. (6.8 m)
- Road Surface: Smooth, clean concrete

Vehicle Damage Scale

- Vehicle Damage Scale: 12-FD-5
- CDC: 12FDEW1
- Maximum Intrusion: 0.3 in. (8 mm) at toepan
### General Information

<table>
<thead>
<tr>
<th>Test Agency</th>
<th>Applus IDIADA KARCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test No.</td>
<td>P39101-01</td>
</tr>
<tr>
<td>Test Designation</td>
<td>3-32</td>
</tr>
<tr>
<td>Test Date</td>
<td>01/27/20</td>
</tr>
</tbody>
</table>

### Test Article

<table>
<thead>
<tr>
<th>Name / Model</th>
<th>TL-3 REACT M Crash Cushion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Crash Cushion</td>
</tr>
<tr>
<td>Crash Cushion Length</td>
<td>22.2 ft. (6.8 m)</td>
</tr>
<tr>
<td>Road Surface</td>
<td>Smooth, clean concrete</td>
</tr>
</tbody>
</table>

### Test Vehicle

<table>
<thead>
<tr>
<th>Year, Make, and Model</th>
<th>2016 Kia Rio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curb Mass</td>
<td>2,538.6 lbs (1,151.5 kg)</td>
</tr>
<tr>
<td>Test Inertial Mass</td>
<td>2,438.3 lbs (1,106.0 kg)</td>
</tr>
<tr>
<td>Gross Static Mass</td>
<td>2,603.6 lbs (1,181.0 kg)</td>
</tr>
</tbody>
</table>

### Impact Conditions

<table>
<thead>
<tr>
<th>Impact Velocity</th>
<th>60.96 mph (98.10 km/h)</th>
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</thead>
<tbody>
<tr>
<td>Impact Angle</td>
<td>15.1°</td>
</tr>
<tr>
<td>Location / Orientation</td>
<td>at article centerline</td>
</tr>
<tr>
<td>Kinetic Energy</td>
<td>302.9 kip-ft (410.6 kJ)</td>
</tr>
<tr>
<td>Minimum KE required</td>
<td>288 kip-ft (390 kJ)</td>
</tr>
</tbody>
</table>

### Exit Conditions

<table>
<thead>
<tr>
<th>Exit Velocity</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit Angle</td>
<td>N/A</td>
</tr>
<tr>
<td>Final Vehicle Position</td>
<td>1.0 ft. (0.3 m) downstream</td>
</tr>
<tr>
<td></td>
<td>14.2 ft. (4.3 m) right</td>
</tr>
<tr>
<td>Exit Box Criteria Met.</td>
<td>N/A</td>
</tr>
<tr>
<td>Vehicle Snagging</td>
<td>None</td>
</tr>
<tr>
<td>Vehicle Pocketing</td>
<td>None</td>
</tr>
<tr>
<td>Vehicle Stability</td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>

### Occupant Risk

<table>
<thead>
<tr>
<th>Longitudinal OIV</th>
<th>26.9 ft/s (8.2 m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral OIV</td>
<td>24.3 ft/s (7.4 m/s)</td>
</tr>
<tr>
<td>Longitudinal RA</td>
<td>-12.8 g</td>
</tr>
<tr>
<td>Lateral RA</td>
<td>-12.1 g</td>
</tr>
<tr>
<td>THIV</td>
<td>39.7 ft/s (12.1 m/s)</td>
</tr>
<tr>
<td>PHD</td>
<td>14.9 g</td>
</tr>
<tr>
<td>ASI</td>
<td>1.61</td>
</tr>
</tbody>
</table>

### Test Article Deflections

| Static               | 2.0 ft. (0.6 m) |
| Dynamic              | 9.0 ft. (2.7 m) |
| Working Width        | N/A             |
| Debris Field         | N/A             |

### Vehicle Damage

| Vehicle Damage Scale | 11-FD-5          |
| CDC                  | 11FDEW2          |
| Maximum Intrusion    | 0.1 in. (3 mm) at toe pan |
MASH 2016 Test 3-33 Summary

Figure 2 Summary of Test 3-33

<table>
<thead>
<tr>
<th>General Information</th>
<th>Impact Conditions</th>
<th>Occupant Risk</th>
<th>Test Article Deflections</th>
<th>Vehicle Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Agency..........</td>
<td>Impact Velocity...</td>
<td>Longitudinal OIV</td>
<td>Static..................</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Test No.............</td>
<td>62.76 mph (101.00 km/h)</td>
<td>32.8 ft/s (10.0 m/s)</td>
<td>2.6 ft. (0.8 m)</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Test No.............</td>
<td>Impact Angle......</td>
<td>Lateral OIV....</td>
<td>Dynamic................</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Test Designation....</td>
<td>14.5°</td>
<td>3.3 ft/s (1.0 m/s)</td>
<td>13.1 ft. (4.0 m)</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Test Date...........</td>
<td>0.39 in. left of article centerline</td>
<td>Longitudinal RA</td>
<td>Working Width...........</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Name / Model........</td>
<td>Kinetic Energy.....</td>
<td>17.4 g</td>
<td>N/A</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Type................</td>
<td>659.2 kip-ft (893.8 kJ)</td>
<td>Lateral RA......</td>
<td>Debris Field............</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Crash Cushion Length</td>
<td>Minimum KE required</td>
<td>3.1 g</td>
<td>N/A</td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Road Surface........</td>
<td>594 kip-ft (806 kJ)</td>
<td>Longitudinal RA</td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Test Vehicle........</td>
<td>Exit Conditions...</td>
<td>32.8 ft/s (10.0 m/s)</td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Type / Designation..</td>
<td>Exit Velocity......</td>
<td>PHD................</td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Year, Make, and Model</td>
<td>Exit Angle........</td>
<td>17.4 g</td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Curb Mass...........</td>
<td>N/A</td>
<td>ASI................</td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Test Inertial Mass...</td>
<td>Final Vehicle Position</td>
<td>1.22</td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Gross Static Mass....</td>
<td>8.3 ft. (2.5 m) upstream</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Exit Box Criteria Met</td>
<td>12.1 ft. (3.7 m) right</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Vehicle Snagging.....</td>
<td>Exit Box Criteria Met</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Vehicle Pocketing.....</td>
<td>N/A</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Vehicle Stability.....</td>
<td>None</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Maximum Roll Angle...</td>
<td>None</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Maximum Pitch Angle...</td>
<td>None</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
<tr>
<td>Maximum Yaw Angle....</td>
<td>None</td>
<td></td>
<td></td>
<td>11-FD-5</td>
</tr>
</tbody>
</table>

Test Article Deflections

Static..................| 2.6 ft. (0.8 m)         | 11-FD-5       |
Dynamic................| 13.1 ft. (4.0 m)        | 11-FD-5       |
Working Width...........| N/A                     | 11-FD-5       |
Debris Field............| N/A                     | 11-FD-5       |

Vehicle Damage

CDC .................. | 11FDEW3                 | 11-FD-5       |
Maximum Intrusion..... | 0.2 in. (5 mm) at floor pan | 11-FD-5       |

Vehicle Damage Scale... | 11-FD-5         | 11-FD-5       |

Table 2 TestParameters of Test 3-33
MASH 2016 Test 3-34 Summary

Figure 2 Summary of Test 3-34
MASH 2016 Test 3-35 Summary

Impact Conditions
- Impact Velocity: 65.30 mph (105.09 km/h)
- Impact Angle: 24.9°
- Location/Orientation: 2.8 in. upstream of CIP
- Impact Severity: 126.7 kip-ft (171.8 kJ)
- Minimum IS required: 106 kip-ft (144 kJ)

Exit Conditions
- Exit Velocity: 46.17 mph (74.30 km/h)
- Exit Angle: 12.0°
- Final Vehicle Position: 169.5 ft. (51.7 m) downstream
- Maximum Roll Angle: 17.1°
- Maximum Pitch Angle: 11.3°
- Maximum Yaw Angle: 35.1°

General Information
- Test Agency: Applus IDIADA KARCO
- Test No: P39104-05
- Test Date: 12/17/19

Test Article
- Name / Model: TL-3 REACT M Crash Cushion
- Crash Cushion Length: 22.2 ft. (6.8 m)
- Road Surface: Smooth, clean concrete

Test Vehicle
- Type / Designation: 2270P
- Year, Make, and Model: 2015 RAM 1500
- Curb Mass: 5,049.6 lbs (2,290.5 kg)
- Test Inertial Mass: 5,015.4 lbs (2,275.0 kg)
- Gross Static Mass: 5,015.4 lbs (2,275.0 kg)

Occupant Risk
- Longitudinal OIV: 28.9 ft/s (8.8 m/s)
- Lateral OIV: -23.0 ft/s (-7.0 m/s)
- Longitudinal RA: 12.7 g
- Lateral RA: 11.0 g
- THIV: 39.7 ft/s (12.1 m/s)
- PHO: 13.1 g
- ASI: 1.58

Test Article Deflections
- Static: 2.4 in. (61.0 mm)
- Dynamic: 9.6 in. (244.0 mm)
- Working Width: 4.0 ft. (1.2 m)
- Debris Field: N/A

Vehicle Damage
- Vehicle Damage Scale: 11-LFO-4
- CDC: 11FDEK1 and 11LDES1
- Maximum Intrusion: 4.1 in. (105 mm) at toe pan

Figure 2 Summary of Test 3-35
MASH 2016 Test 3-36 Summary

General Information
- Test Agency: Applus IDIADA KARCO
- Test No.: P39105-02
- Test Designation: 3-36
- Test Date: 09/30/19

Test Article
- Name / Model: TL-3 REACT M Crash Cushion
- Type: Crash Cushion
- Crash Cushion Length: 22.2 ft. (6.8 m)
- Road Surface: Smooth, clean concrete

Test Vehicle
- Type / Designation: 2270P
- Year, Make, and Model: 2013 RAM 1500
- Curb Mass: 4,915.1 lbs (2,229.5 kg)
- Test Inertial Mass: 5,019.8 lbs (2,277.0 kg)
- Gross Static Mass: 5,019.8 lbs (2,277.0 kg)

Impact Conditions
- Impact Velocity: 62.10 mph (99.94 km/h)
- Impact Angle: 24.5°
- Location / Orientation: 1.7 in. downstream from CIP
- Impact Severity: 111.3 kip-ft (150.9 kJ)
- Minimum IS required: 106 kip-ft (144 kJ)

Exit Conditions
- Exit Velocity: 47.60 mph (76.60 km/h)
- Exit Angle: 7.0°
- Final Vehicle Position: 148.2 ft. (45.2 m) downstream
  11.8 ft. (3.6 m) left
- Exit Box Criteria Met: Yes
- Vehicle Snagging: None
- Vehicle Pocketing: None
- Vehicle Stability: Satisfactory
- Maximum Roll Angle: -29.6°
- Maximum Pitch Angle: 9.5°
- Maximum Yaw Angle: -33.1°

Occupant Risk
- 31.8 ft/s (9.7 m/s)
- -24.6 ft/s (-7.5 m/s)
- -9.9 g
- 8.9 g
- 42.0 ft/s (12.8 m/s)
- 9.6 g
- 1.44

Test Article Deflections
- 1.7 in. (43.0 mm)
- 8.0 in. (204.0 mm)
- 49.2 in. (1.3 m)
- N/A

Vehicle Damage
- Vehicle Damage Scale: 11-LFQ-4
- CDC: 11FDEK2 and 11LDAS2
- Maximum Intrusion: 7.8 in. (199 mm) at toepan

Figure 2 Summary of Test 3-36
### General Information

<table>
<thead>
<tr>
<th>Test Agency</th>
<th>Applus IDIADA KARCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test No.</td>
<td>P39106-05</td>
</tr>
<tr>
<td>Test Designation</td>
<td>3-37a</td>
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<tr>
<td>Test Date</td>
<td>08/06/20</td>
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### Test Article

<table>
<thead>
<tr>
<th>Name / Model</th>
<th>TL-3 REACT M Transition to Vertical Wall Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Crash Cushion</td>
</tr>
<tr>
<td>Crash Cushion Length</td>
<td>22.2 ft. (6.8 m)</td>
</tr>
<tr>
<td>Transition Length</td>
<td>9.9 ft. (3.0 m)</td>
</tr>
<tr>
<td>Road Surface</td>
<td>Smooth, clean concrete</td>
</tr>
</tbody>
</table>

### Test Vehicle

<table>
<thead>
<tr>
<th>Type / Designation</th>
<th>2270P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year, Make, and Model</td>
<td>2015 RAM 1500</td>
</tr>
<tr>
<td></td>
<td>Test Inertial Mass</td>
</tr>
<tr>
<td></td>
<td>Gross Static Mass</td>
</tr>
</tbody>
</table>

### Impact Conditions

<table>
<thead>
<tr>
<th>Impact Velocity</th>
<th>62.41 mph (100.44 km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Angle</td>
<td>25.9°</td>
</tr>
<tr>
<td>Location / Orientation</td>
<td>8.3 ft. upstream of backup</td>
</tr>
<tr>
<td>Impact Severity</td>
<td>124.6 kip-ft (168.9 kJ)</td>
</tr>
<tr>
<td>Minimum IS required</td>
<td>106 kip-ft (144 kJ)</td>
</tr>
</tbody>
</table>

### Exit Conditions

<table>
<thead>
<tr>
<th>Exit Velocity</th>
<th>46.17 mph (74.30 km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit Angle</td>
<td>8.8°</td>
</tr>
<tr>
<td>Final Vehicle Position</td>
<td>138.7 ft. (42.3 m) downstream</td>
</tr>
<tr>
<td>Exit Box Criteria Met</td>
<td>Yes</td>
</tr>
<tr>
<td>Vehicle Snagging</td>
<td>None</td>
</tr>
<tr>
<td>Vehicle Pocketing</td>
<td>None</td>
</tr>
<tr>
<td>Vehicle Stability</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>Maximum Roll Angle</td>
<td>21.6 °</td>
</tr>
<tr>
<td>Maximum Pitch Angle</td>
<td>-21.7 °</td>
</tr>
<tr>
<td>Maximum Yaw Angle</td>
<td>39.0 °</td>
</tr>
</tbody>
</table>

### Occupant Risk

- 23.6 ft/s (7.2 m/s)
- 27.6 ft/s (8.4 m/s)
- -9.1 g
- -10.0 g
- 13.5 g
- 1.87

### Test Article Deflections

- 2.3 in. (59.0 mm)
- 2.3 in. (59.0 mm)
- 3.5 ft. (1.1 m)
- N/A

### Vehicle Damage

- Vehicle Damage Scale: 01-RFQ-4
- CDC: 01FYEK3 and 01RDES3
- Maximum Intrusion: 8.6 in. (218 mm) at toepan
MASH 2016 Test 3-38 Summary

General Information
- Test Agency: Applus IDIADA KARCO
- Test No: P40248-01
- Test Designation: 3-38
- Test Date: 09/03/20

Test Article
- Name / Model: TL-3 REACT M Crash Cushion
- Type / Designation: Crash Cushion
- Crash Cushion Length: 22.2 ft (6.8 m)
- Road Surface: Smooth, clean concrete

Test Vehicle
- Type / Designation: 1500A
- Year, Make, and Model: 2014 Chevrolet Malibu
- Curb Mass: 3,443.6 lbs (1,562.0 kg)
- Gross Static Mass: 3,317.9 lbs (1,505.0 kg)

Impact Conditions
- Impact Velocity: 61.58 mph (99.10 km/h)
- Impact Angle: 0.0°
- Location / Orientation: at article centerline
- Kinetic Energy: 420.6 kip-ft (570.2 kJ)
- Minimum KE required: 392 kip-ft (532 kJ)

Exit Conditions
- Exit Velocity: N/A
- Exit Angle: N/A
- Final Vehicle Position: 17.5 ft (5.3 m) upstream, 0.7 ft (0.2 m) right
- Exit Box Criteria Met: N/A
- Vehicle Snagging: None
- Vehicle Pocketing: None
- Vehicle Stability: Satisfactory
- Maximum Roll Angle: 10.4°
- Maximum Pitch Angle: 6.9°
- Maximum Yaw Angle: 9.0°

Occupant Risk
- Longitudinal OIV: 35.1 ft/s (10.7 m/s)
- Lateral OIV: 0.7 ft/s (-0.2 m/s)
- Longitudinal RA: 16.1 g
- Lateral RA: 1.7 g
- THIV: 35.1 ft/s (10.7 m/s)
- PHD: 16.1 g
- ASI: 1.26

Test Article Deflections
- Minimum KE required: 392 kip-ft (532 kJ)

Vehicle Damage
- Vehicle Damage Scale: 12-FD-1
- CDC: 12FDEW1
- Maximum Intrusion: No measurable deformation

Figure 2 Summary of Test 3-38
INTENDED USE
The REACT™ M system is a redirective, non-gating, crash cushion designed to shield fixed hazards up to 30" wide. The REACT™ M system is designed to offer impact protection for both MASH light and heavy vehicles and shield hazards such as gore areas and bifurcations. It is effective against head-on and redirection impacts at typical highway speeds. The REACT™ M system has been shown to provide self-restoring characteristics when impacted within MASH 2016 crash test standards.

FEATURES
The REACT™ M system consists of six high density polyethylene (HDPE) cylinders attached to a galvanized steel backup and basetrack assembly. The REACT™ M system's HDPE cylinders are designed to compress during head-on impacts and redirect vehicles away from the shielded hazard for impacts along the side of the system. The REACT™ M is eligible for federal reimbursement as a MASH Test Level 3 crash cushion. The system uses two thicknesses of 36" outside diameter HDPE cylinders and HDPE laminates within certain HDPE cylinders. The structural portions of the REACT™ M consist of backup, basetrack and diaphragms that are hot-dipped galvanized steel. The REACT™ M utilizes 3/4" diameter cable assemblies designed to assist with vehicle redirection performance. Lightweight reflector markers may also be attached to the sides of the HDPE cylinders to provide additional delineation per customer requirements.

SPECIFICATIONS
Length: 267 [6781mm] nominal
Width: 36 [914mm] nominal
Height: 53 [1346mm] nominal
Weight: 4928 lb [2235 kg] nominal

ELIGIBILITY
The REACT™ M has been tested in conformance to MASH 2016 Test Level 3 and is eligible for Federal reimbursement by FHWA.

FHWA Eligibility Letter(s): CC-XXX dated__________ for MASH 2016 Test Level 3.

REFERENCES
Manual for Assessing Safety Hardware (MASH), American Association of State Highway and Transportation Officials (AASHTO), 2016.

CONTACT INFORMATION
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