



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

November 19, 2020

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

In Reply Refer To:  
HSST-1/CC-164

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

Dear Mr. Eckert:

This letter is in response to your June 05, 2020 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number CC-164 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:

- TL-3 Energite III Sand Barrel Array

### **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: TL-3 Energite III Sand Barrel Array  
Type of system: Crash Cushion  
Test Level: MASH Test Level 3 (TL3)  
Testing conducted by: Applus IDIADA KARCO Engineering, LLC.  
Date of request: June 05, 2020

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

### **Full Description of the Eligible Device**

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

### **Notice**

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

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

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

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

### Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number CC-164 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 blue 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

<b>Submitter</b>	Date of Request:	June 05, 2020	<input checked="" type="radio"/> New <input type="radio"/> Resubmission
	Name:	Bret R.Eckert, P.E.	
	Company:	Trinity Highway Products, LLC	
	Address:	3617 Cincinnati Avenue, 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	TL-3 Energite® III Sand Barrel Array	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:	Anthony Van Brocklin	Same as Submitter <input type="checkbox"/>
Company Name:	Trinity Highway Products, LLC	Same as Submitter <input checked="" type="checkbox"/>
Address:	3617 Cincinnati Avenue, 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 TL-3 Energite® III Sand Barrel Array is manufactured and sold by Trinity Highway Products, LLC ("THP"). THP does not pay royalties for sales of the TL-3 Energite® III Sand Barrel Array. The TL-3 Energite® III Sand Barrel Array was designed and developed by engineers and employees at Energy Absorption Systems, Inc. (EAS), a fully owned subsidiary of THP.

Applus IDIADA Karco Engineering, LLC (KARCO) conducted the certification tests of the TL-3 Energite® III Sand Barrel Array. KARCO is an internationally accredited third party crash testing laboratory. Physical crash testing of the Energite® III system was performed in accordance with the 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

<div style="border: 1px solid black; display: inline-block; padding: 2px 5px; margin-bottom: 5px;">Help</div>		
<p> <input checked="" type="radio"/> New Hardware or Significant Modification              <input type="radio"/> Modification to Existing Hardware       </p> <p>         The TL-3 Energite® III Sand Barrel Array is a gating, non-redirective crash cushion designed to shield the end of rigid objects in both temporary and permanent roadside installation. The Energite® III Sand Barrel Array consists of twelve sand barrel modules positioned in a combined pattern of a single column of four barrels followed by two columns, each four barrels deep. The barrels are spaced 6 in. apart minimum front to back and diagonally. They are spaced 6 in. apart maximum side to side. The approximate width of the array is 80 in. by 335.5 in. deep. The barrels are filled with washed concrete sand conforming to ASTM C33 standard. The amount of sand in each barrel varies, depending on the location of the barrel within the array. The Energite® III Sand Barrel Array was tested on a level concrete surface but it may also be used on asphalt, smooth compacted soil or gravel, and inertial pallets as referenced in the AASHTO Roadside Design Guide.       </p> <p>         The Energite® III Sand Barrel Array utilizes two 2,100 lb. barrels with an overall height with lid of 52 in. and ten 1400 lb. barrels with an overall height with lid of 43 in. The barrels are arranged with gradually increasing weights from front to back. Each sand barrel module in the array consists of a free-standing one-piece barrel and a 37 in. diameter snap-on lid. Inside each barrel is a label with a fill line for the sand. Specified barrels contain an inner cone that locates the sand at the specified height. The initial eight 1,400 lb. barrels have inner cones that, when filled, produce one 200 lb. barrel, two 400 lb. barrels, and five 700 lb. barrels. The remaining two 1,400 lb. barrels and two 2,100 lb. barrels are filled without an inner cone.       </p> <p>         The Energite® III Sand Barrels used in this MASH test series are the same components that were used during NCHRP Report 350 testing. Existing stock of these barrels can therefore be used in MASH arrays.       </p>		
<h3>CRASH TESTING</h3>		
<p>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.</p>		
Engineer Name:	Steve Matusaka	
Engineer Signature:	<div style="font-size: 24pt; font-weight: bold; text-align: center;">Steven Matusaka</div> <small style="font-size: 8pt; text-align: center;">           DN: cn=Steven Matusaka, email=steven.matusaka@idiada.com, c=US            Digitally signed by Steven Matusaka            Date: 2020.05.26 13:02:03 -07'00'         </small>	
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: 

Help

Required Test Number	Narrative Description	Evaluation Results
3-30 (1100C)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-31 (2270P)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-32 (1100C)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-33 (2270P)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-34 (1100C)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-35 (2270P)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted

Required Test Number	Narrative Description	Evaluation Results
3-36 (2270P)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-37 (2270P)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-38 (1500A)	Per MASH, this test is intended for gating/non-gating, redirective type crash cushions.	Non-Relevant Test, not conducted
3-40 (1100C)	<p>Applus IDIADA KARCO Test No. P39257-01. Test Date August 23, 2019. MASH Test 3-40 Crash Test Report No. TR-P39257-01-NC for Trinity Highway Products TL-3 Energite®III Sand Barrel Array.</p> <p>The crash cushion was impacted by a 2010 KiaRio 4-door sedan. The test vehicle impacted the TL-3 Energite®III Sand Barrel Array at a velocity of 60.22 mph (96.91 km/h) and an angle of 0.0°. Upon impact the vehicle's kinetic energy was absorbed as the Energite®III sand barrels were crushed. The TL-3 Energite®III Sand Barrel Array brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 24.6 ft/s (7.5 m/s) and a maximum ridedown acceleration of -10.0 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 Energite®III Sand Barrel Array met all the requirements for MASH 2016 Test 3-40.</p>	PASS

3-41 (2270P)	<p>Applus IDIADA KARCO Test No. P39258-01. Test Date August 21, 2019. MASH Test 3-41 Crash Test Report No. TR-P39258-01-NC for Trinity Highway Products TL-3 Energite® III Sand Barrel Array.</p> <p>The crash cushion was impacted by a 2014 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 Energite® III Sand Barrel Array at a velocity of 60.68 mph (97.66 km/h) and an angle of 0.0°. Upon impact the vehicle's kinetic energy was absorbed by the system as the Energite® III sand barrels were crushed. The TL-3 Energite® III Sand Barrel Array brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 25.9 ft/s (7.9 m/s) and a maximum ridedown acceleration of -14.4 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 Energite® III Sand Barrel Array met all the requirements for MASH 2016 Test 3-41.</p>	PASS
3-42 (1100C)	<p>Applus IDIADA KARCO Test No. P39259-01. Test Date September 27, 2019. MASH Test 3-42 Crash Test Report No. TR-P39259-01-NC for Trinity Highway Products TL-3 Energite® III Sand Barrel Array.</p> <p>The crash cushion was impacted by a 2013 Kia Rio 4-door sedan. The test vehicle impacted the TL-3 Energite® III Sand Barrel Array at a velocity of 62.50 mph (100.58 km/h) and an angle of 5.1°. Upon impact the vehicle's kinetic energy was absorbed by the system as the Energite® III sand barrels were crushed. The TL-3 Energite® III Sand Barrel Array brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 25.3 ft/s (7.7 m/s) and a maximum ridedown acceleration of -11.5 g. The windshield deformation exceeded the MASH intrusion limit but the damage was caused by a vehicle component, not by direct contact with the test article, per MASH Section 5.2.2 (Occupant Risk). There was no other significant deformation and no penetration into the occupant compartment. The Trinity Highway Products TL-3 Energite® III Sand Barrel Array met all the requirements for MASH 2016 Test 3-42.</p>	PASS

3-43 (2270P)	<p>Applus IDIADA KARCO Test No. P39260-01. Test Date October 4, 2019. MASH Test 3-43 Crash Test Report No. TR-P39260-01-NC for Trinity Highway Products TL-3 Energite® III Sand Barrel Array.</p> <p>The crash cushion was impacted by a 2014 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 Energite® III Sand Barrel Array at a velocity of 61.63 mph (99.18 km/h) and an angle of 4.5°. Upon impact the vehicle's kinetic energy was absorbed by the system as the Energite® III sand barrels were crushed. The TL-3 Energite® III Sand Barrel Array brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 24.9 ft/s (7.6 m/s) and a maximum ridedown acceleration of -9.9 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 Energite® III Sand Barrel Array met all the requirements for MASH 2016 Test 3-43.</p>	PASS
3-44 (2270P)	<p>Applus IDIADA KARCO Test No. P39316-01. Test Date October 17, 2019. MASH Test 3-44 Crash Test Report No. TR-P39316-01-NC for Trinity Highway Products TL-3 Energite® III Sand Barrel Array.</p> <p>The crash cushion was impacted by a 2014 RAM 1500 4-door pickup truck. The test vehicle impacted the TL-3 Energite® III Sand Barrel Array at a velocity of 61.34 mph (98.72 km/h) and an angle of 20.5°. Upon impact the vehicle's kinetic energy was absorbed by the system as six of the twelve Energite® III sand barrels were crushed. The TL-3 Energite® III Sand Barrel Array brought the vehicle to a complete stop. 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 Energite® III Sand Barrel Array met all the requirements for MASH 2016 Test 3-44.</p>	PASS



3-45 (1500A)	<p>Applus IDIADA KARCO Test No. P39322-01. Test Date November 6, 2019. MASH Test 3-45 Crash Test Report No. TR-P39322-01-NC for Trinity Highway Products TL-3 Energite®III Sand Barrel Array.</p> <p>The crash cushion was impacted by a 2013 Chevy Malibu 4-door sedan. The test vehicle impacted the TL-3 Energite®III Sand Barrel Array at a velocity of 62.89 mph (101.21 km/h) and an angle of 0.0°. Upon impact the vehicle's kinetic energy was absorbed as the Energite®III sand barrels were crushed. The TL-3 Energite®III Sand Barrel Array brought the vehicle to a complete stop with a maximum Occupant Impact Velocity (OIV) of 24.9 ft/s (7.6 m/s) and a maximum ridedown acceleration of -14.6 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 Energite®III Sand Barrel Array met all the requirements for MASH 2016 Test 3-45.</p>	PASS
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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:	<b>Steven Matsusaka</b> <small>DN: cn=Steven Matsusaka, email=steven.matsusaka@idiada.com, c=US  Digitally signed by Steven Matsusaka  Date: 2020.05.26 13:02:11 -0700'</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 :	International Accreditation Services (IAS) ISO 17025 Accreditation Certificate #TL-371 Expires July 1, 2022	

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@trin.net, c=US  
Date: 2020.05.26 14:38:44 -0700'

**Submit Form**

**ATTACHMENTS**

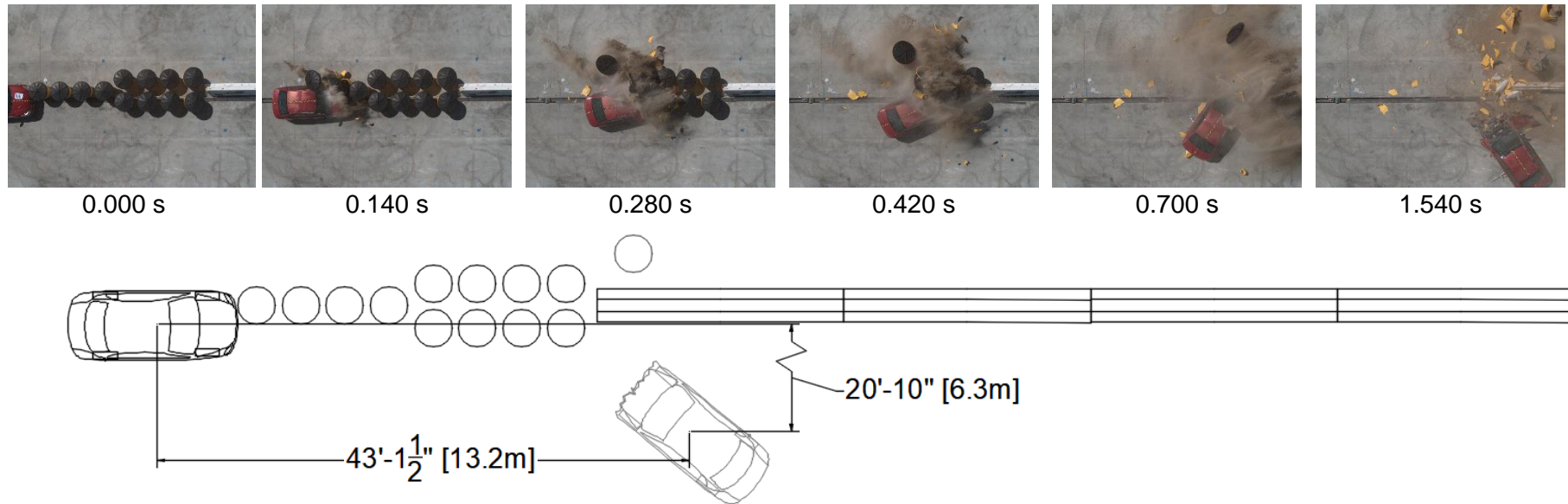
Attach to this form:

- 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 3-40 Summary



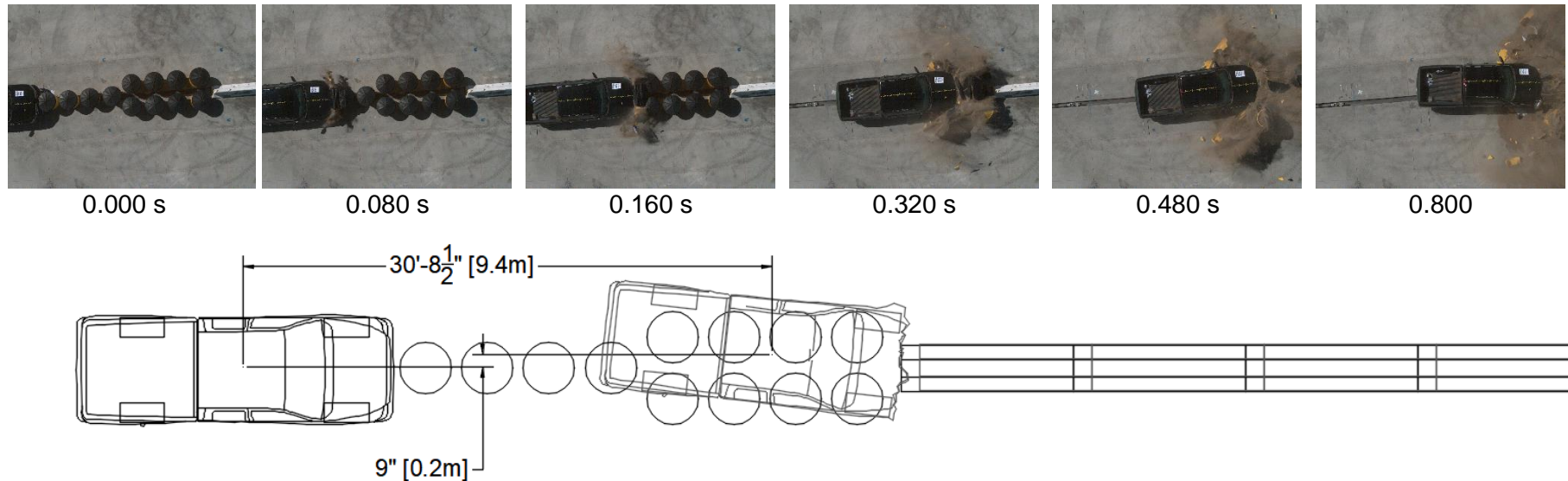
<b>General Information</b>	
Test Agency.....	Applus IDIADA KARCO
Test No.....	P39257-01
Test Designation.....	3-40
Test Date.....	8/23/19
<b>Test Article</b>	
Name / Model.....	TL-3 Energite III Sand Barrel Array
Type.....	Crash Cushion
Crash Cushion Length.....	27.8 ft. (8.5 m)
Road Surface.....	Smooth, clean concrete
<b>Test Vehicle</b>	
Type / Designation.....	1100C
Year, Make, and Model....	2010 Kia Rio
Curb Mass.....	2,350.1 lbs (1,066.0 kg)
Test Inertial Mass.....	2,447.1 lbs (1,110.0 kg)
Gross Static Mass.....	2,622.4 lbs (1,189.5 kg)

<b>Impact Conditions</b>	
Impact Velocity.....	60.22 mph (96.91 km/h)
Impact Angle.....	0.0°
Location / Orientation.....	400 mm left of centerline
Kinetic Energy.....	296.7 kip-ft (402.2 kJ)
<b>Exit Conditions</b>	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	43.1 ft. (13.1 m) downstream
	20.8 ft. (6.3 m) right
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability.....	Satisfactory
Maximum Roll Angle.....	-4.2 °
Maximum Pitch Angle.....	3.7 °
Maximum Yaw Angle.....	85.0 °

<b>Occupant Risk</b>	
Longitudinal OIV.....	24.6 ft/s (7.5 m/s)
Lateral OIV.....	0.7 ft/s (0.2 m/s)
Longitudinal RA.....	-10.0 g
Lateral RA.....	-5.3 g
THIV.....	24.6 ft/s (7.5 m/s)
PHD.....	10.0 g
ASI.....	0.71
<b>Test Article Deflections</b>	
Static.....	N/A
Dynamic.....	N/A
Working Width.....	N/A
Debris Field (longitudinal) .....	103.7 ft. (31.6 m)
Debris Field (lateral).....	47.2 ft. (14.4 m)
<b>Vehicle Damage</b>	
Vehicle Damage Scale.....	12-FD-5
CDC.....	12FDEW1
Maximum Intrusion.....	0.2 in. (5 mm) at floor pan

**Figure 2 Summary of Test 3-40**

# MASH 2016 Test 3-41 Summary



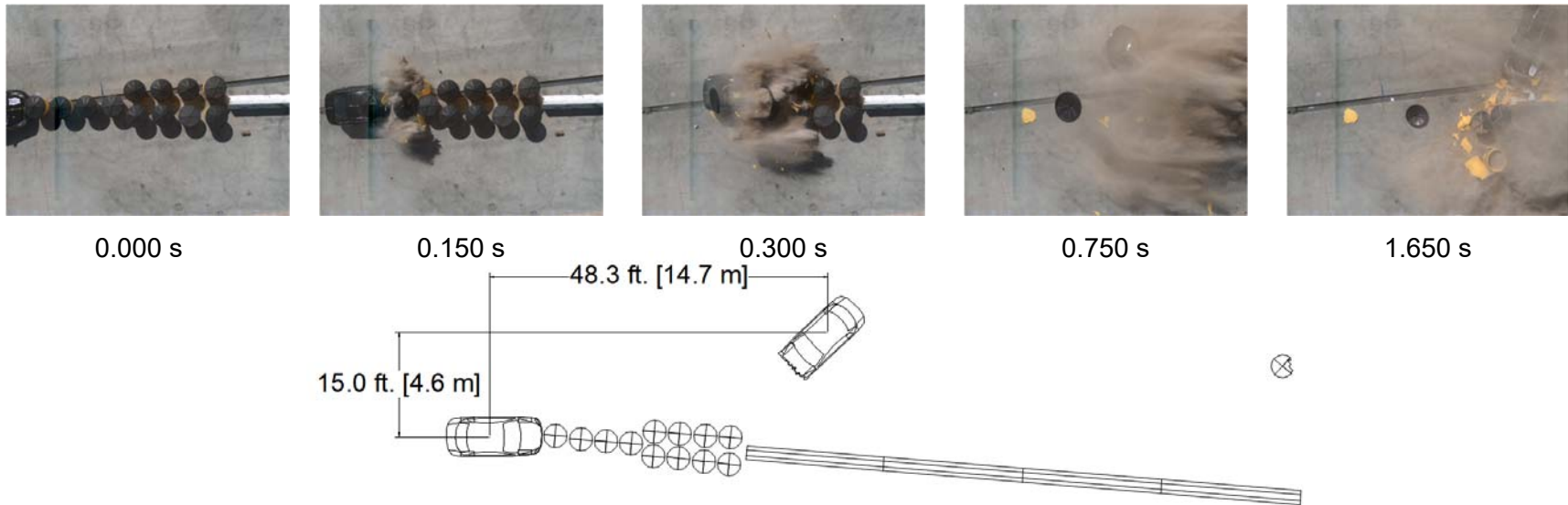
<b>General Information</b>	
Test Agency.....	Applus IDIADA KARCO
Test No.....	P39258-01
Test Designation.....	3-41
Test Date.....	8/21/19
<b>Test Article</b>	
Name / Model.....	TL-3 Energite III Sand Barrel Array
Type.....	Crash Cushion
Crash Cushion Length.....	27.8 ft. (8.5 m)
Road Surface.....	Smooth, clean concrete
<b>Test Vehicle</b>	
Type / Designation.....	2270P
Year, Make, and Model....	2014 RAM 1500
Curb Mass.....	5,056.2 lbs (2,293.5 kg)
Test Inertial Mass.....	5,012.1 lbs (2,273.5 kg)
Gross Static Mass.....	5,012.1 lbs (2,273.5 kg)

<b>Impact Conditions</b>	
Impact Velocity.....	60.68 mph (97.66 km/h)
Impact Angle.....	0.0°
Location / Orientation.....	29 mm right of impact point
Kinetic Energy.....	642.6 kip-ft (871.3 kJ)
<b>Exit Conditions</b>	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	30.7 ft. (9.4 m) downstream
	0.8 ft. (0.2 m) left
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability.....	Satisfactory
Maximum Roll Angle.....	-6.5 °
Maximum Pitch Angle.....	6.1 °
Maximum Yaw Angle.....	-7.7 °

<b>Occupant Risk</b>	
Longitudinal OIV.....	25.9 ft/s (7.9 m/s)
Lateral OIV.....	0.0 ft/s (0.0 m/s)
Longitudinal RA.....	-14.4 g
Lateral RA.....	-3.5 g
THIV.....	25.9 ft/s (7.9 m/s)
PHD.....	14.4 g
ASI.....	1.01
<b>Test Article Deflections</b>	
Static.....	N/A
Dynamic.....	N/A
Working Width.....	N/A
Debris Field (longitudinal) .....	189.0 ft. (57.6 m)
Debris Field (lateral).....	32.4 ft. (9.9 m)
<b>Vehicle Damage</b>	
Vehicle Damage Scale.....	12-FD-4
CDC.....	12FDEW1
Maximum Intrusion.....	0.4 in. (10 mm) at floor pan

Figure 2 Summary of Test 3-41

# MASH 2016 Test 3-42 Summary



<b>General Information</b>	
Test Agency.....	Applus IDIADA KARCO
Test No.....	P39259-01
Test Designation.....	3-42
Test Date.....	9/27/19
<b>Test Article</b>	
Name / Model.....	TL-3 Energite III Sand Barrel Array
Type.....	Crash Cushion
Crash Cushion Length.....	27.8 ft. (8.5 m)
Road Surface.....	Smooth, clean concrete
<b>Test Vehicle</b>	
Type / Designation.....	1100C
Year, Make, and Model....	2013 Kia Rio
Curb Mass.....	2,389.8 lbs (1,084.0 kg)
Test Inertial Mass.....	2,433.9 lbs (1,104.0 kg)
Gross Static Mass.....	2,601.4 lbs (1,180.0 kg)

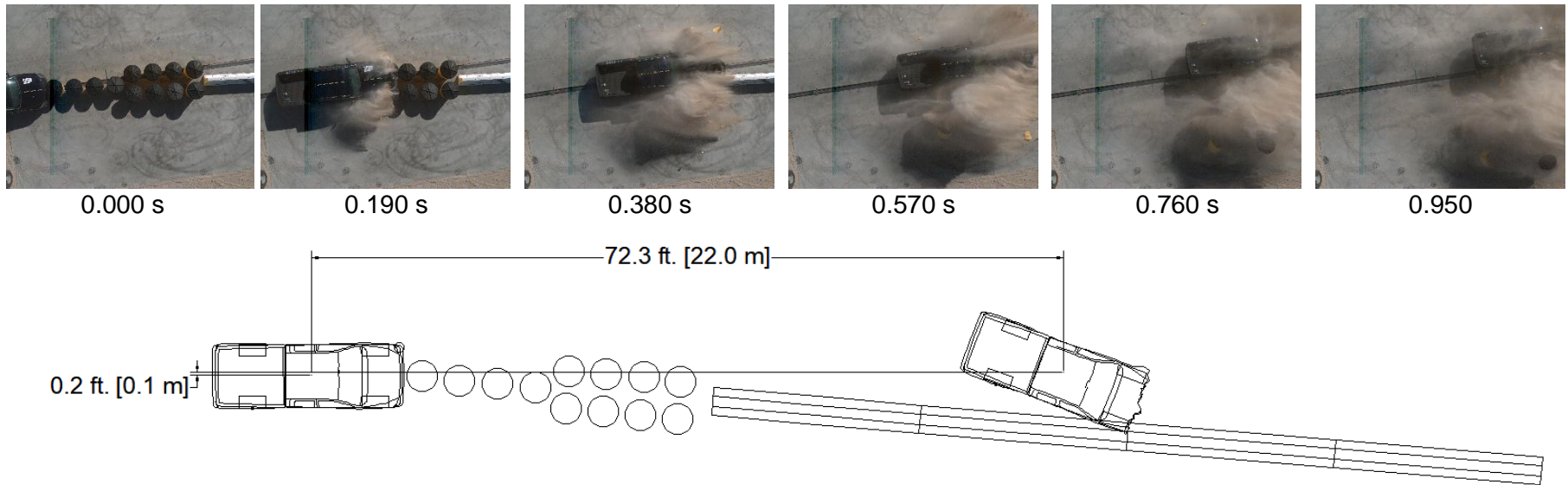
<b>Impact Conditions</b>	
Impact Velocity.....	62.50 mph (100.58 km/h)
Impact Angle.....	5.1°
Location / Orientation.....	At Centerline of First Sand Barrel
Kinetic Energy.....	317.8 kip-ft (430.9 kJ)
<b>Exit Conditions</b>	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	48.3 ft. (14.7 m) downstream 15.0 ft. (4.6 m) left
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability.....	Satisfactory
Maximum Roll Angle.....	3.3°
Maximum Pitch Angle.....	-3.4°
Maximum Yaw Angle.....	-127.6°

<b>Occupant Risk</b>	
Longitudinal OIV.....	25.3 ft/s (7.7 m/s)
Lateral OIV.....	0.7 ft/s (0.2 m/s)
Longitudinal RA.....	-11.5 g
Lateral RA.....	1.7 g
THIV.....	25.3 ft/s (7.7 m/s)
PHD.....	11.6 g
ASI.....	0.68
<b>Test Article Deflections</b>	
Static.....	N/A
Dynamic.....	N/A
Working Width.....	N/A
Debris Field (longitudinal) .....	105.6 ft. (32.2 m)
Debris Field (lateral).....	53.3 ft. (16.2 m)
<b>Vehicle Damage</b>	
Vehicle Damage Scale.....	12-FD-3
CDC.....	12FDEW2
*Maximum Intrusion.....	3.9 in. (100 mm) at windshield

\*Damage caused by test vehicle hood, not test article

Figure 2 Summary of Test 3-42

# MASH 2016 Test 3-43 Summary



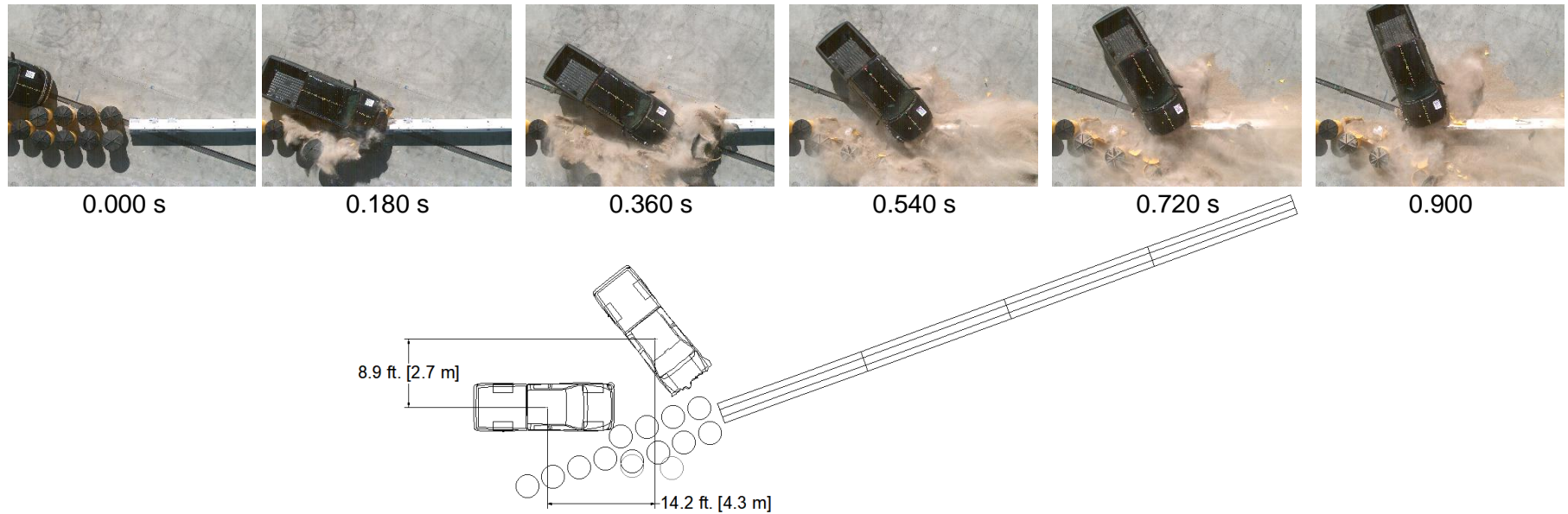
<b>General Information</b>	
Test Agency.....	Applus IDIADA KARCO
Test No.....	P39260
Test Designation.....	3-43
Test Date.....	10/4/19
<b>Test Article</b>	
Name / Model.....	TL-3 Energite III Sand Barrel Array
Type.....	Crash Cushion
Crash Cushion Length.....	27.8 ft. (8.5 m)
Road Surface.....	Smooth, clean concrete
<b>Test Vehicle</b>	
Type / Designation.....	2270P
Year, Make, and Model....	2014 RAM 1500
Curb Mass.....	4,989.0 lbs (2,263.0 kg)
Test Inertial Mass.....	5,013.2 lbs (2,274.0 kg)
Gross Static Mass.....	5,013.2 lbs (2,274.0 kg)

<b>Impact Conditions</b>	
Impact Velocity.....	61.63 mph (99.18 km/h)
Impact Angle.....	4.5°
Location / Orientation.....	0.6 in. (15 mm) left
Kinetic Energy.....	636.5 kip-ft (863.1 kJ)
<b>Exit Conditions</b>	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	72.3 ft. (22 m) downstream
	0.2 ft. (0.1 m) left
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability.....	Satisfactory
Maximum Roll Angle.....	5.8 °
Maximum Pitch Angle.....	6.3 °
Maximum Yaw Angle.....	3.4 °

<b>Occupant Risk</b>	
Longitudinal OIV.....	24.9 ft/s (7.6 m/s)
Lateral OIV.....	-1.0 ft/s (-0.3 m/s)
Longitudinal RA.....	-9.9 g
Lateral RA.....	-2.6 g
THIV.....	24.9 ft/s (7.6 m/s)
PHD.....	9.9 g
ASI.....	0.51
<b>Test Article Deflections</b>	
Static.....	N/A
Dynamic.....	N/A
Working Width.....	N/A
Debris Field (longitudinal) .....	123.7 ft. (37.7 m)
Debris Field (lateral).....	43.6 ft. (13.3 m)
<b>Vehicle Damage</b>	
Vehicle Damage Scale.....	12-FD-4
CDC.....	12FDEW2
Maximum Intrusion.....	0.2 in. (5 mm) at floor pan

Figure 2 Summary of Test 3-43

# MASH 2016 Test 3-44 Summary



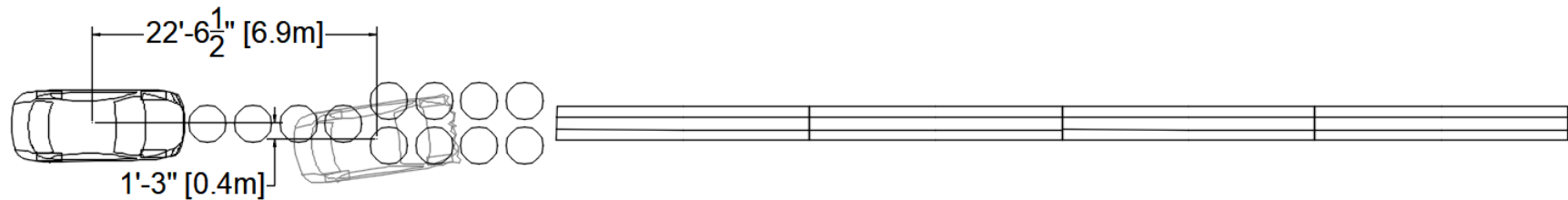
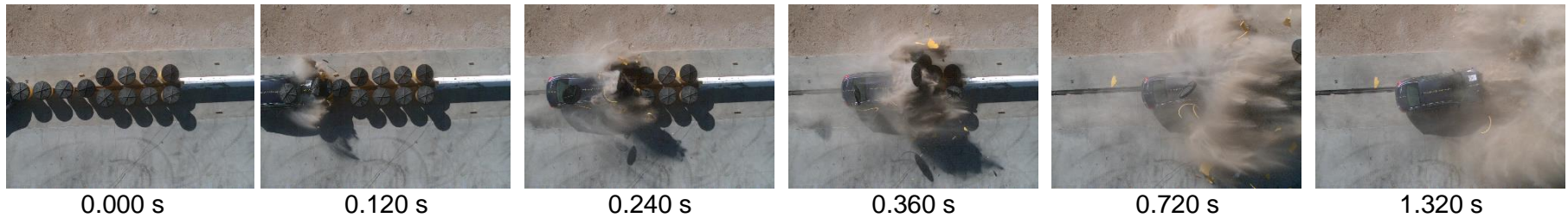
<b>General Information</b>	
Test Agency.....	Applus IDIADA KARCO
Test No.....	P39316-01
Test Designation.....	3-44
Test Date.....	10/17/19
<b>Test Article</b>	
Name / Model.....	TL-3 Energite III Sand Barrel Array
Type.....	Crash Cushion
Crash Cushion Length.....	27.8 ft. (8.5 m)
Road Surface.....	Smooth, clean concrete
<b>Test Vehicle</b>	
Type / Designation.....	2270P
Year, Make, and Model....	2014 RAM 1500
Curb Mass.....	4,963.6 lbs (2,251.5 kg)
Test Inertial Mass.....	5,014.3 lbs (2,274.5 kg)
Gross Static Mass.....	5,014.3 lbs (2,274.5 kg)

<b>Impact Conditions</b>	
Impact Velocity.....	61.34 mph (98.72 km/h)
Impact Angle.....	20.5°
Location / Orientation.....	Fifth Row, Sand Barrel on Traffic Side
Kinetic Energy.....	630.7 kip-ft (855.1 kJ)
<b>Exit Conditions</b>	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	14.2 ft. (4.3 m) downstream
	8.9 ft. (2.7 m) left
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability.....	Satisfactory
Maximum Roll Angle.....	9.9°
Maximum Pitch Angle.....	-7.9°
Maximum Yaw Angle.....	-46.2°

<b>Occupant Risk</b>	
Longitudinal OIV.....	33.1 ft/s (10.1 m/s)
Lateral OIV.....	1.6 ft/s (0.5 m/s)
Longitudinal RA.....	-29.3 g
Lateral RA.....	-5.2 g
THIV.....	33.1 ft/s (10.1 m/s)
PHD.....	29.3 g
ASI.....	1.91
<b>Test Article Deflections</b>	
Static.....	N/A
Dynamic.....	N/A
Working Width.....	N/A
Debris Field (longitudinal) ...	139.2 ft. (42.4 m)
Debris Field (lateral).....	30.5 ft. (9.3 m)
<b>Vehicle Damage</b>	
Vehicle Damage Scale.....	12-FD-5
CDC.....	12FDEW4
Maximum Intrusion.....	0.1 in. (3 mm) at windshield

Figure 2 Summary of Test 3-44

# MASH 2016 Test 3-45 Summary



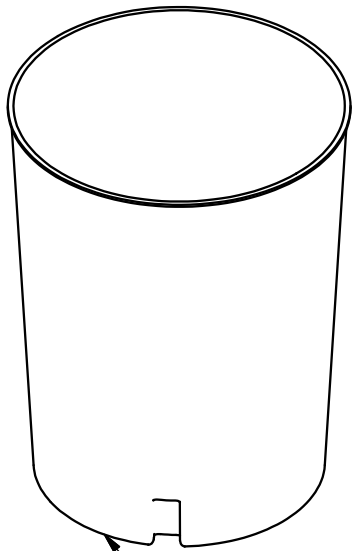
<b>General Information</b>	
Test Agency.....	Applus IDIADA KARCO
Test No.....	P39322-01
Test Designation.....	3-45
Test Date.....	11/6/19
<b>Test Article</b>	
Name / Model.....	TL-3 Energite III Sand Barrel Array
Type.....	Crash Cushion
Crash Cushion Length.....	27.8 ft. (8.5 m)
Road Surface.....	Smooth, clean concrete
<b>Test Vehicle</b>	
Type / Designation.....	1500A
Year, Make, and Model....	2013 Chevy Malibu
Curb Mass.....	3,365.3 lbs (1,526.5 kg)
Test Inertial Mass.....	3,337.7 lbs (1,514.0 kg)
Gross Static Mass.....	3,337.7 lbs (1,514.0 kg)

<b>Impact Conditions</b>	
Impact Velocity.....	62.89 mph (101.21 km/h)
Impact Angle.....	0.0°
Location / Orientation.....	0.5 in. (12 mm) right of centerline
Kinetic Energy.....	441.3 kip-ft (598.3 kJ)
<b>Exit Conditions</b>	
Exit Velocity.....	N/A
Exit Angle.....	N/A
Final Vehicle Position.....	22.5 ft. (6.9 m) downstream 1.3 ft. (0.4 m) left
Exit Box Criteria Met.....	N/A
Vehicle Snagging.....	None
Vehicle Pocketing.....	None
Vehicle Stability.....	Satisfactory
Maximum Roll Angle.....	2.4 °
Maximum Pitch Angle.....	5.7 °
Maximum Yaw Angle.....	-5.4 °

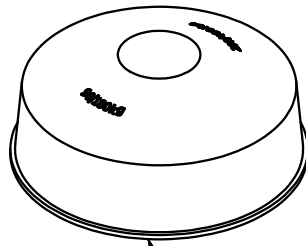
<b>Occupant Risk</b>	
Longitudinal OIV.....	24.9 ft/s (7.6 m/s)
Lateral OIV.....	4.3 ft/s (1.3 m/s)
Longitudinal RA.....	-14.6 g
Lateral RA.....	-3.3 g
THIV.....	25.3 ft/s (7.7 m/s)
PHD.....	14.6 g
ASI.....	0.79
<b>Test Article Deflections</b>	
Static.....	N/A
Dynamic.....	N/A
Working Width.....	N/A
Debris Field (longitudinal).....	151.8 ft. (46.3 m)
Debris Field (lateral).....	42.3 ft. (12.9 m)
<b>Vehicle Damage</b>	
Vehicle Damage Scale....	12-FD-4
CDC.....	12FDAW1
Maximum Intrusion.....	No measurable deformation

**Figure 2 Summary of Test 3-45**

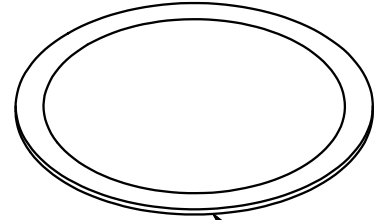




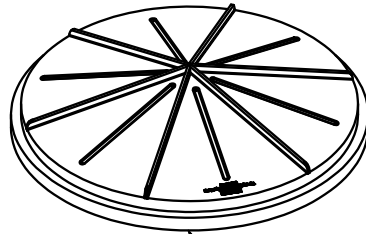
MODEL 2100  
OUTER CONTAINER



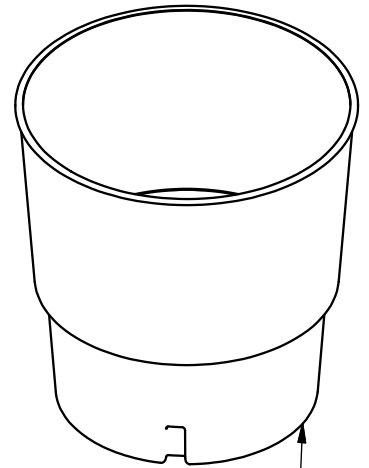
200 / 400 CONE



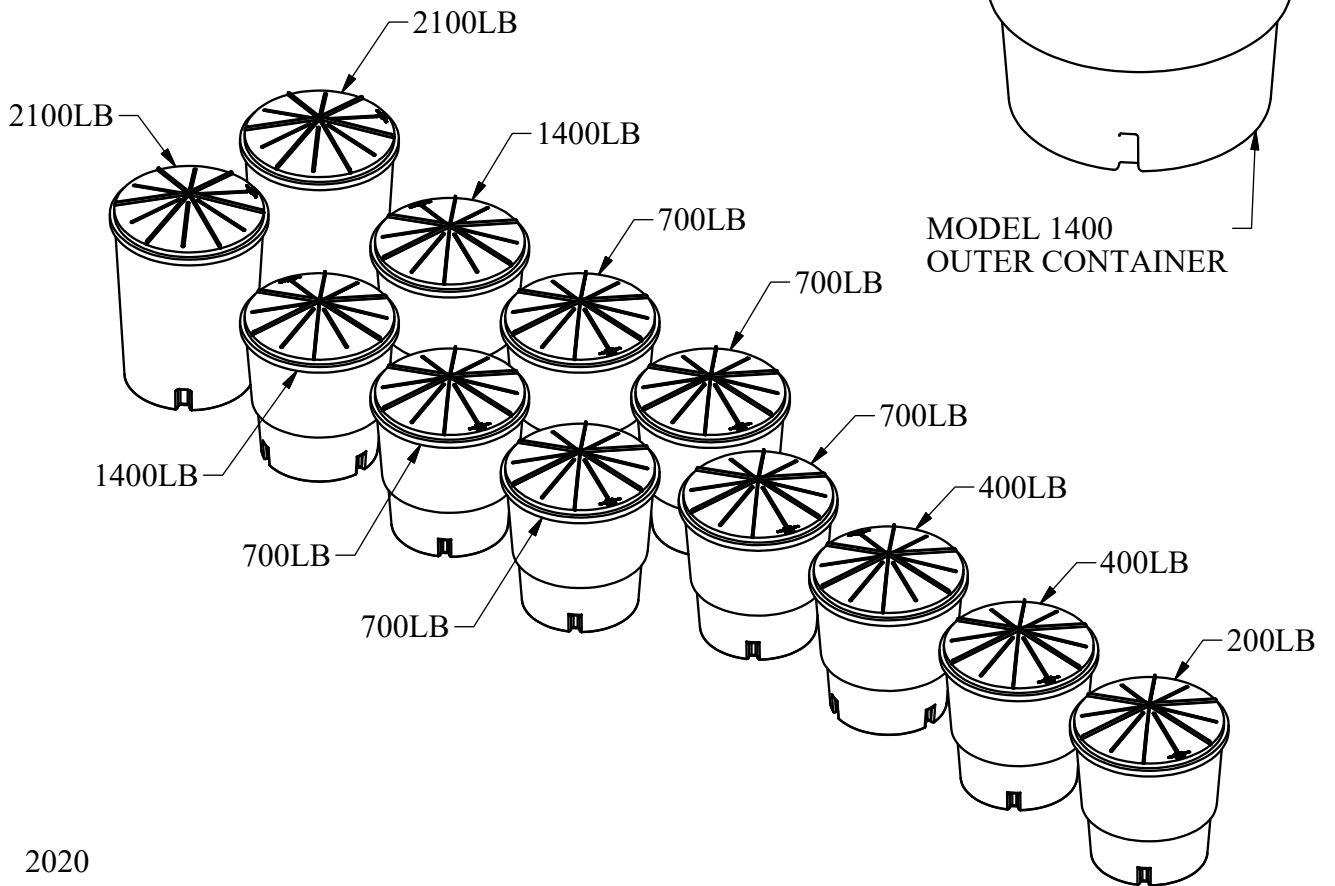
700 CONE



LID



MODEL 1400  
OUTER CONTAINER



2020

### ENERGITE III SAND BARREL ARRAY



# TRINITY HIGHWAY

SCI###

SHEET NO.

DATE

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### INTENDED USE

The Energite® III Sand Barrel Array is a gating, non-redirective crash cushion designed to shield the end of rigid objects in both temporary and permanent roadside installations.

### FEATURES

The Energite® III Sand Barrel Array consists of twelve sand barrel modules positioned in a combined pattern of a single column of four barrels followed by two columns of four barrels deep. The barrels are spaced at least 6 in. apart front to back and 6 in apart maximum side to side. The approximate width of the array is 80 in. by 335.5 in. deep. The barrels are filled with washed concrete sand conforming to the ASTM C-33 standard. The amount of sand in each barrel varies, depending on the barrel's location in the array. The Energite® III Sand Barrel Array was tested on a level concrete surface but it may also be used on asphalt or smooth compacted soil.

Each sand barrel module in the array consists of a free-standing one-piece barrel and a 37 in. diameter snap-on lid. Inside each barrel is a label with demarcation fill lines and in some cases, an inner cone which locates the sand at the proper height. The Energite® III Sand Barrel Array utilizes two 2,100 lb. capacity barrels with an overall height with lid of 52.1 in. and ten 1400 lb. capacity barrels with an overall height with lid of 42.9 in. The barrels are arranged from front to back with gradually increasing weights. The initial eight 1,400 capacity barrels all have inner cones and are filled to obtain one 200 lb. barrel, two 400 lb. barrels, and five 700 lb. barrels. The remaining two 1,400 capacity barrels and two 2,100 lb. capacity barrels are filled without an inner cone, to obtain 1400 lb. and 2100lb. barrels respectively.

### ELIGIBILITY

The Energite® III Sand Barrel Array has been fully tested in conformance to MASH 2016 Test Level 3 and is determined eligible for Federal reimbursement by FHWA.

FHWA Eligibility Letter(s): CC-XXXX 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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## ENERGITE III SAND BARREL ARRAY

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