U.S. Department
of Transportation
Federal Highway Administration

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

June 15, 2017

In Reply Refer To:
HSST-1/CC-132

Mr. Felipe Almanza
TrafFix Devices Inc.
160 Avenida La Pata
San Clemente, CA 92673

Dear Mr. Almanza:

This letter is in response to your January 10, 2017 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-132 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following devices are eligible, with details provided in the form which is attached as an integral part of this letter:

- Scorpion II

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: Scorpion II
Type of system: Truck-Trailer Mounted Attenuator (TTMA)
Test Level: MASH Test Level 3 (TL3)
Testing conducted by: KARCO
Date of request: January 13, 2017

FHWA concurs with the recommendation of the accredited crash testing laboratory as stated within 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 and will need to be tested in accordance with all recommended tests in AASHTO's MASH as part of a new and separate submittal.

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-132 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.

- If the subject device is a patented product it may be considered to be proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects: (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

Sincerely,

Robert Ritter
Acting Director, Office of Safety
Technologies
Office of Safety

Enclosures

Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Submitter	Date of Request:	1-10-17	◉ New ○ Resubmission
	Name:	Felipe Almanza	
	Company:	TrafFix Devices Inc	
	Address:	160 Avenida La Pata San Clemente	
	Country:	United States	
	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': Truck-Mounted Attenuators (TMA)	◉ Physical Crash Testing ○ Engineering Analysis	Scorpion II	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:	Felipe Almanza	Same as Submitter ☒
Company Name:	TrafFix Devices Inc	Same as Submitter ☒
Address:	160 Avenida La Pata San Clemente	Same as Submitter ☒
Country:	United States	Same as Submitter ☒
Enter below all disclosures of financial interests as required by the FHWA `Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.		
TrafFix Devices Inc. and Karco Engineering LLC share no financial interests between the two organizations. This includes no shared financial interest but not limited to: i. Compensation included wages, salaries, commissions, professional fees, or fees for business referrals iii. Research funding or other forms of research support; iv. Patents, copyrights, licenses, and other intellectual property interests; vi. Business ownership and investment interests;		

PRODUCT DESCRIPTION

(•) New Hardware or Significant Modification ( ) Modification to Existing Hardware

The Scorpion Truck Mounted Attenuator (TMA) is a mobile crash cushion attached to the rear of a support vehicle's frame. The TMA may be used on shadow, stationary block vehicle, or on advanced warning vehicles upstream of a moving or stationary operation. The Scorpion TMA can be used on support vehicles with a min. actual/curb weight of 15,000 lbs with no upper weight limit (infinite weight). Lighting consists of LED or incandescent brake, directional, and running lights meeting FMVSS requirements and optional strobe/flashing lights can be accommodated for enhancement of advanced warning to drivers. The structural mounting system incorporates extender frames to provide clearance for support vehicles with excess bed overhang and to provide clearance of equipment on the back of a support vehicle when the TMA is in the stored position. The Scorpion TL-3 TMA has overall dimensions of 12.94 ft. (3.9 m) X 8.0 ft (2.4 m) X 2.0 ft (0.6 m) and has a ground clearance of 12 in ± 1 in (305 mm ± 25.4 mm) when deployed in the horizontal operating position. The Scorpion TMA consists of three main components: Strut, Cartridge, and backup/diaphragm frames. The Strut and Cartridge are the energy attenuation components. The Strut is positioned nearest to the support vehicle and the Cartridge is positioned furthest away from the support vehicle. The Cartridge is typically the first component impacted by an errant vehicle. The Strut consists of four outboard convex aluminum tubes (two on each side) forming an aluminum structural weldment. The aluminum structural weldments bolt to a structural steel diaphragm/backup frame. The structural assembly encompasses the aluminum crush Module D. The module is made from an aluminum outer skin that contains expanded aluminum honeycomb and has overall dimensions of 4.0 ft (1.2 m) X 6.7 ft (2.0 m) X 1.9 ft (0.6 m). Module D is designed to accommodate an assortment of rear facing reflective sheeting colors and patterns. The complete Strut consists of two aluminum tube weldments, diaphragm/backup, and one Module D and has overall dimensions of 5.2 ft (1.6 m) X 8.0 ft (2.4 m) X 2.2 ft (0.7 m). The Cartridge consists of four outboard convex aluminum tubes (two on each side) forming an aluminum structural weldment. The aluminum structural weldments bolt to a set of steel structural diaphragm frames. The structural assembly encompasses the two-aluminum crush Modules C. Attached to the rear most end of the Cartridge, is the single crush Module A. Crush Modules A and C are made from an aluminum outer skin that contains expanded aluminum honeycomb. Module A has overall dimension of 1.0 ft (0.3 m) X 5.0 ft (1.5 m) X 2.0 ft (0.6 m) and Module C has overall dimension of 2 ft (0.6 m) X 5 ft (1.594 m) X 2 ft (0.6 m). Module A is designed to accommodate an assortment of rear facing reflective sheeting colors and patterns. The complete Cartridge consists of two aluminum tube weldments, diaphragm's, one Module A, and two Module C and has overall dimensions of 7.71 (2.3 m) X 8 ft (2.4 m) X 2.2 ft (0.7 m). The steel diaphragm/ backup frames are are made from structural steel angles, plates, and channels that are welded into the backup and diaphragm components and are the supporting frame members for the aluminum tubes and crush modules. For Test 3-51 the lower Module A mounting angle was 4" (102 mm) X 4" (102 mm) and for Tests 3-50, 3-52, and 3-53 the lower Module A mounting angle is 4" (102 mm) X 6" (152 mm). The Scorpion TMA is rotated into the stored and deployed positions by means of an on board hydraulic system. The Scorpion TMA can be rotated in double 90° fold position over the support vehicles bed or in a single 90° fold in a vertical stored position. An optional hydraulic powered vertical lift can be utilized with the TMA to deploy a display panel when the TMA is lowered into the deployed position. The vertical lift is powered by the same onboard hydraulic system that rotates the TMA into the stored and deployed position. The vertical lift is sequenced to raise and lower a panel for displaying advanced messages, directional indicators, or other notifications.

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:	Balbino A. Beltran	
Engineer Signature:	Balbino A. Beltran Digitally signed by Balbino A. Beltran DN: cn=Balbino A. Beltran, o=KARCO Engineering, LLC., ou, email=abeltran@karco.com, c=US Date: 2017.01.13 16:35:04 -08'00'	
Address:	9270 Holly Road, Adelanto, CA. 92301	Same as Submitter ☐
Country:	United States	Same as Submitter ☐

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-50 (1100C)	The TMA was positioned in line with the test vehicle's centerline. The inline centered position examines the TMA's energy dissipation capacity, structural adequacy, occupant risk, with a rigidly blocked support vehicle for no upper support vehicle weight limit (infinite weight). The test was conducted using a commercially available 2013 Kia Rio 4-door sedan with test inertial mass of 2,431.17 lbs (1,103.0 kg). The vehicle was in good condition, was free of major body damage, and was not missing any structural components. The bumpers were standard equipment and were not modified for this test. Based on CarFax reporting there was no recorded history of major accidents, was not a salvage titled vehicle, not involved in flooding, or fire. The test vehicle impacted the TMA at a velocity of 60.83 mph (97.90 km/hr) and at an impact angle of 0.6°. The vehicle made initial contact with the rear Cartridge crushing Module A upon impact and the outboard convex tube weldments began to collapse. After the convex tube weldments fully collapsed the two inboard Cartridge Modules C contacted each other and were crushed. The front Strut sustained moderate collapse of the outboard convex tube weldments and minimal crush of Module D. The impacting vehicle was brought to a controlled stop and remained upright throughout the impact event. The test vehicles occupant compartment was not penetrated and there was no measurable in cab deformation beyond the maximum allowable limits. The maximum roll and pitch did not exceed 75°and occupant risk values are within limits per MASH specifications for Occupant Impact Velocity and Ridedown Acceleration.	PASS

Required Test Number	Narrative Description	Evaluation Results
3-51 (2270P)	The TMA was positioned in line with the test vehicle's centerline. The inline centered position examines the TMA'S energy dissipation capacity, structural adequacy, occupant risk, with a rigidly blocked support vehicle for no upper support vehicle weight limit (infinite weight). The test was conducted using a commercially available 2012 RAM 1500 4-door pickup truck with test inertial mass of 4920.6 lbs (2232.0 kg). The vehicle was in good condition, was free of major body damage, and was not missing any structural components. The bumpers were standard equipment and were not modified for this test. Based on CarFax reporting there was no recorded history of major accidents, was not a salvage titled vehicle, not involved in flooding, or fire. The test vehicle impacted the TMA at a velocity of 63.16 mph (101.65 km/hr) and at an impact angle of 0.9°. The vehicle made initial contact with the rear Cartridge crushing Module A upon impact and the outboard convex tube weldments began to collapse. After the convex tube weldments fully collapsed the two inboard Cartridge Modules C contacted each other and were crushed. The front Strut sets of outboard convex tube weldments fully collapsed and the inner Module D crushed to a near flattened state. The TMA system contained the hydraulic powered vertical lift to raise and lower a display panel. The display panel and lift system did not pose or show potential to be a hazard in the impact event. The impacting vehicle was brought to a controlled stop and remained upright throughout the impact event. The test vehicles occupant compartment was not penetrated and there was no measurable in cab deformation beyond the maximum allowable limits. The maximum roll and pitch did not exceed 75°and occupant risk values are within limits per MASH specifications for Occupant Impact Velocity and Ridedown Acceleration.	PASS

3-52 (2270P)	The TMA was positioned offset 1/3 of the test vehicles width to the centerline of the test vehicle. The offset position examines the capability of a TMA to safely attenuate off-center impacts, the TMA's structural adequacy, occupant risk, with a rigidly blocked support vehicle for no upper support vehicle weight limit (infinite weight). The test was conducted using a commercially available 2012 RAM 1500 4-door pickup truck with test inertial mass of 4993.4 lbs (2265.0 kg). The vehicle was in good condition, was free of major body damage, and was not missing any structural components. The bumpers were standard equipment and were not modified for this test. Based on CarFax reporting there was no recorded history of major accidents, was not a salvage titled vehicle, not involved in flooding, or fire. The test vehicle impacted the TMA at a velocity of 63.31 mph (101.89 km/hr) and at an impact angle of 0.2°. The vehicle made initial contact with the rear Cartridge crushing Module A upon impact and the outboard convex tube weldments began to collapse. After the convex tube weldments fully collapsed the two inboard Cartridge Modules C contacted each other and were crushed. The front Strut sets of outboard convex tube weldments fully collapsed and the inner Module D crushed to a near flattened state. The TMA system contained the hydraulic powered vertical lift to raise and lower a display panel. The display panel and lift system did not pose or show potential to be a hazard in the impact event. The impacting vehicle was brought to a controlled stop and remained upright throughout the impact event. The test vehicles occupant compartment was not penetrated and there was no measurable in cab deformation beyond the maximum allowable limits. The maximum roll and pitch did not exceed 75°and occupant risk values are within limits per MASH specifications for Occupant Impact Velocity and Ridedown Acceleration.	PASS

3-53 (2270P)	The TMA was positioned offset ¼ of the test vehicles width and at a nominal angle of 10° with the center of the test vehicle. The offset and angular position impact examines the energy dissipation capacity of a TMA, the TMA's structural adequacy, occupant risk, and with a minimum support vehicle weight of 15,000 lbs (6803 kg) with the parking brake engaged and the transmission in 2nd gear. The recorded roll ahead for the support vehicle was 16.8 ft (5.1 m). The test was conducted using a commercially available 2012 RAM 1500 4-door pickup truck with test inertial mass of 4995.6 lbs (2266.0 kg). The vehicle was in good condition, was free of major body damage, and was not missing any structural components. The bumpers were standard equipment and were not modified for this test. Based on CarFax reporting there was no recorded history of major accidents, was not a salvage titled vehicle, not involved in flooding, or fire. The test vehicle impacted the TMA at a velocity of 64.05 mph (103.08 km/hr) and at an impact angle of 10.3°. The vehicle made initial contact with the rear Cartridge crushing Module A upon impact and the outboard convex tube weldments began to collapse. After the convex tube weldments fully collapsed the two inboard Cartridge Modules C made contact with each other and were crushed. The front Strut sets of outboard convex tube weldments fully collapsed and the inner Module D crushed to near a near flattened state. The TMA system contained the hydraulic powered vertical lift to raise and lower a display panel. The display panel and lift system did not pose or show potential to be a hazard in the impact event. The impacting vehicle was brought to a controlled stop and remained upright throughout the impact event. The test vehicles occupant compartment was not penetrated and there was no measurable in cab deformation beyond the maximum allowable. The maximum roll and pitch did not exceed 75°and occupant risk values are within limits per MASH specifications for Occupant Impact Velocity and Ridedown Acceleration.	PASS
3-54 (1500A)	Per MASH Test is optional	Non-Critical, 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:	Balbino A. Beltran — Digitally signed by Balbino A. Beltran DN: cn=Balbino A. Beltran, o=KARCO Engineering, LLC., ou, email=abeltran@karco.com, c=US Date: 2017.01.13 16:35:23 -08'00'	
Address:	9270 Holly Road, Adelanto, CA. 92301	Same as Submitter ☐
Country:	United States	Same as Submitter ☐
Accreditation Certificate Number and Dates of current Accreditation period :	TL-371; December 18, 2015 through December 18, 2017	

Submitter Signature*: Felipe Almanza — Digitally signed by Felipe Almanza DN: cn=Felipe Almanza, o=TrafFix Devices Inc., ou, email=falmanza@traffixdevices.com, c=US Date: 2017.01.05 09:54:55 -08'00'

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:

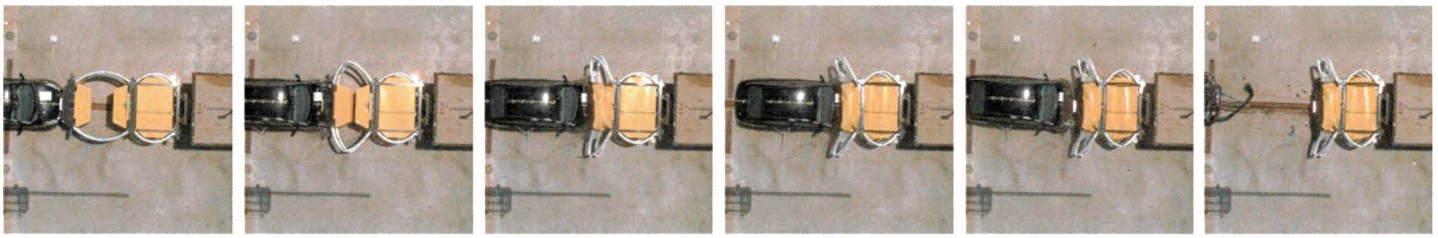
Eligibility Letter		
Number	Date	Key Words

SECTION 4

MASH TEST 3-50 SUMMARY

Test Article:	TrafFix Devices Scorpion TL3 TMA	Project No.	P36116-01
Test Program:	MASH 3-50	Test Date:	06/24/16

SEQUENTIAL PHOTOGRAPHS



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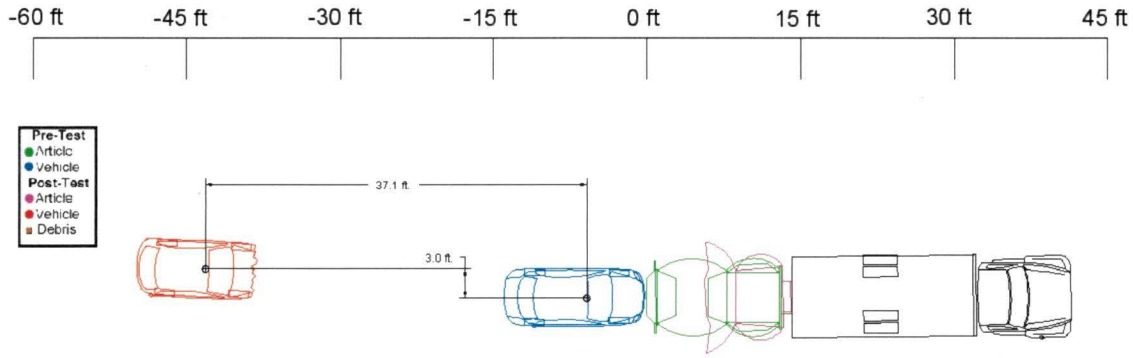
PLAN VIEW



SECTION 4 ... (CONTINUED)

MASH TEST 3-50 SUMMARY

Test Article: TrafFix Devices Scorpion TL3 TMA Project No. P36116-01

Test Program: MASH 3-50 Test Date: 06/24/16

GENERAL INFORMATION	
TEST AGENCY	KARCO Engineering, LLC.
TEST NUMBER	P36116-01
TEST DESIGNATION	3-50
TEST DATE	06/24/16
TEST ARTICLE	
NAME / MODEL	Scorpion TL3 TMA
TYPE	Truck Mounted Attenuator
KEY ELEMENTS	Curved Tubes, Aluminum Honeycomb, Support Frame, Cartridge Section
ARTICLE LENGTH	12.9 ft. (3.9 m)
HEIGHT FROM GROUND	11.25 in. (286 mm)
MAXIMUM WIDTH	8.0 ft. (2.4 m)
ROAD SURFACE	Concrete
SUPPORT VEHICLE	
TOTAL INSTALLATION LENGTH	41.3 ft (12.6 m)
YEAR, MAKE AND MODEL	1991 Ford F700
RESTRAINT	Blocked Against Roll Ahead
TEST VEHICLE	
TYPE / DESIGNATION	1100C
YEAR, MAKE AND MODEL	2013 Kia Rio
CURB MASS	2,520.9 lbs (1,143.5 kg)
TEST INERTIAL MASS	2,431.7 lbs (1,103.0 kg)
GROSS STATIC MASS	2,597.0 lbs (1,178.0 kg)
IMPACT CONDITIONS	
IMPACT VELOCITY	60.83 mph (97.90 km/h)
IMPACT ANGLE	0.6°
IMPACT LOCATION / ORIENTATION	0.3 in. (8 mm) left of TMA centerline.

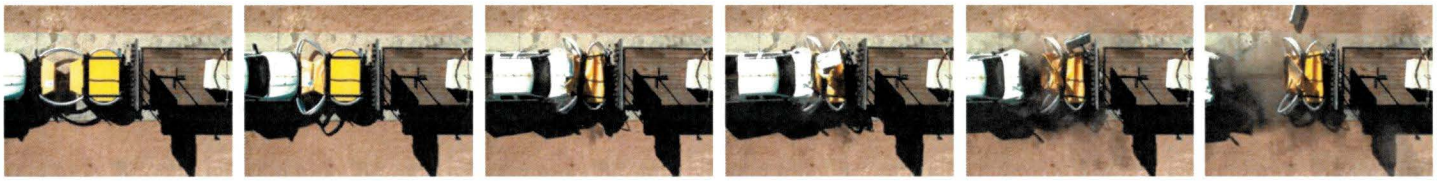
EXIT CONDITIONS		
EXIT VELOCITY		
EXIT ANGLE		
VEHICLE STABILITY		Satisfactory
FINAL VEHICLE POSITION		37.1 ft. (11.3 m) rearward and 3.0 ft. (0.9 m) left from its initial point on contact.
VEHICLE SNAGGING		None
VEHICLE POCKETING		None
MAXIMUM ROLL ANGLE		2.5°
MAXIMUM PITCH ANGLE		-5.1°
MAXIMUM YAW ANGLE		2.4°
KINETIC ENERGY		300.79 kip-ft (407.81 kJ)
OCCUPANT RISK VALUES		
OCCUPANT IMPACT VELOCITY	Longitudinal	34.8 ft/s (10.6 m/s)
	Lateral	2.6 ft/s (0.8 m/s)
RIDEDOWN ACCELERATION	Longitudinal	-19.2 g
	Lateral	-4.8 g
THIV		35.1 ft/s (10.7 m/s)
PHD		19.7 g
ASI		1.37
TEST ARTICLE DEFLECTIONS		
DYNAMIC DEFLECTION		6.8 ft. (2.1 m)
STATIC DEFORMATION		5.6 ft. (1.7 m)
ARTICLE DAMAGE		Damage to cartridge, strut and tube sections.
VEHICLE DAMAGE		
VEHICLE DAMAGE SCALE		12-FD-3
COLLISION DAMAGE CLASSIFICATION		12FDEW4

SECTION 4

MASH TEST 3-51 SUMMARY

Test Article:	TrafFix Devices Scorpion TL3 TMA	Project No.	P35200-01
Test Program:	MASH 3-51	Test Date:	10/22/15

SEQUENTIAL PHOTOGRAPHS



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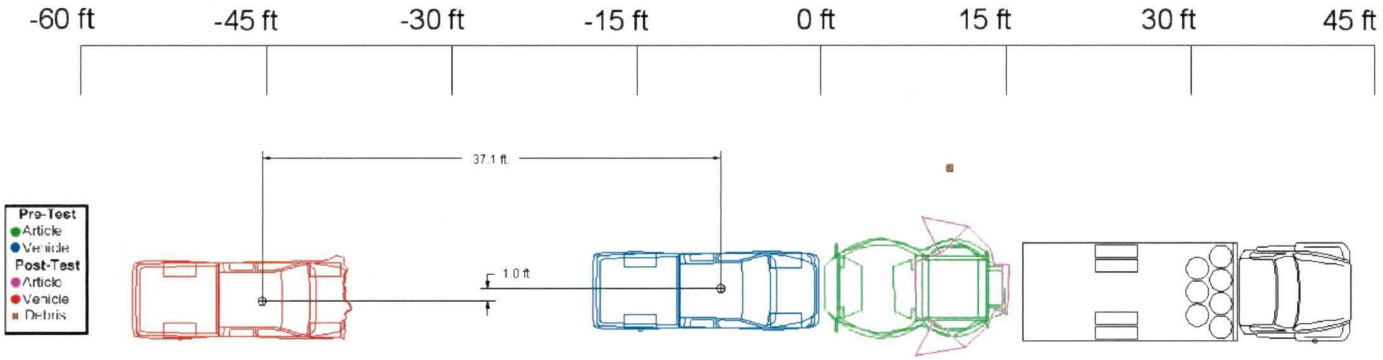
PLAN VIEW



SECTION 4 ... (CONTINUED)

MASH TEST 3-51 SUMMARY

Test Article: TrafFix Devices Scorpion TL3 TMA Project No. P35200-01

Test Program: MASH 3-51 Test Date: 10/22/15

GENERAL INFORMATION	
TEST AGENCY	KARCO Engineering, LLC.
TEST NUMBER	P35200-01
TEST DESIGNATION	3-51
TEST DATE	10/22/15
TEST ARTICLE	
NAME / MODEL	Scorpion TL3 TMA
TYPE	Truck Mounted Attenuator
KEY ELEMENTS	Curved Tubes, Aluminum Honeycomb, Support Frame, Cartridge Sections
ARTICLE LENGTH	12.9 ft. (3.9 m)
HEIGHT FROM GROUND	11.75 in. (298 mm)
MAXIMUM WIDTH	8.0 ft. (2.4 m)
ROAD SURFACE	Concrete
SUPPORT VEHICLE	
TOTAL INSTALLATION LENGTH	41.3 ft (12.6 m)
YEAR, MAKE AND MODEL	1991 Ford F700
RESTRAINT	Blocked Against Roll Ahead
TEST VEHICLE	
TYPE / DESIGNATION	2270P
YEAR, MAKE AND MODEL	2012 RAM 1500
CURB MASS	4,901.9 lbs (2,223.5.0 kg)
TEST INERTIAL MASS	4,920.6 lbs (2,232.0 kg)
GROSS STATIC MASS	4,920.6 lbs (2,232.0 kg)
IMPACT CONDITIONS	
IMPACT VELOCITY	63.16 mph (101.65 km/h)
IMPACT ANGLE	0.9°
IMPACT LOCATION / ORIENTATION	0.7 in. (18 mm) right of TMA centerline.

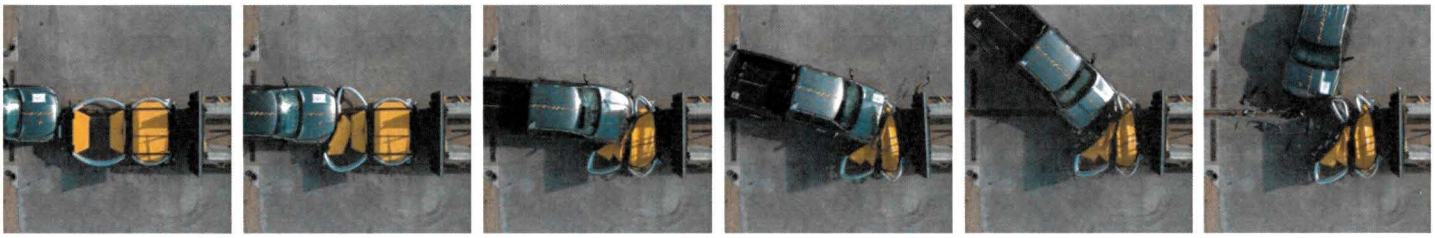
EXIT CONDITIONS		
EXIT VELOCITY		
EXIT ANGLE		
VEHICLE STABILITY		Satisfactory
FINAL VEHICLE POSITION		37.1 ft. (11.3 m) rearward and 1.0 ft. (0.3 m) right from its initial point on contact.
VEHICLE SNAGGING		None
VEHICLE POCKETING		None
MAXIMUM ROLL ANGLE		-1.8°
MAXIMUM PITCH ANGLE		-5.9°
MAXIMUM YAW ANGLE		-2.3°
KINETIC ENERGY		656.6 kip-ft (889.8 kJ)
OCCUPANT RISK VALUES		
OCCUPANT IMPACT VELOCITY	Longitudinal	38.7 ft/s (11.8 m/s)
	Lateral	1.0 ft/s (0.3 m/s)
RIDEDOWN ACCELERATION	Longitudinal	-20.0 g
	Lateral	-3.7 g
THIV		38.4 ft/s (11.7 m/s)
PHD		20.1 g
ASI		1.46
TEST ARTICLE DEFLECTIONS		
DYNAMIC DEFLECTION		7.9 ft. (2.4 m)
STATIC DEFORMATION		7.2 ft. (2.2 m)
ARTICLE DAMAGE		Damage to backup structure, strut section, cartridge section, and tubes. Module C detached.
VEHICLE DAMAGE		
VEHICLE DAMAGE SCALE		12-FD-5
COLLISION DAMAGE CLASSIFICATION		12FDEW2

SECTION 4

MASH TEST 3-52 SUMMARY

Test Article:	TrafFix Devices Scorpion TL3 TMA	Project No.	P36206-01
Test Program:	MASH 3-52	Test Date:	08/22/16

SEQUENTIAL PHOTOGRAPHS



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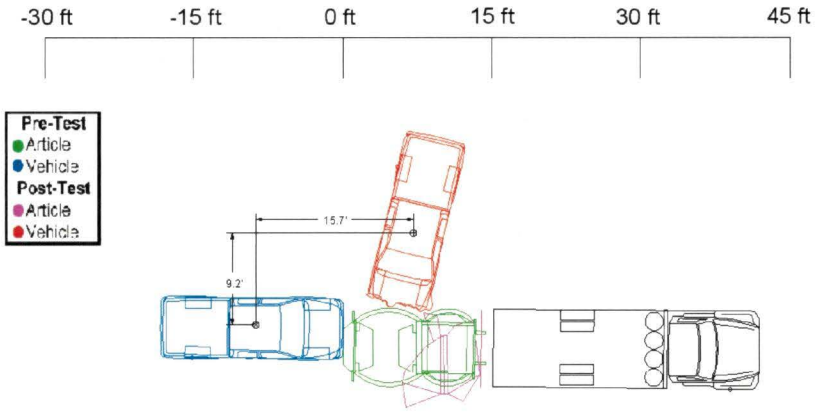
PLAN VIEW



SECTION 4 ... (CONTINUED)

MASH TEST 3-52 SUMMARY

Test Article: TrafFix Devices Scorpion TL3 TMA Project No. P36206-01

Test Program: MASH 3-52 Test Date: 08/22/16

GENERAL INFORMATION	
TEST AGENCY	KARCO Engineering, LLC.
TEST NUMBER	P36206-01
TEST DESIGNATION	3-52
TEST DATE	08/22/16
TEST ARTICLE	
NAME / MODEL	Scorpion TL3 TMA
TYPE	Truck Mounted Attenuator
KEY ELEMENTS	Curved Tubes, Aluminum Honeycomb, Support Frame, Cartridge Section
ARTICLE LENGTH	12.9 ft. (3.9 m)
HEIGHT FROM GROUND	11.42 in. (290 mm)
MAXIMUM WIDTH	8.0 ft. (2.4 m)
ROAD SURFACE	Concrete
SUPPORT VEHICLE	
TOTAL INSTALLATION LENGTH	41.3 ft (12.6 m)
YEAR, MAKE AND MODEL	1991 Ford F700
RESTRAINT	Blocked Against Roll Ahead
TEST VEHICLE	
TYPE / DESIGNATION	2270P
YEAR, MAKE AND MODEL	2012 RAM 1500
CURB MASS	5,046.3 lbs (2,289.0 kg)
TEST INERTIAL MASS	4,993.4 lbs (2,265.0 kg)
GROSS STATIC MASS	4,993.4 lbs (2,265.0 kg)
IMPACT CONDITIONS	
IMPACT VELOCITY	63.31 mph (101.89 km/h)
IMPACT ANGLE	0.2°
IMPACT LOCATION / ORIENTATION	26.97 in. (685 mm) Right of Vehicle Centerline.

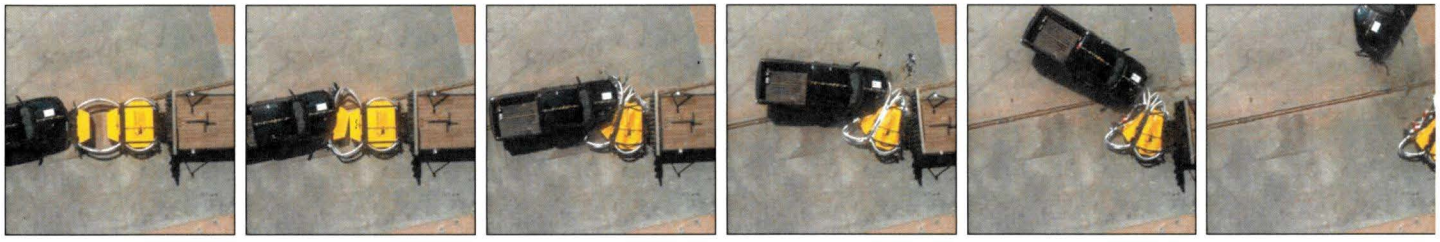
EXIT CONDITIONS		
EXIT VELOCITY		
EXIT ANGLE		
VEHICLE STABILITY		Satisfactory
FINAL VEHICLE POSITION		15.7 ft. (4.8 m) forward and 9.2 ft. (2.8 m) left from its initial point on contact.
VEHICLE SNAGGING		None
VEHICLE POCKETING		None
MAXIMUM ROLL ANGLE		18.9°
MAXIMUM PITCH ANGLE		-14.8°
MAXIMUM YAW ANGLE		104.5°
KINETIC ENERGY		669.11 kip-ft (907.19 kJ)
OCCUPANT RISK VALUES		
OCCUPANT IMPACT VELOCITY	Longitudinal	37.7 ft/s (11.5 m/s)
	Lateral	6.2 ft/s (1.9 m/s)
RIDEDOWN ACCELERATION	Longitudinal	-18.6 g
	Lateral	-2.6 g
THIV		38.1 ft/s (11.6 m/s)
PHD		18.7 g
ASI		1.22
TEST ARTICLE DEFLECTIONS		
DYNAMIC DEFLECTION		10.2 ft. (3.1 m)
STATIC DEFORMATION		9.2 ft. (2.8 m)
ARTICLE DAMAGE		Damage to backup structure, strut section, cartridge section, and tubes.
VEHICLE DAMAGE		
VEHICLE DAMAGE SCALE		12-FD-4
COLLISION DAMAGE CLASSIFICATION		12FDEW2

SECTION 4

MASH TEST 3-53 SUMMARY

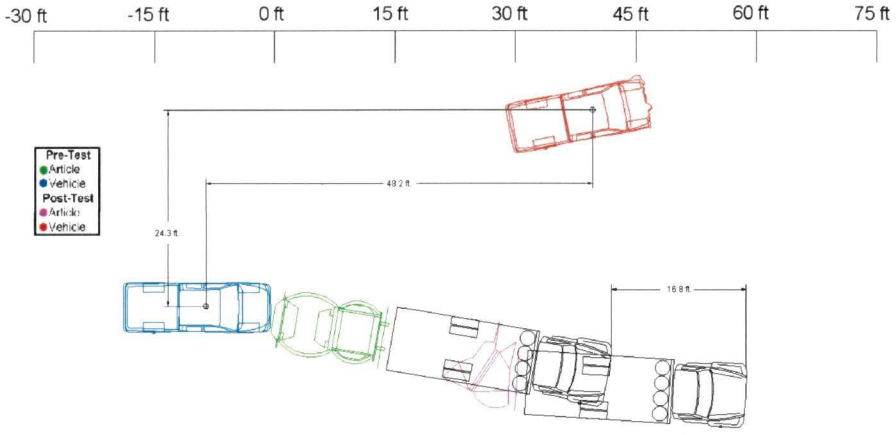
Test Article:	TrafFix Devices Scorpion TL3 TMA	Project No.	P36129-01
Test Program:	MASH 3-53	Test Date:	09/07/16

SEQUENTIAL PHOTOGRAPHS



0.000 s | 0.050 s | 0.150 s | 0.300 s | 0.500 s | 1.200 s

PLAN VIEW



SECTION 4 ... (CONTINUED)

MASH TEST 3-53 SUMMARY

Test Article: TrafFix Devices Scorpion TL3 TMA Project No. P36129-01

Test Program: MASH 3-53 Test Date: 09/07/16

GENERAL INFORMATION	
TEST AGENCY	KARCO Engineering, LLC.
TEST NUMBER	P36129-01
TEST DESIGNATION	3-53
TEST DATE	09/07/16
TEST ARTICLE	
NAME / MODEL	Scorpion TL3 TMA
TYPE	Truck Mounted Attenuator
KEY ELEMENTS	Curved Tubes, Aluminum Honeycomb, Support Frame, Cartridge Section
ARTICLE LENGTH	12.9 ft. (3.9 m)
HEIGHT FROM GROUND	11.02 in. (280 mm)
MAXIMUM WIDTH	8.0 ft. (2.4 m)
ROAD SURFACE	Concrete
SUPPORT VEHICLE	
TOTAL INSTALLATION LENGTH	41.3 ft (12.6 m)
YEAR, MAKE AND MODEL	1991 Ford F700
RESTRAINT	2nd gear and parking brake engaged
TEST VEHICLE	
TYPE / DESIGNATION	2270P
YEAR, MAKE AND MODEL	2012 RAM 1500
CURB MASS	4,964.7 lbs (2,252.0 kg)
TEST INERTIAL MASS	4,995.6 lbs (2,266.0 kg)
GROSS STATIC MASS	4,996.6 lbs (2,266.5 kg)
IMPACT CONDITIONS	
IMPACT VELOCITY	64.05 mph (103.08 km/h)
IMPACT ANGLE	10.3°
IMPACT LOCATION / ORIENTATION	10° and 20.6 in. (523 mm) from vehicle centerline

EXIT CONDITIONS		
EXIT VELOCITY		
EXIT ANGLE		
VEHICLE STABILITY		Satisfactory
FINAL VEHICLE POSITION		48.2 ft. (14.7 m) forward and 24.3 ft. (7.4 m) left from its initial point on contact.
VEHICLE SNAGGING		None
VEHICLE POCKETING		None
MAXIMUM ROLL ANGLE		37.2°
MAXIMUM PITCH ANGLE		20.9°
MAXIMUM YAW ANGLE		164.6°
KINETIC ENERGY		685.12 kip-ft (928.10 kJ)
OCCUPANT RISK VALUES		
OCCUPANT IMPACT VELOCITY	Longitudinal	35.8 ft/s (10.9 m/s)
	Lateral	3.9 ft/s (1.2 m/s)
RIDEDOWN ACCELERATION	Longitudinal	-12.5 g
	Lateral	-4.9 g
THIV		36.1 ft/s (11.0 m/s)
PHD		12.8 g
ASI		1.10
TEST ARTICLE DEFLECTIONS		
DYNAMIC DEFLECTION		11.2 ft. (3.4 m)
STATIC DEFORMATION		10.8 ft. (3.3 m)
ARTICLE DAMAGE		Damage to backup structure, strut section, cartridge section, and tubes.
VEHICLE DAMAGE		
VEHICLE DAMAGE SCALE		12-FD-4
COLLISION DAMAGE CLASSIFICATION		12FDEW2

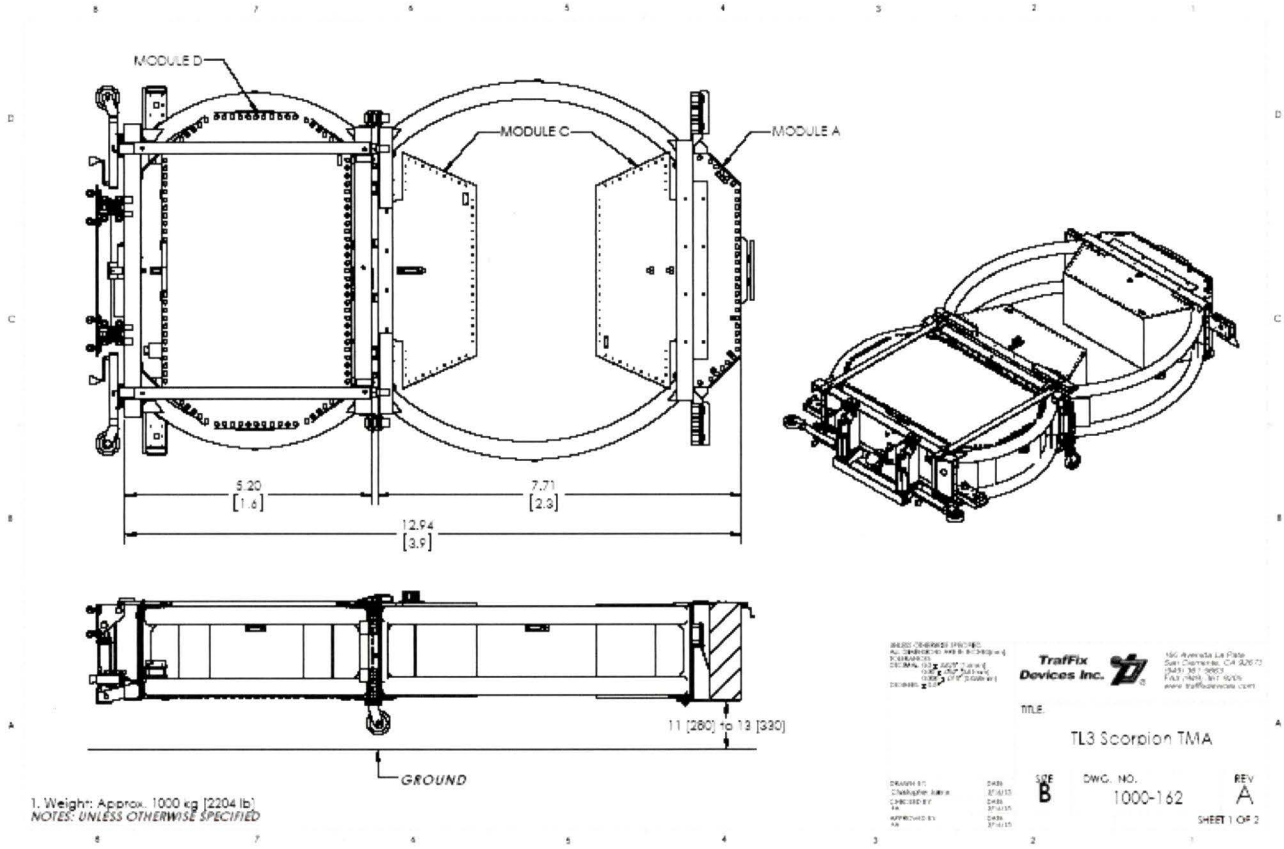


Figure 1:TL3 Scorpion TMA Sheet 1 of 2

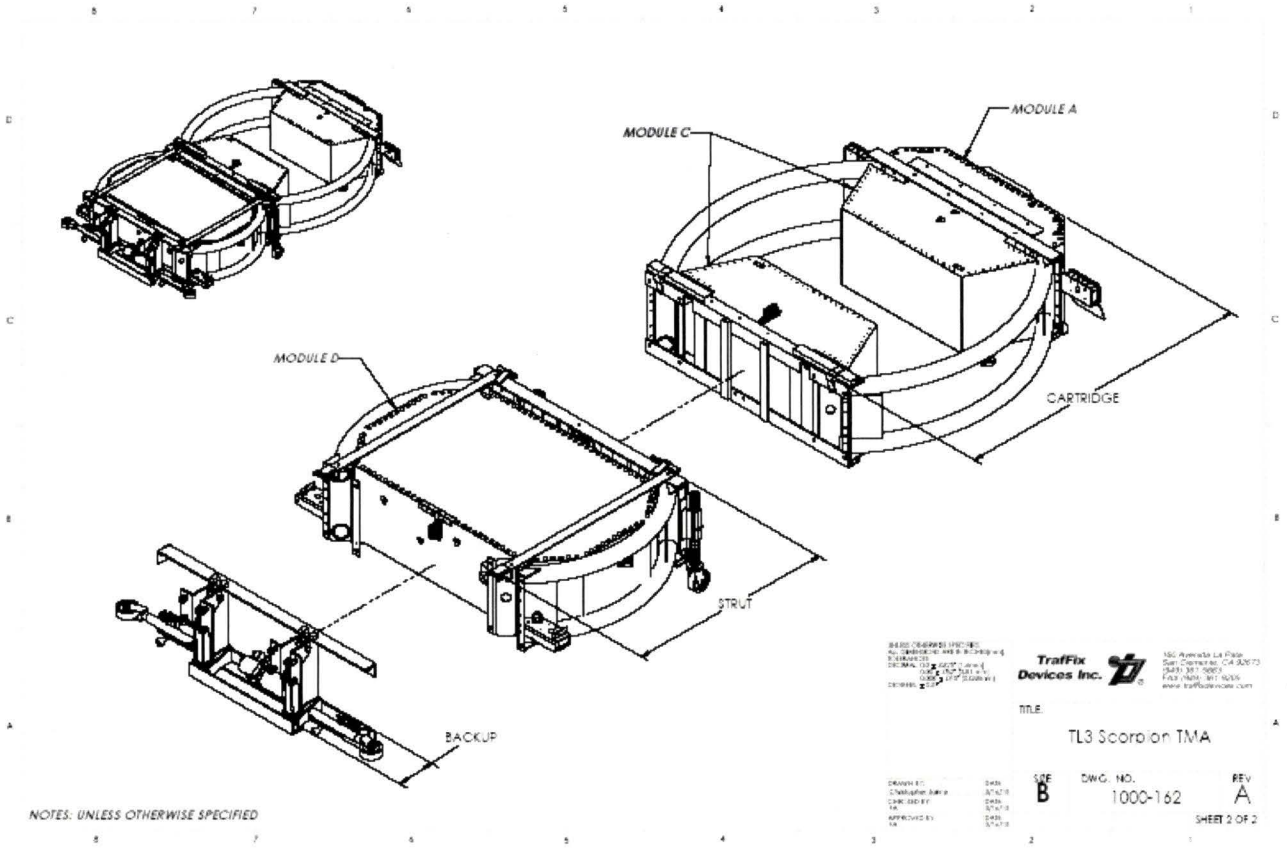


Figure 2:TL3 Scorpion TMA Sheet 2 of 2