U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Ave., S.E.
Washington, DC 20590

October 6, 2008

In Reply Refer To: HSSD/CC-103

Gerrit A. Dyke, P.E.
Engineering Manager
Barrier Systems, Inc.
180 River Road
Rio Vista, CA 94571

Dear Mr. Dyke:

This letter is in response to your request for Federal Highway Administration (FHWA) acceptance of a roadside safety device for use on the National Highway System (NHS).

Name of device: U-MAD™ Trailer Mounted Crash Cushion
Type of device: Trailer mounted TMA
Test Level: TL-2 and TL-3
Testing conducted by: Transportation Research Center
Date of request: March 21, 2008
Date of completed package: July 22, 2008

You requested that we find this device acceptable for use on the NHS under the provisions of National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features." Barrier Systems, Inc. recently purchased the rights to the U-MAD™ Truck Mounted Attenuator system from Albert W. Unrath.

Requirements
Roadside safety devices should meet the guidelines contained in the NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". FHWA Memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description
The U-MAD™ crash cushion is comprised of an energy absorbing cartridge consisting of an aluminum and steel box structure with reinforcing materials and energy absorbing materials. The system has been successfully tested and accepted by the FHWA to the NCHRP Report 350, Test Level 3 (TL-3) and TL-2, mounted on a shadow vehicle weighing approximately 19,000 lbs

(8600 kg). The truck mounting allows deployment from a 90-degree upright travel position to a horizontal configuration where it has energy absorbing capacity. The cushions are assembled in 129 inch (3.2 m) TL-3 and 78 inch (2.0 m) TL-2 lengths.

A trailer mounting system was developed for use with the U-MAD energy absorbing cartridge. Testing was conducted on this system, in accordance with the NCHRP Report 350, TL-3, to verify the performance of the U-MAD crash cushion mounted to a steel fabricated, load dampening trailer with an anti-rotation mechanism that activates upon impact. The trailer utilizes a hydraulic system mounted within the tongue to increase the ride down distance and control the engagement of anti-rotation arms with the tow vehicle. The rigid axle with torsion bar suspension can be fitted with emergency or impact activated brakes when required. The crash cushion mounts directly to the trailer and remains in the deployed (horizontal) position at all times.

The U-MAD 100K TMA was constructed from an aluminum box, having an outer shell thickness of .050 inch, with structural supports, cushion constructed into eight compartments, with each compartment containing variable cellular velocity dissipating material of varying density (CVDM). All seams are welded or steel riveted and both internally and externally sealed to prevent moisture intrusion. Additionally, each unit of crushable CVDM is contained in its own separate moisture barrier.

The U-MAD 100K TMA assembly was mounted to a two-wheel trailer which was connected to the rear of the support truck by means of a hitch. Overall length of the U-MAD 100K TMA was 10.9 feet (3.3 m). The overall weight of the U-MAD Trailer system was 2525 pounds (1147.6 kg). Individually, the trailer weighed 1617 pounds (734.8 kg), and the U-MAD 100K TMA weighed 908 pounds (412.8 kg). The support truck weighed 19, 220 pounds (8,736.2 kg).

Crash Testing

Two full-scale tests using the 2000P vehicle were conducted on the U-MAD Trailer, the NCHRP Report 350 Tests 3-51 and 3-52. The FHWA initially only required test 3-52 to be conducted in order to assess the ability of the trailer to maintain its alignment during an off-center impact. Subsequently, all TMA trailers were required to pass test 3-51 to verify that the attenuation system was not adversely affected by the hardware needed to fabricate a trailer version. As the proposed trailer system incorporated wheels behind the basic TMA design, conversion to a trailer system was not as extensive as required by TMA trailers of other manufacturers. Copies of the test data summary sheets are enclosed for reference.

In both tests the vehicle was brought to a controlled stop without intruding into adjacent traffic lanes. Occupant impact velocities and ride down accelerations were within the recommended limits. In Test 3-51 the “shadow vehicle” to which the trailer was attached moved forward 32.5 feet (9.9 m). In Test 3-52 this roll-ahead distance was 25.6 feet (7.8 m).

Findings

Therefore, the device described in the various requests above and detailed in the enclosed drawings is acceptable for use on the NHS under the range of conditions tested, when acceptable to a highway agency.

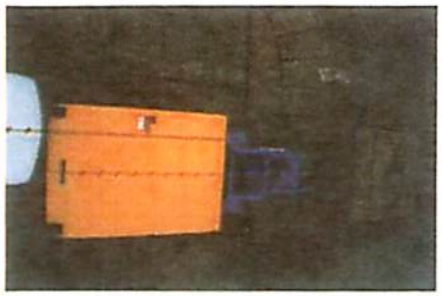
Please note the following standard provisions that apply to the FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the devices and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the device will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the device being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-103 and 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 at our office upon request.
- The U-MAD family of attenuators are patented products and considered proprietary. The use of proprietary TMA devices in Federal-aid projects is generally of a temporary nature. They are *selected by the contractor* for use as needed and removed upon completion of the project. Under such conditions they can be presumed to meet requirement "a" given below for the use of proprietary products on Federal-aid projects. On the other hand, if proprietary devices 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.
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented device for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate device, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

David A. Nicol, P.E.
Director, Office of Safety Design
Office of Safety

Enclosures



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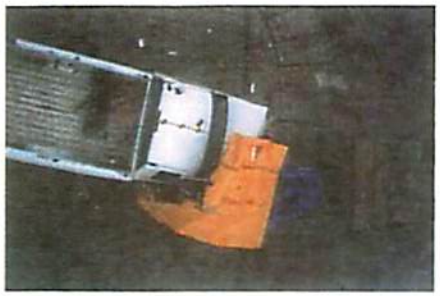

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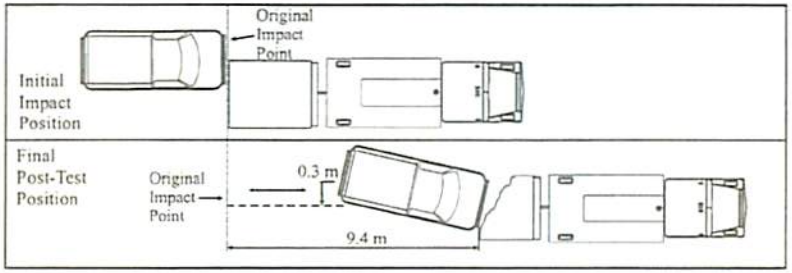


General Information	
Test Agency	Transportation Research Center Inc. (TRC Inc.)
Test Type	Optional 3-52
Test No.	070220
Date	February 20, 2007
Test Article	
Type	Truck Mounted Attenuator
Name or Manufacturer	U-MAD 100K by Al W. Unrath, Inc
Size and/or dimension and material of key elements	8 compartments, each containing various cellular velocity dissipating material of varying density.
Soil Type and Condition	N/A
Test Vehicle	
Type	Production Model
Designation	2000P
Model	Chevrolet Silverado C2500
Mass (kg)	
Curb	2269.2
Test Inertial	2043.4
Dummy(s)	N/A
Gross Static	2043.4

Impact Conditions	
Speed (km/h)	98.0
Angle (deg)	0
Exit Conditions	
Speed (km/h)	N/A
Angle (deg)	N/A
Occupant Risk Values	
Impact Velocity (m/s)	
x-direction	9.4
y-direction	0.5
THIV (optional) (m/s)	9.4
Ridedown Acceleration (g's)	
x-direction	18.6
y-direction	4.8
PHD (optional)	18.64 g
ASI (optional)	1.29
Max. 0.050 –s Average (g's)	
x-direction	15.5
y-direction	3.6
z-direction	2.7

Test Article Deflections (m)	
Dynamic	0.9
Permanent	0.9
Vehicle Damage	
Exterior	
VDS	N/A
CDC	12FDEW2
Interior	
OCDI	FS1000000
Maximum Exterior	
Vehicle Crush (mm)	390[1]
Max. Occ. Compart.	
Deformation (mm)	0
Post-Impact Vehicular Behavior	
Maximum Roll Angle (deg)	-5.14
Maximum Pitch Angle (deg)	1.53
Maximum Yaw Angle (deg)	-45.86

Vehicle Trajectory Post Test

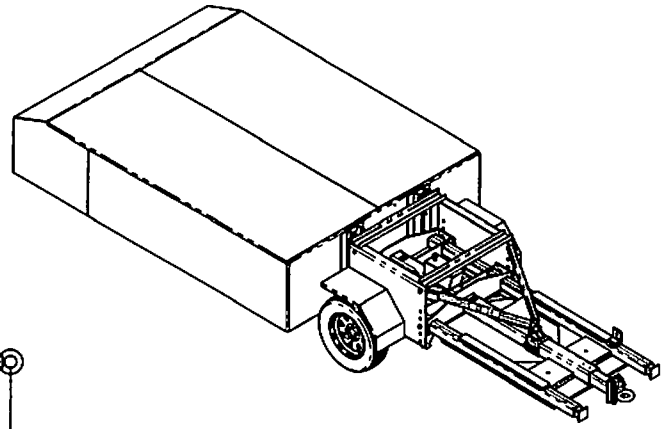
The impacting vehicle's final most outer left trajectory stayed within six feet of the centerline on which it was traveling. Assuming that the impacting vehicle was centered mid-lane at impact, it would have stayed within a 12-foot lane width.

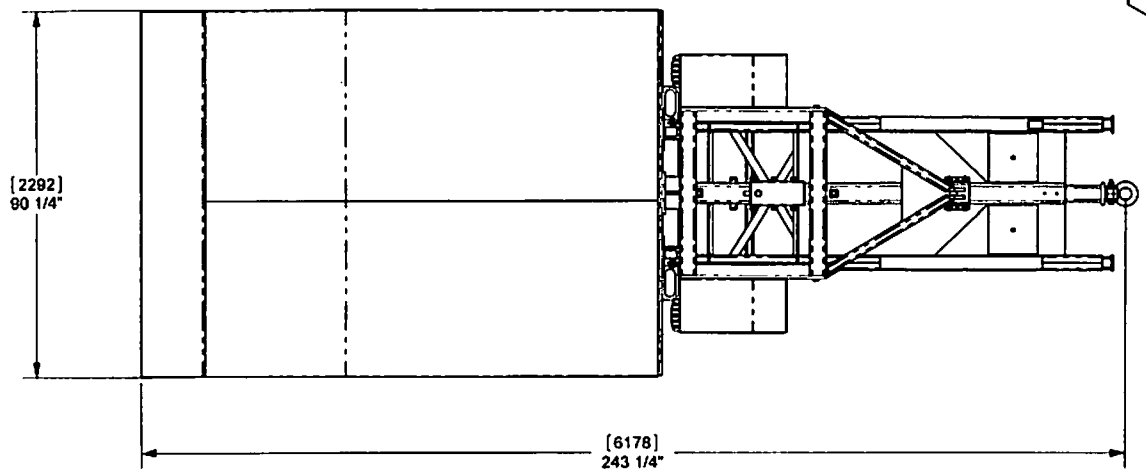
[1] Vehicle pre-test crush measurements were taken with the bumper intact. The post-test measurements were taken without the bumper, thus giving no accurate comparison.

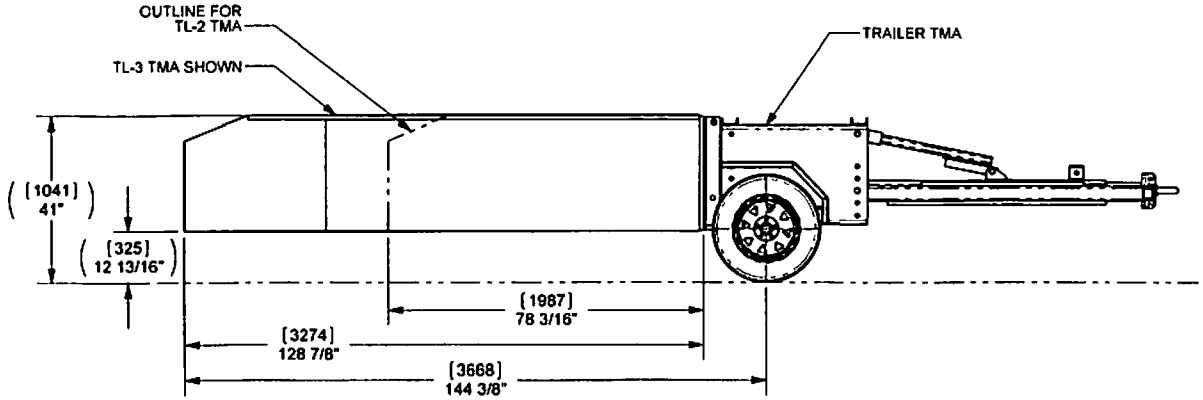
Figure 9. Summary of results for test 060809

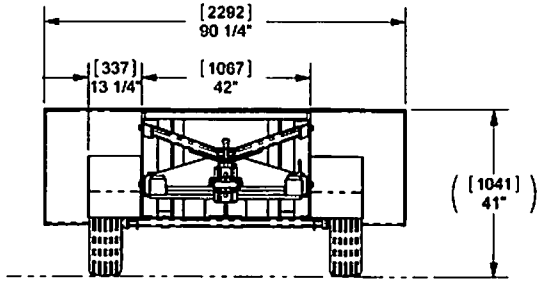
NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS IN PARENTHESIS ARE REFERENCES
   DIMENSIONS IN BRACKETS ARE mm.









REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:30

	DATE	INIT
DRAWN BY	02/05/08	AEM
APPR'D BY		

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

TITLE:
U-MAD TRAILER MOUNTED CRASH CUSHION

BARRIER SYSTEMS
160 RIVER RD, RIO VISTA, CA 94571
TEL 707-374-6800 FAX 707-374-6801

SHEET	DRAWING NUMBER	REV
1 OF 1	B080188-US	