



U.S. Department
of Transportation
**Federal Highway
Administration**

June 23,2021

1200 New Jersey Ave., SE
Washington, D.C. 20590

In Reply Refer To:
HSST-1/CC-169

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.

Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number CC-169 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,

A handwritten signature in black ink that reads "Michael S. Griffith". The signature is written in a cursive style with a large initial "M" and "G".

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

Enclosures

Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Submitter	Date of Request:	April 29, 2021	<input checked="" type="radio"/> New <input type="radio"/> Resubmission
	Name:	Bret R. Eckert, P.E.	
	Company:	Trinity Highway Products, LLC	
	Address:	3617 Cincinnati Ave., Rocklin, CA 95765	
	Country:	USA	
	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

!-!-!

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'CC': Crash Cushions, Attenuators, & Terminals	<input checked="" type="radio"/> Physical Crash Testing <input type="radio"/> Engineering Analysis	REACT™ M	AASHTO MASH	TL3

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.	Same as Submitter <input checked="" type="checkbox"/>
Company Name:	Trinity Highway Products, LLC	Same as Submitter <input checked="" type="checkbox"/>
Address:	3617 Cincinnati Ave., Rocklin, CA 95765	Same as Submitter <input checked="" type="checkbox"/>
Country:	USA	Same as Submitter <input checked="" type="checkbox"/>

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

New Hardware or Significant Modification
 Modification to Existing Hardware

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	Digitally signed by Steven Matsusaka DN: cn=Steven Matsusaka, email=steven.matsusaka@diada.com, c=US Date: 2021.04.28 17:27:02 -07'00'
Address:	9270 Holly Road, Adelanto, CA 92301	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input checked="" type="checkbox"/>

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-30 (11O0C)	<p>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.</p> <p>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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-30.</p>	PASS
3-31 (2270P)	<p>Applus IDIADA KARCO Test No. P39100-02. Test Date March 9, 2020. Crash Test Report No. TR-P39100-02-NC for MASH Test 3-31 Crash Test of Trinity Highway Products TL-3 REACT™ M.</p> <p>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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-31.</p>	PASS

Required Test Number	Narrative Description	Evaluation Results
3-32 (1100C)	<p>Applus IDIADA KARCO Test No. P39 101-01. 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.</p> <p>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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-32.</p>	PASS
3-33 (2270P)	<p>Applus IDIADA KARCO Test No. P391 02-02. 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.</p> <p>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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-33.</p>	PASS

<p>3-34 (1100C)</p>	<p>Applus IDIADA KARCO Test No. P39103-01 . Test Date March 11, 2020. Crash Test Report No. TR-P39103-01-NC for MASH Test 3-34 Crash Test of Trinity Highway Products TL-3 REACT™ M.</p> <p>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 61.85 mph (99.54 km/h) and at an impact angle of 15.1°. The TL-3 REACT™ M Crash Cushion contained and redirected the test vehicle with a maximum Occupant Impact Velocity (OIV) of 22.0 ft/s (6.7 <i>mis</i>) and a maximum ridedown acceleration of -9.3 g. Damage to the vehicle was concentrated at its front right quarter without penetration or significant deformation into the occupant compartment.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-34.</p>	<p>PASS</p>
<p>3-35 (2270P)</p>	<p>Applus IDIADA KARCO Test No. P39104-05. Test Date December 17, 2019. Crash Test Report No. TR-P39104-05-NC for MASH Test 3-35 Crash Test of Trinity Highway Products TL-3 REACT™ M.</p> <p>The crash cushion was impacted by a 2015 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 REACT™ M Crash Cushion at a velocity of 65.30 mph (105.09 km/h) and at an impact angle of 24.9°. The TL-3 REACT™ M Crash Cushion contained and redirected the test vehicle with a maximum Occupant Impact Velocity (OIV) of 28.9 ft/s (8.8 <i>mis</i>) and a maximum ridedown acceleration of -12.7 g. Damage to the vehicle was concentrated at its front left quarter without penetration or significant deformation into the occupant compartment.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-35.</p>	<p>PASS</p>

<p>3-36 (2270P)</p>	<p>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.</p> <p>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 <i>mis</i>) 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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-36.</p>	<p>PASS</p>
<p>3-37a (2270P)</p>	<p>Applus IDIADA KARCO Test No. P39106-05. Test Date August 6, 2020. Crash Test Report No. TR-P39106-05-NC for MASH Test 3-37a Crash Test of Trinity Highway Products TL-3 REACT™ M.</p> <p>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 <i>mis</i>) 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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Transition to Vertical Wall Barrier met all the requirements for MASH 2016 Test 3-37a.</p>	<p>PASS</p>

3-38 (1500A)	<p>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.</p> <p>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.</p> <p>The Trinity Highway Products TL-3 REACT™ M Crash Cushion met all the requirements for MASH 2016 Test 3-38.</p>	PASS
3-40 (1100C)	Per MASH, this test intended for non-redirective crash cushions.	Non-Relevant Test, not conducted
3-41 (2270P)	Per MASH, this test intended for non-redirective crash cushions.	Non-Relevant Test, not conducted
3-42 (1100C)	Per MASH, this test intended for non-redirective crash cushions.	Non-Relevant Test, not conducted
3-43 (2270P)	Per MASH, this test intended for non-redirective crash cushions.	Non-Relevant Test, not conducted
3-44 (2270P)	Per MASH, this test intended for non-redirective crash cushions.	Non-Relevant Test, not conducted
3-45 (1500A)	Per MASH, this test intended for non-redirective crash cushions.	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.):

Laboratory Name:	KARCO Engineering, INC	
Laboratory Signature:	<p>Steven Matsusaka</p> <small>Digitally signed by Steven Matsusaka DN: cn=Steven Matsusaka, email=steven@matsusaka-idiada.com, c=US Date: 2022.06.17 11:00:00</small>	
Address:	9270 Holly Road, Adelanto, CA 92301	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input checked="" type="checkbox"/>
Accreditation Certificate Number and Dates of current Accreditation period :	<p>nternational Accreditation Services (IAS) ISO 17025 Accreditation Certificate #TL-371 Expires July 1, 2022</p>	

Submitter Signature*: Bret Eckert, P.E.

Digitally signed by Bret Eckert, P.E.
DN: cn=Bret Eckert, P.E., ou=Trinity
Highway Products,
email=bret.eckert@trinity.com
Date: 2021.04.29 07:49:15 -0700

Submit Form

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

MASH 2016 Test 3-30 Summary



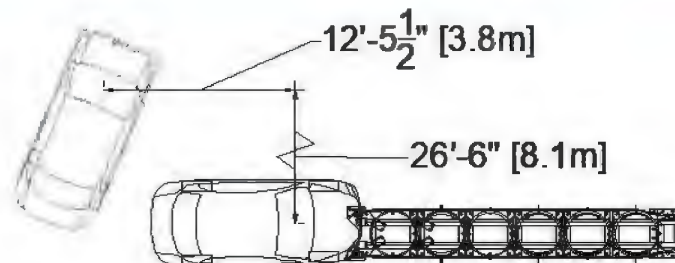
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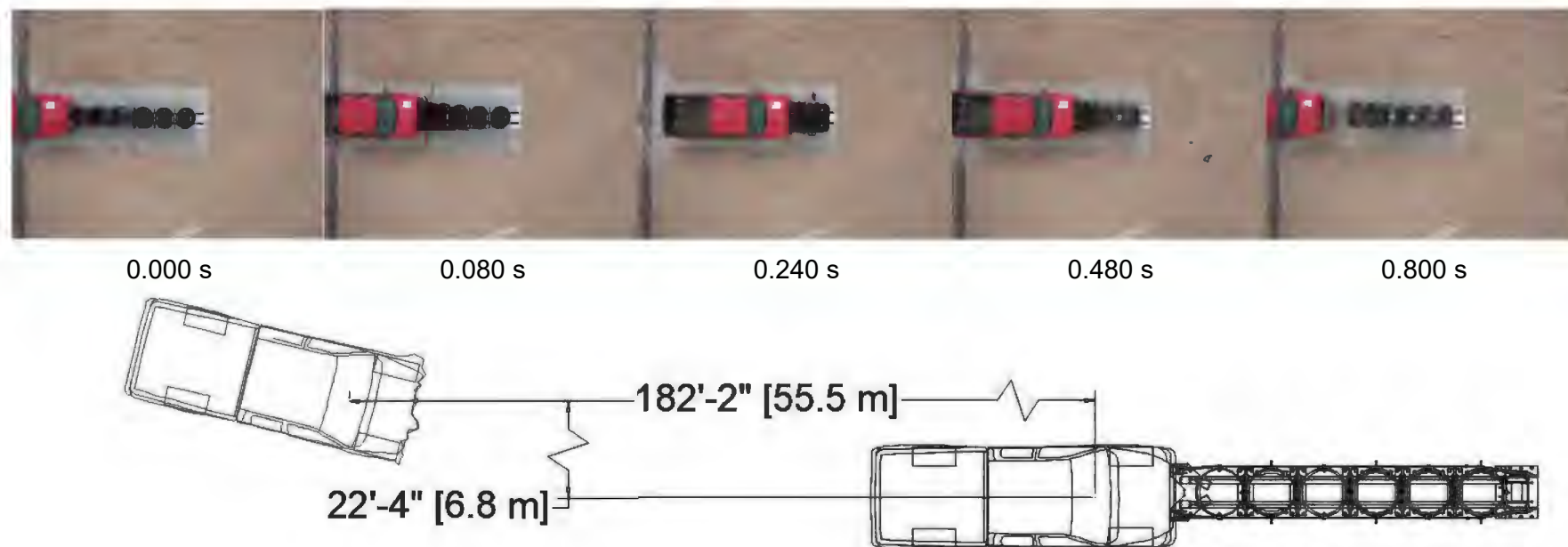
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<u>General Information</u>	<u>Impact Conditions</u>	<u>Occupant Risk</u>
Test AgencyApplus IDIADA KARCO Test No.....P39099-01 Test Designation.....3-30 Test Date.....02/24/20	Impact Velocity63.06 mph (101.48 km/h) Impact Angle0.1° Location/ Orientationat intended w/4 (430 mm) offset Kinetic Energy323.1 kip-ft (438.0 kJ) Minimum KE Required288 kip-ft (390 kJ)	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 RA3.4 g THIV40.0 ft/s (12.2 m/s) PHO..... 14.9 g ASI..... 1.34
<u>Test Article</u>	<u>Exit Conditions</u>	<u>Test Article Deflections</u>
Name/ Model.....TL-3 REACT M Crash Cushion TypeCrash Cushion Crash Cushion Length.....22.2 ft. (6.8 m) Road Surface.....Smooth, clean concrete	Exit VelocityN/A Exit AngleN/A Final Vehicle Position12.5 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 StabilitySatisfactory Maximum Roll Angle 11.2 ° Maximum Pitch Angle..... 13.4 ° Maximum Yaw Angle..... 299.2 °	Static2.7 ft. (0.8 m) Dynamic.....11.2 ft. (3.4 m) Working Width N/A Debris Field..... N/A
<u>Test Vehicle</u>		<u>Vehicle Damage</u>
Type / Designation..... 1100C Year, Make, and Model.2015 Kia Rio Curb Mass2,620.1 lbs (1,188.5 kg) Test Inertial Mass.....2,430.6 lbs (1,102.5 kg) Gross Static Mass2,593.7 lbs (1,176.5 kg)		Vehicle Damage Scale..... 12-FD-5 CDC..... 12FDEW2 Maximum Intrusion 0.2 in. (6 mm) at toepan

Figure 2 Summary of Test 3-30

MASH 2016 Test 3-31 Summary



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	5,004.4lbs (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 22.3 ft. (6.8 m)
leftExit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability	Satisfactory
Maximum Roll Angle.....	2.5 °
Maximum Pitch Angle.....	5.7 °
Maximum Yaw Angle.....	0.7 °

Occupant Risk	
Longitudinal OIV	31.2 ft/s (9.5 m/s)
Lateral OIV.....	-1.0 ft/s (-0.3 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

Figure 2 Summary of Test 3-31

MASH 2016 Test 3-32 Summary



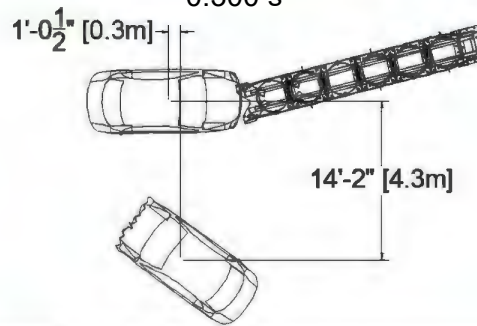
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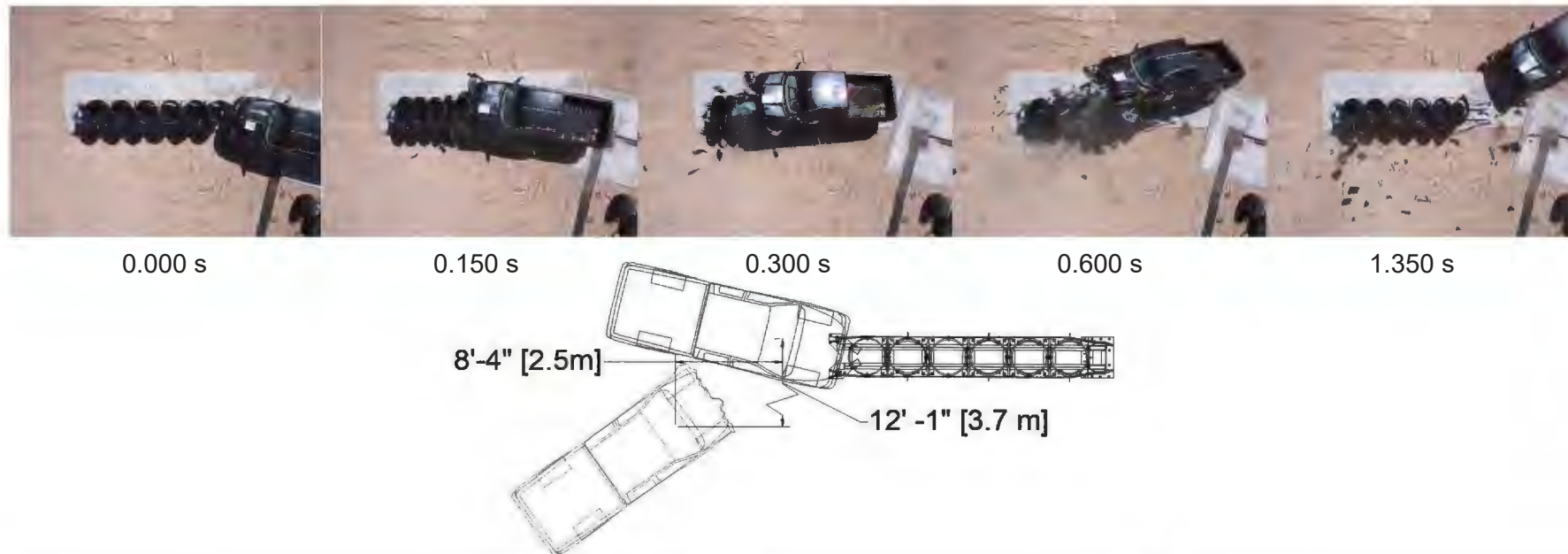
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General Information		Impact Conditions		Occupant Risk	
Test Agency.....	Applus IDIADA KARCO	Impact Velocity.....	60.96 mph (98.10 km/h)	Longitudinal OIV.....	26.9 ft/s (8.2 m/s)
Test No.....	P39101-01	Impact Angle.....	15.1°	Lateral OIV.....	24.3 ft/s (7.4 m/s)
Test Designation.....	3-32	Location / Orientation.....	at article centerline	Longitudinal RA.....	-12.9 g
Test Date.....	01/27/20	Kinetic Energy.....	302.9 kip-ft (410.6 kJ)	Lateral RA.....	-12.1 g
Test Article		Minimum KE required.....	288 kip-ft (390 kJ)	THIV.....	39.7 ft/s (12.1 m/s)
Name / Model.....	TL-3 REACT M Crash Cushion	Exit Conditions		PHD.....	14.9 g
Type.....	Crash Cushion	Exit Velocity.....	N/A	ASI.....	1.61
Crash Cushion Length....	22.2 ft. (6.8 m)	Exit Angle.....	N/A	Test Article Deflections	
Road Surface.....	Smooth, clean concrete	Final Vehicle Position.....	1.0 ft. (0.3 m) downstream	Static.....	2.0 ft. (0.6 m)
Test Vehicle			14.2 ft. (4.3 m) right	Dynamic.....	9.0 ft. (2.7 m)
Type / Designation.....	1100C	Exit Box Criteria Met.....	N/A	Working Width.....	N/A
Year, Make, and Model....	2016 Kia Rio	Vehicle Snagging.....	None	Debris Field.....	N/A
Curb Mass.....	2,538.6 lbs (1,151.5 kg)	Vehicle Pocketing.....	None	Vehicle Damage	
Test Inertial Mass.....	2,438.3 lbs (1,106.0 kg)	Vehicle Stability.....	Satisfactory	Vehicle Damage Scale....	11-FD-5
Gross Static Mass.....	2,603.6 lbs (1,181.0 kg)	Maximum Roll Angle.....	17.2 °	CDC.....	11FDEW2
		Maximum Pitch Angle.....	-12.8 °	Maximum Intrusion.....	0.1 in. (3 mm) at toe pan
		Maximum Yaw Angle.....	44.6 °		

Figure 2 Summary of Test 3-32

MASH 2016 Test 3-33 Summary



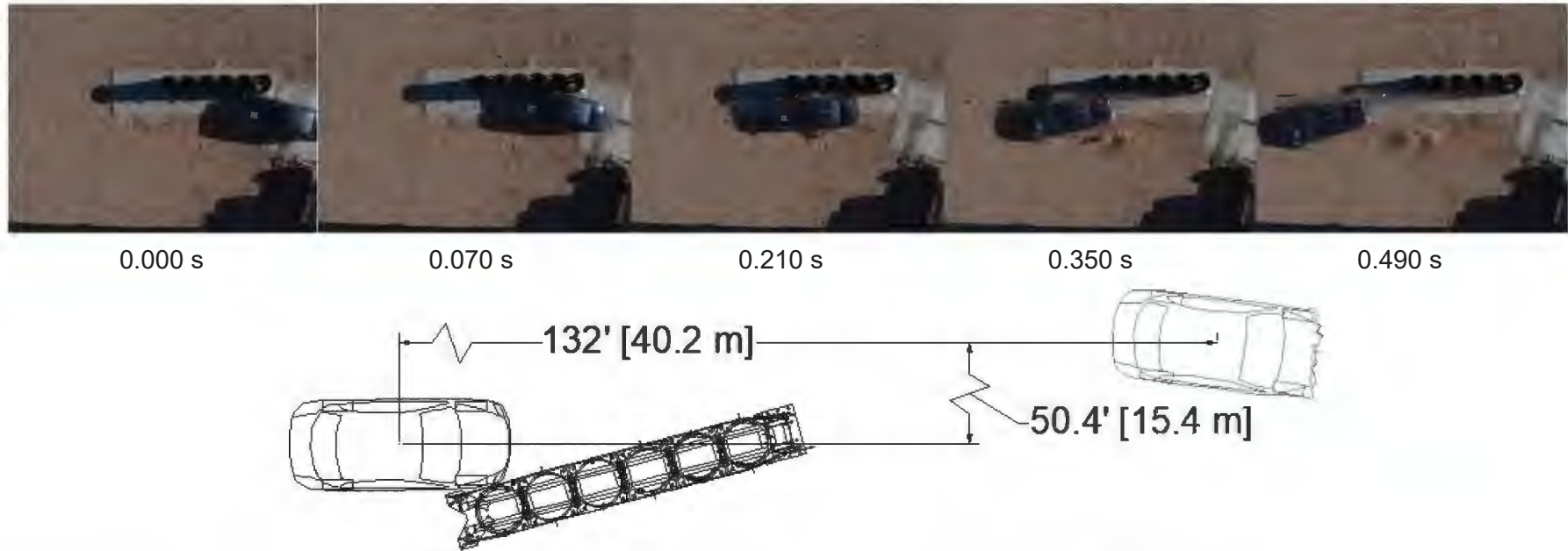
General Information	
Test Agency	Applus IDIADA KARCO
Test No.....	P39102-02
Test Designation.....	3-33
Test Date.....	03/16/20
Test Article	
Name / Model	TL-3 REACT M Crash Cushion
Type	Crash Cushion
Crash Cushion Length.....	22.2 ft. (6.8 m)
Road Surface	Smooth, clean concrete
Test Vehicle	
Type / Designation.....	2270P
Year, Make, and Model	2014 RAM 1500
Curb Mass	5,132.3 lbs (2,328.0 kg)
Test Inertial Mass.....	5,006.6 lbs (2,271.0 kg)
Gross Static Mass.....	5,006.6 lbs (2,271.0 kg)

Impact Conditions	
Impact Velocity	62.76 mph (101.00 km/h)
Impact Angle.....	14.5°
Location / Orientation	3.9 in. left of article centerline
Kinetic Energy.....	659.2 kip-ft (893.8 kJ)
Minimum KE required.....	594 kip-ft (806 kJ)
Exit Conditions	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	8.3 ft. (2.5 m) upstream 12.1 ft. (3.7 m) right
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability	Satisfactory
Maximum Roll Angle... ..	45.6 °
Maximum Pitch Angle... ..	30.8 °
Maximum Yaw Angle.....	27.6 °

Occupant Risk	
Longitudinal OIV.....	32.8 ft/s (10.0 m/s)
Lateral OIV.....	3.3 ft/s (1.0 m/s)
Longitudinal RA	17.4 g
Lateral RA	3.1 g
THIV.....	32.8 ft/s (10.0 m/s)
PHD.....	17.4 g
ASI.....	1.22
Test Article Deflections	
Static.....	2.6 ft. (0.8 m)
Dynamic.....	13.1 ft. (4.0 m)
Working Width.....	N/A
Debris Field.....	N/A
Vehicle Damage	
Vehicle Damage Scale... ..	11-FD-5
CDC	11FDEW3
Maximum Intrusion.....	0.2 in. (5 mm) at floor pan

Figure 2 Summary of Test 3-33

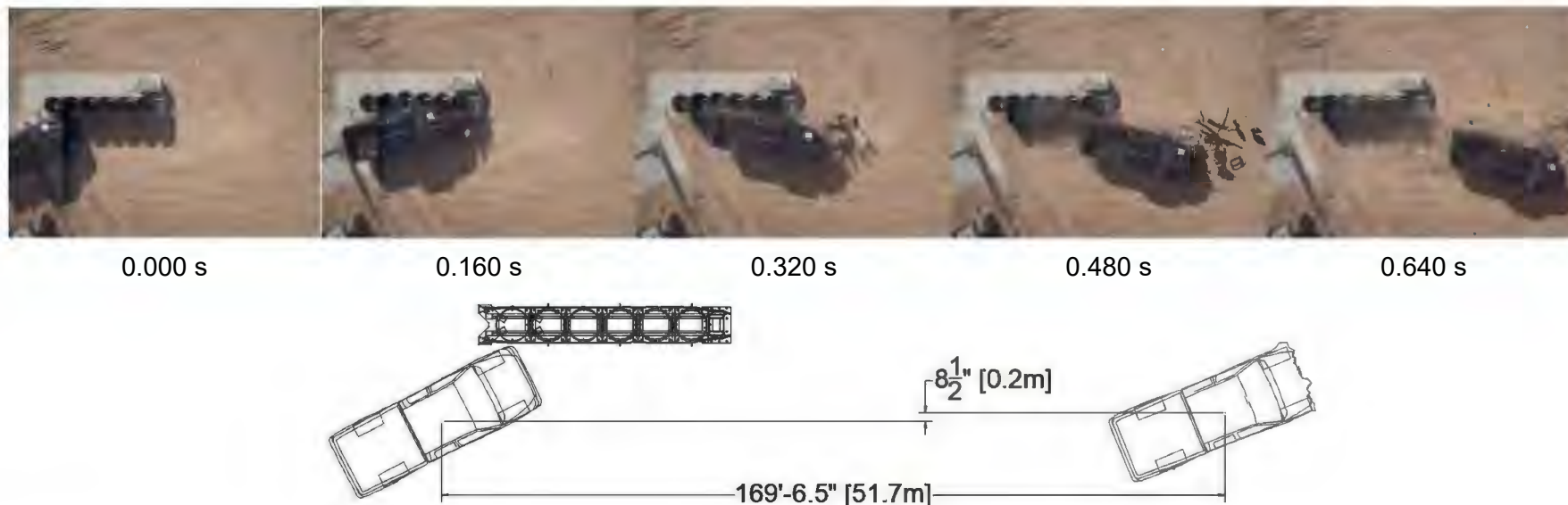
MASH 2016 Test 3-34 Summary



General Information Test Agency Applus IDIADA KARCO Test No. P39103-01 Test Designation 3-34 Test Date..... 03/11/20	Impact Conditions Impact Velocity 61.85 mph (99.54 km/h) Impact Angle..... 15.1° Location / Orientation..... at intended CIP Impact Severity..... 21.4 kip-ft (29.0 kJ) Minimum IS required..... 19 kip-ft (26 kJ)	Occupant Risk Longitudinal OIV..... 20.3 ft/s (6.2 m/s) Lateral OIV..... 22.0 ft/s (6.7 m/s) Longitudinal RA..... 7.4 g Lateral RA..... 9.3 g THIV..... 28.9 ft/s (8.8 m/s) PHD 11.0 g ASI 1.41
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	Exit Conditions Exit Velocity 46.48 mph (74.80 km/h) Exit Angle..... 4.5° Final Vehicle Position 132.0 ft. (40.2 m) downstream 50.4 ft. (15.4 m) left Exit Box Criteria Met Yes Vehicle Snagging None Vehicle Pocketing..... None Vehicle Stability Satisfactory	Test Article Deflections Static..... No measurable deflection Dynamic 1.9 in. (48.0 mm) Working Width... 3.5 ft. (1.1 m) Debris Field..... N/A
Test Vehicle Type / Designation 1100C Year, Make, and Model.... 2016 Kia Rio Curb Mass 2,611.3 lbs (1,184.5 kg) Test Inertial Mass... 2,462.5 lbs (1,117.0 kg) Gross Static Mass 2,626.8 lbs (1,191.5 kg)	Maximum Roll Angle... 8.9° Maximum Pitch Angle... 3.7° Maximum Yaw Angle... 31.9°	Vehicle Damage Vehicle Damage Scale... 01-RFQ-4 CDC 01FYEK1 and 01RDES1 Maximum Intrusion..... 0.2 in. (5 mm) at toepan

Figure 2 Summary of Test 3-34

MASH 2016 Test 3-35 Summary



<p>General Information</p> <p>Test AgencyApplus IDIADA KARCO Test No..... P39104-05 Test Designation.....3-35 Test Date.....12/17/19</p>	<p>Impact Conditions</p> <p>Impact Velocity65.30 mph (105.09 km/h) Impact Angle.....24.9° Location/ Orientation2.8 in. upstream of CIP Impact Severity.....126.7 kip-ft (171.8 kJ) Minimum IS required106 kip-ft (144 kJ)</p>	<p>Occupant Risk</p> <p>Longitudinal OIV28.9 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 THIV39.7 ft/s (12.1 m/s) PHO13.1 g ASI.....1.58</p>
<p>Test Article</p> <p>Name / ModelTL-3 REACT M Crash Cushion TypeCrash Cushion Crash Cushion Length.....22.2 ft. (6.8 m) Road Surface.....Smooth, clean concrete</p>	<p>Exit Conditions</p> <p>Exit Velocity46.17 mph (74.30 km/h) Exit Angle12.0° Final Vehicle Position169.5 ft. (51.7 m) downstream 0.7 ft. (0.2 m) left Exit Box Criteria Met.....Yes Vehicle Snagging.....None Vehicle Pocketing.....None Vehicle StabilitySatisfactory Maximum Roll Angle17.1 ° Maximum Pitch Angle..... 11.3 ° Maximum Yaw Angle..... 35.1 °</p>	<p>Test Article Deflections</p> <p>Static2.4 in. (61.0 mm) Dynamic9.6 in. (244.0 mm) Working Width4.0 ft. (1.2 m) Debris Field..... N/A</p>
<p>Test Vehicle</p> <p>Type / Designation.....2270P Year, Make, and Model2015 RAM 1500 Curb Mass5,049.6 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)</p>	<p>Vehicle Damage</p> <p>Vehicle Damage Scale..... 11-LFQ-4 CDC..... 11FDEK1 and 11LDES1 Maximum Intrusion 4.1 in. (105 mm) at toepan</p>	

Figure 2 Summary of Test 3-35

MASH 2016 Test 3-36 Summary



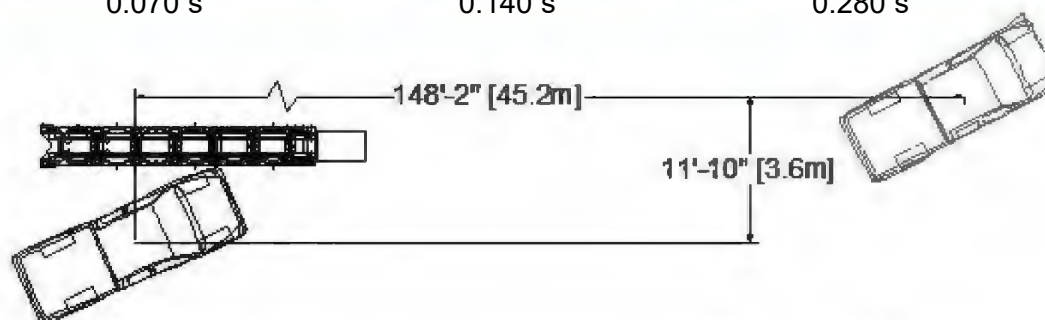
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0.140 s

0.280 s

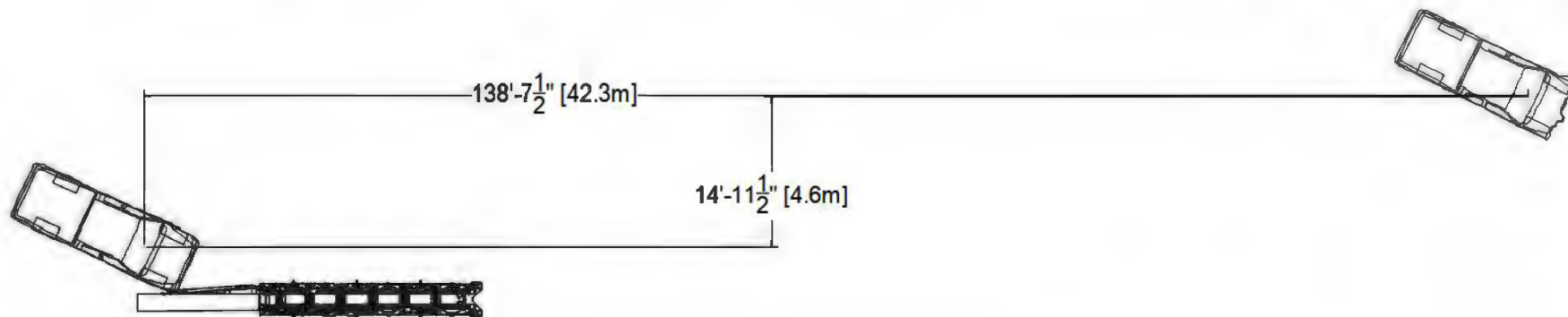
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<u>General Information</u>		<u>Impact Conditions</u>		<u>Occupant Risk</u>	
Test Agency.....	Applus IDIADA KARCO	Impact Velocity.....	62.10 mph (99.94 km/h)	Longitudinal OIV.....	31.8 ft/s (9.7 m/s)
Test No.....	P39105-02	Impact Angle.....	24.5°	Lateral OIV.....	-24.6 ft/s (-7.5 m/s)
Test Designation.....	3-36	Location / Orientation.....	1.7 in. downstream from CIP	Longitudinal RA.....	-9.9 g
Test Date.....	09/30/19	Impact Severity.....	111.3 kip-ft (150.9 kJ)	Lateral RA.....	8.9 g
<u>Test Article</u>		Minimum IS required.....	106 kip-ft (144 kJ)	THIV.....	42.0 ft/s (12.8 m/s)
Name / Model.....	TL-3 REACT M Crash Cushion	<u>Exit Conditions</u>		PHD.....	9.6 g
Type.....	Crash Cushion	Exit Velocity.....	47.60 mph (76.60 km/h)	ASI.....	1.44
Crash Cushion Length.....	22.2 ft. (6.8 m)	Exit Angle.....	7.0°	<u>Test Article Deflections</u>	
Road Surface.....	Smooth, clean concrete	Final Vehicle Position.....	148.2 ft. (45.2 m) downstream 11.8 ft. (3.6 m) left	Static.....	1.7 in. (43.0 mm)
<u>Test Vehicle</u>		Exit Box Criteria Met.....	Yes	Dynamic.....	8.0 in. (204.0 mm)
Type / Designation.....	2270P	Vehicle Snagging.....	None	Working Width.....	49.2 in. (1.3 m)
Year, Make, and Model....	2013 RAM 1500	Vehicle Pocketing.....	None	Debris Field.....	N/A
Curb Mass.....	4,915.1 lbs (2,229.5 kg)	Vehicle Stability.....	Satisfactory	<u>Vehicle Damage</u>	
Test Inertial Mass.....	5,019.8 lbs (2,277.0 kg)	Maximum Roll Angle.....	-29.6°	Vehicle Damage Scale....	11-LFQ-4
Gross Static Mass.....	5,019.8 lbs (2,277.0 kg)	Maximum Pitch Angle.....	9.5°	CDC.....	11FDEK2 and 11LDAS2
		Maximum Yaw Angle.....	-33.1°	Maximum Intrusion.....	7.8 in. (199 mm) at toepan

Figure 2 Summary of Test 3-36

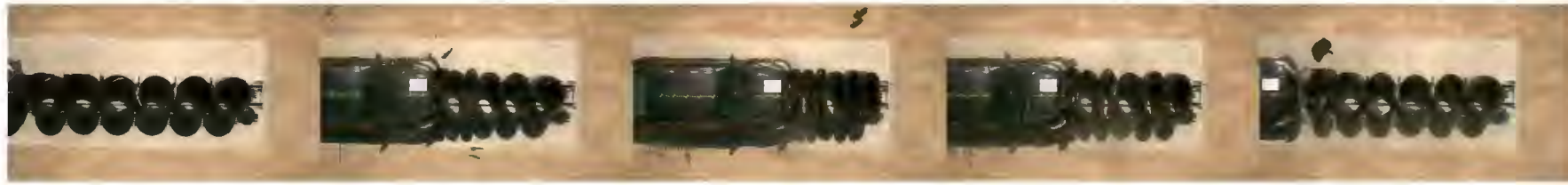
MASH 2016 Test 3-37a Summary



<p>General Information</p> <p>Test Agency..... Applus IDIADA KARCO Test No..... P39106-05 Test Designation..... 3-37a Test Date..... 08/06/20</p>	<p>Impact Conditions</p> <p>Impact Velocity..... 62.41 mph (100.44 km/h) Impact Angle..... 25.9° Location / Orientation..... 8.3 ft. upstream of backup Impact Severity..... 124.6 kip-ft (168.9 kJ) Minimum IS required..... 106 kip-ft (144 kJ)</p>	<p>Occupant Risk</p> <p>Longitudinal OIV..... 23.6 ft/s (7.2 m/s) Lateral OIV..... 27.6 ft/s (8.4 m/s) Longitudinal RA..... -9.1 g Lateral RA..... -10.0 g THIV..... 37.4 ft/s (11.4 m/s) PHD..... 13.5 g ASI..... 1.87</p>
<p>Test Article</p> <p>Name / Model..... TL-3 REACT M Transition to Vertical Wall Barrier Type..... Crash Cushion Crash Cushion Length..... 22.2 ft. (6.8 m) Transition Length..... 9.9 ft. (3.0 m) Road Surface..... Smooth, clean concrete</p>	<p>Exit Conditions</p> <p>Exit Velocity..... 46.17 mph (74.30 km/h) Exit Angle..... 8.8° Final Vehicle Position..... 138.7 ft. (42.3 m) downstream 15.0 ft. (4.6 m) left Exit Box Criteria Met..... Yes Vehicle Snagging..... None Vehicle Pocketing..... None Vehicle Stability..... Satisfactory Maximum Roll Angle..... 21.6° Maximum Pitch Angle..... -21.7° Maximum Yaw Angle..... 39.0°</p>	<p>Test Article Deflections</p> <p>Static..... 2.3 in. (59.0 mm) Dynamic..... 2.3 in. (59.0 mm) Working Width..... 3.5 ft. (1.1 m) Debris Field..... N/A</p>
<p>Test Vehicle</p> <p>Type / Designation..... 2270P Year, Make, and Model.... 2015 RAM 1500 Curb Mass..... 5,119.0 lbs (2,322.0 kg) Test Inertial Mass..... 5,014.3 lbs (2,274.5 kg) Gross Static Mass..... 5,014.3 lbs (2,274.5 kg)</p>	<p>Vehicle Damage</p> <p>Vehicle Damage Scale..... 01-RFQ-4 CDC..... 01FYEK3 and 01RDES3 Maximum Intrusion..... 8.6 in. (218 mm) at toepan</p>	

Figure 2 Summary of Test 3-37a

MASH 2016 Test 3-38 Summary



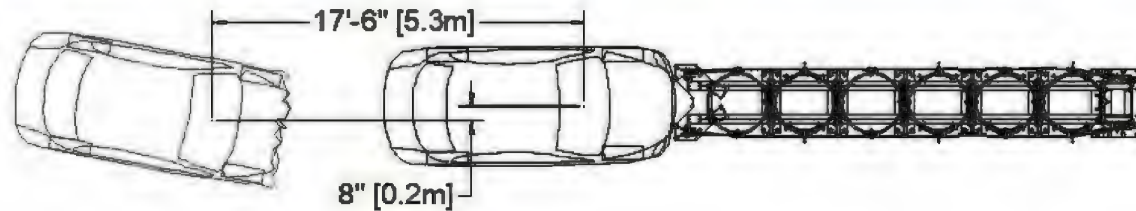
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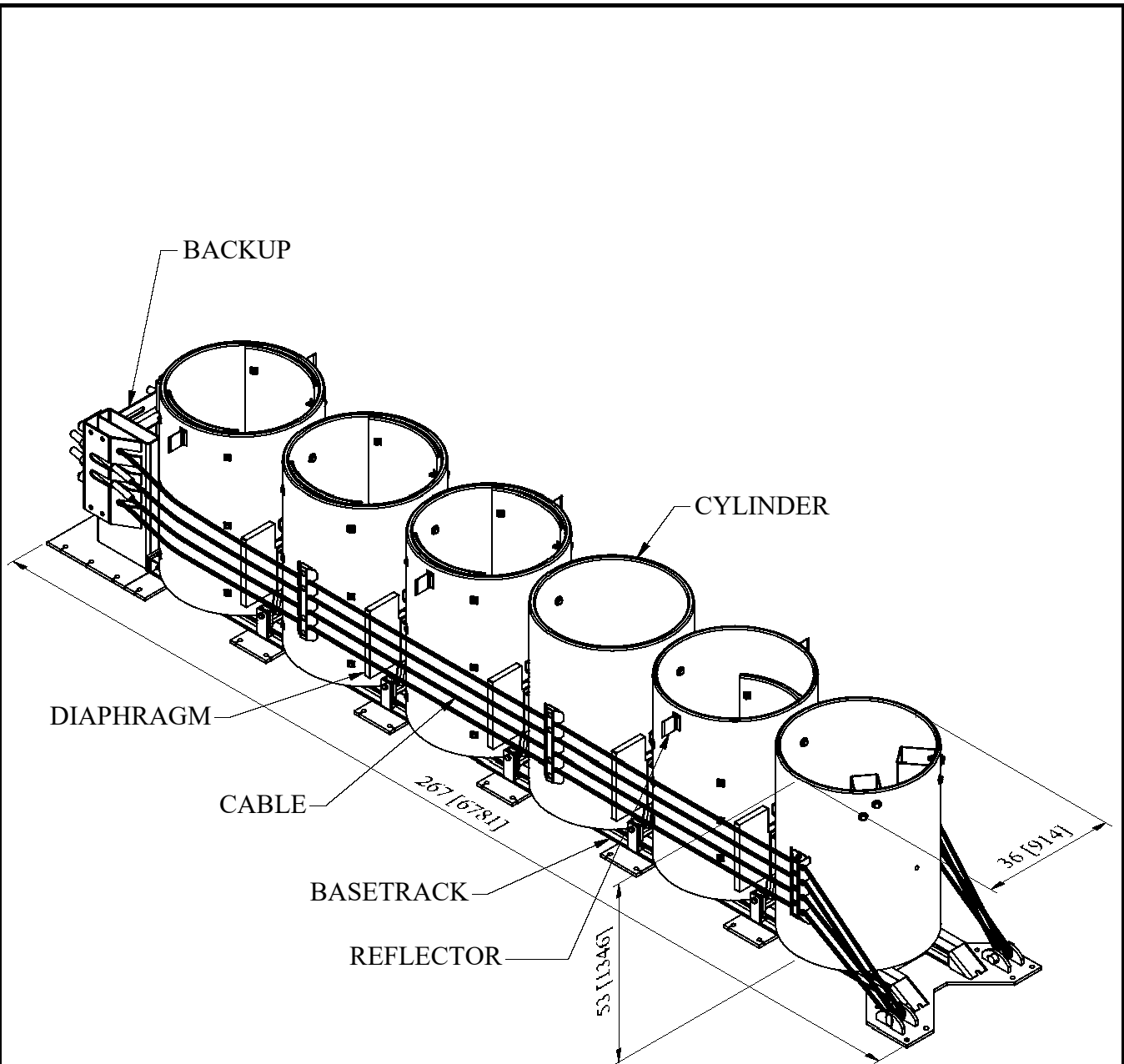
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General Information		Impact Conditions		Occupant Risk	
Test Agency.....	Applus IDIADA KARCO	Impact Velocity.....	61.58 mph (99.10 km/h)	Longitudinal OIV.....	35.1 ft/s (10.7 m/s)
Test No.....	P40248-01	Impact Angle.....	0.0°	Lateral OIV.....	-0.7 ft/s (-0.2 m/s)
Test Designation.....	3-38	Location / Orientation.....	at article centerline	Longitudinal RA.....	-16.1 g
Test Date.....	09/03/20	Kinetic Energy.....	420.6 kip-ft (570.2 kJ)	Lateral RA.....	1.7 g
Test Article		Minimum KE required.....	392 kip-ft (532 kJ)	THIV.....	35.1 ft/s (10.7 m/s)
Name / Model.....	TL-3 REACT M Crash Cushion	Exit Conditions		PHD.....	16.1 g
Type.....	Crash Cushion	Exit Velocity.....	N/A	ASI.....	1.26
Crash Cushion Length.....	22.2 ft. (6.8 m)	Exit Angle.....	N/A	Test Article Deflections	
Road Surface.....	Smooth, clean concrete	Final Vehicle Position.....	17.5 ft. (5.3 m) upstream 0.7 ft. (0.2 m) right	Static.....	3.4 ft. (1.0 m)
Test Vehicle		Exit Box Criteria Met.....	N/A	Dynamic.....	12.9 ft. (3.9 m)
Type / Designation.....	1500A	Vehicle Snagging.....	None	Working Width.....	N/A
Year, Make, and Model.....	2014 Chevrolet Malibu	Vehicle Pocketing.....	None	Debris Field.....	N/A
Curb Mass.....	3,443.6 lbs (1,562.0 kg)	Vehicle Stability.....	Satisfactory	Vehicle Damage	
Test Inertial Mass.....	3,317.9 lbs (1,505.0 kg)	Maximum Roll Angle.....	10.4 °	Vehicle Damage Scale....	12-FD-1
Gross Static Mass.....	3,317.9 lbs (1,505.0 kg)	Maximum Pitch Angle.....	6.9 °	CDC.....	12FDEW1
		Maximum Yaw Angle.....	9.0 °	Maximum Intrusion.....	No measurable deformation

Figure 2 Summary of Test 3-38



2020

REACT™ M



TRINITY
HIGHWAY

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SHEET NO.

DATE

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12/9/2020

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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<https://trinityhighway.com>

REACT™ M

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