Vorteq™ TL-3 Trailer TMA
GENERAL SPECIFICATION

I. GENERAL:

Scope: This specification describes a truck-mounted attenuator (TMA) system for 'mobile work zone' shadow vehicles and 'stationary work zone' barrier vehicles. The TMA system is designed to provide safety protection in the event an errant vehicle collides with the rear of these support vehicles. The TMA safely dissipates the collision energy of typical passenger vehicles traveling at speeds up to 100 km/h (62mph).

Functional benefits of the TMA are:

1. Increased survival rate/lowered injury rate for the occupants of errant vehicles.
2. Reducion in the impact severity for occupants of the shadow or barrier vehicle.
3. Elimination of, or reduction in, the damage to barrier or shadow vehicle.
4. Decreased incident management time.

II. PRODUCT:

All Vorteq® Trailer Truck Mounted Attenuators [TMA's] shall be designed and manufactured in accordance with this specification by Energy Absorption Systems, Inc. a Trinity Highway Products, LLC.

The Vorteq® Trailer TMA, when properly deployed, shall meet the National Cooperative Highway Research Program Report 350 (NCHRP 350) performance criteria at Test Level 3 (100 km/h) impact severity. The TMA shall meet the NCHRP 350 criteria for the specified mandatory Tests 3-50 and 3-51 as well as optional Tests 3-52 and 53. The TMA shall satisfy the criteria when attached to support vehicles completely restrained from forward and lateral movement during impact.

The Vorteq® Trailer TMA shall have inherent features to minimize rotation during offset impacts, thus helping to minimize possible secondary accidents. The TMA shall accomplish anti-rotation by a combination of features such as a trapezoidal impact head, load balancing and self centering shaper vanes, and a collapsible tongue. This system will allow the trailer to act like a normal trailer when trailering and resist rotation when impacted.

The support vehicle roll-ahead distance is affected among other things by the weight of the shadow or barrier vehicle, TMA weight, degree of braking, surface conditions, and errant vehicle collision energy. When equipped with a Vorteq Trailer TMA, an unrestrained support vehicle weighing 4500 kg (9920 lb) typically has a maximum forward skid distance of 8 m (25ft) when positioned on a clean and dry asphalt surface and impacted under Test 3-51 impact conditions with the park brake set and the transmission in second gear. The Vorteq® TMA has the capabilities of being used with lighter shadow and barrier vehicles.

Shadow or Barrier Recommended Vehicle Weight

Recommended minimum vehicle weight – 4,500 Kg (9,920 lbs.)
Recommended maximum vehicle weight – No Limitation

The following table lists calculations of roll-ahead distance versus support vehicle weight and type:

**Table T-4 Roll-Ahead Distance for Shadow Vehicles*

Weight of Shadow Vehicle (moving)	Prevailing speed (mph)	Weight of Impacting Vehicle to be Contained*			
		4,500 lbs	10,000 lbs	15,000 lbs	24,000 lbs
10,000 lbs	60-65	100 ft	175 ft	225 ft	275 ft
	50-55	100 ft	150 ft	175 ft	200 ft
	45	75 ft	100 ft	125 ft	150 ft
15,000 lbs	60-65	75 ft	150 ft	175 ft	225 ft
	50-55	75 ft	125 ft	150 ft	175 ft
	45	50 ft	100 ft	100 ft	100 ft
24,000 lbs	60-65	75 ft	100 ft	150 ft	175 ft
	50-55	50 ft	75 ft	100 ft	150 ft
	45	50 ft	75 ft	75 ft	100 ft

Note: Distances are appropriate for shadow vehicles speeds up to 15 mph.

**Table T-5 Roll-Ahead Distance for Barrier Vehicles*

Weight of Barrier Vehicle (stationery)	Prevailing speed (mph)	Weight of Impacting Vehicle to be Contained*			
		4,500 lbs	10,000 lbs	15,000 lbs	24,000 lbs
10,000 lbs	60-65	50 ft	100 ft	150 ft	200 ft
	50-55	25 ft	75 ft	100 ft	150 ft
	45	25 ft	50 ft	75 ft	100 ft
15,000 lbs	60-65	25 ft	75 ft	100 ft	150 ft
	50-55	25 ft	50 ft	75 ft	100 ft
	45	25 ft	25 ft	50 ft	75 ft
24,000 lbs	60-65	25 ft	50 ft	75 ft	100 ft
	50-55	25 ft	25 ft	50 ft	75 ft
	45	25 ft	25 ft	25 ft	50 ft

**Source: "Use of Truck Mounted Attenuators in Work Zones" by Jack B. Humphreys, P.E. and T. Darcy Sullivan, P.E., University of Tennessee.*

Weights of typical vehicles:

Mid-size automobile — 2,250 lbs
Full-size automobile — 3,500 lbs
Loaded 3/4-ton pickup truck — 6,000 lbs
Loaded 1-ton cargo truck — 10,000 lbs
Loaded 4-yard dump truck — 24,000 lbs

III. DESCRIPTION OF SYSTEM:

A. General Assembly

The Vorteq® Trailer TMA shall be equipped with a heavy duty, forged 10 Ton lunette eye (pintle ring) to make attachment to, and detachment from, the support vehicle quick and simple. The TMA shall then be capable of deforming and safely absorbing collision energy when impacted by errant vehicles under any of the mandatory or optional TL-3 NCHRP 350 specified test conditions.

B. Major Components:

The Vorteq® Trailer TMA shall consist of the following components:

1. Impact Head

The Impact Head engages the front end of the errant vehicles effectively preventing under-ride, over-ride, and side-slip past the TMA. The Impact Head deforms the Frame Rails as it is forced forward thereby absorbing collision energy and bringing impacting vehicles to a safe controlled stop. The Impact Head deforms the Frame Rails such that the debris is contained within the width of the TMA thereby preventing an undue hazard to other traffic, pedestrians, or personnel in the work zone.

2. Rear Collar (left / right)

The Rear Collar couples the Impact Head, Frame Rail, and Suspension components. The Rear Collar guides the Frame Rail against the Impact Head as the TMA collapses thereby resisting under-ride, over-ride, and side-slip past the TMA.

3. Frame Rail (upper / lower)

The Frame Rail couples the Rear Collar and Tongue components and provides load-bearing support for the TMA. The Frame Rail provides the principle collision energy absorption for the TMA when it is deformed by the forward movement of the Impact Head.

4. X-Brace

The X-Brace cross ties the Frame Rails reducing their unsupported length and providing increased side load support to the TMA.

5. Tongue

The Tongue couples the TMA to the support vehicle and resists the forces from head on collisions. The Tongue functions to provide an additional means of energy absorption during offset and angled collsions from errant vehicles.

6. Suspension

The Suspension consists of the axles, wheels, tires, and fenders which support the TMA and allow it to be trailered by the support vehicle.

C. Lights & Visibility

The Vorteq® Trailer TMA shall have a trailer lighting assembly per Federal Motor Vehicle Safety Standards (FMVSS) No. 108 “Lamps, Reflective Devices, and Associated Equipment.” All components shall be appropriate for their intended purpose under any adoptions issued by the FMVSS, National Highway Transportation Safety Administration (NHTSA), and Society of Automotive Engineers (SAE) for standard practice for electrical lighting. TMA conspicuity tape and reflectors shall be installed following these same established standards as specified by local requirements.

The TMA shall include brake lights, taillights, turn signals and an ICC bar light. An industry standard 7-pin trailer connector shall be provided to power TMA lighting.

D. Jack

One hand crank jack with swivel caster with a total rated load capacity of at least 910 kg (2000 lbs.) shall be supplied with the TMA to facilitate removing it from a truck for storage.

E. Optional Striping

The surface of the Impact Head facing oncoming traffic shall be capable of supporting a display pattern and color bands as required. The colors shall meet the value and tolerance limits established by MUTCD.

G. Galvanizing

All exposed steel surfaces on the TMA shall be hot dip galvanized after fabrication per ASTM A-123.

H. Hardware

The TMA shall be assembled with Commercial Quality bolts, nuts, and washers conforming to ANSI (American National Standard) specifications unless otherwise specified.

IV. WEIGHT AND DIMENSIONS:

	Nominal Length*	**Nominal Height**	**Nominal Width**	**Nominal Weight**
English Units	23’-2”	28”	92”	<1300 lb.
Metric Units	7061mm	711mm	2337mm	<590 kg

Tongue weight: 194 kg (300 lbs.) included in total weight

*** Measured from center of pintle eye to impact face**

V. CRASH TEST PERFORMANCE CRITERIA:

The Vorteq® Trailer TMA has successfully passed both the mandatory and optional tests contained in the NCHRP Report 350 Test Level 3 guidelines for truck mounted attenuator with the support vehicle restrained from both forward and lateral movement:

NCHRP 350 Test 3-50 - Vehicles with a mass of 820 kg (1,808 lb.) impacting straight into the rear of the TMA at 100 km/h (62 mph) shall remain upright with a theoretical occupant impact velocity of 12 m/s (39 fps) or less and an occupant ridedown acceleration of 20 g's or less.

NCHRP 350 Test 3-51 - Vehicles with a mass of 2000 kg (4,410 lb.), impacting straight into the rear of the TMA at 100 km/h (62 mph) shall remain upright with a theoretical occupant impact velocity of 12 m/s (39 fps) or less and an occupant ridedown acceleration of 20 g's or less.

NCHRP 350 Test 3-52 - Vehicles with a mass of 2000 kg (4,410 lb.), impacting straight into the rear of the TMA with an offset of W/3 with respect to the TMA centerline at 100 km/h (62 mph) shall remain upright with a theoretical occupant impact velocity of 12 m/s (39 fps) or less and an occupant ridedown acceleration of 20 g's or less.

NCHRP 350 Test 3-53 - Vehicles with a mass of 2000 kg (4,410 lb.) impacting at 10 degrees into the rear of the TMA at 100 km/h (62 mph), and an offset of W/4 at an angle of 10 degrees with respect to the TMA centerline, shall remain upright with a theoretical occupant impact velocity of 12 m/s (39 fps) or less and an occupant ridedown acceleration of 20 g's or less.

Following any of these tests, the impacted TMA shall remain attached to the support vehicle at the pintle hook even when the support vehicle has been constrained from both forward and sidewise movement.

When impacted no portion of the TMA shall protrude over, under, or around the sides of the support vehicle and thereby risk damaging it during these impacts. Likewise any TMA debris from these impacts shall be contained to a distance of 2600 mm (8'-6") or less to either side of support vehicle centerline. No TMA debris from any these impacts shall become detached or contain shards of metal that present an undue hazard to other traffic, pedestrians, or personnel in the work zone.

Further, the TMA shall not impede the line-of-site of either an Arrowboard or Message Board mounted on the support that has been installed per the Manual on Uniform Traffic Control Devices (MUTCD) guidelines at a height of 2135 mm (7'-0") to the bottom of board. Lastly, the impacted TMA shall be capable of being safely transported a short distance off the road essentially intact after these impacts. For Tests 3-50 and 3-51 the impacted unit should be able to be towed away from the impact scene by the support vehicle without dragging or the need for a secondary vehicle. If necessary the TMA damage from these impacts shall be capable of being refurbished using simple hand tools and replacement parts.

Certified test results and associated test reports and films produced in compliance with NCHRP Report 350 procedures shall be submitted, upon request, showing that the Vorteq® Trailer TMA conforms to the performance criteria in this specification.

VI. DURABILITY TESTING:

A. Road Test:

The Vorteq® Trailer TMA shall be subjected to an accelerated road durability test that simulates actual in-service use. The road test shall cover a minimum of 16,000 km (10,000 miles) on representative roadways and in representative traffic conditions.

B. Speed Bump Test:

The Vorteq® Trailer TMA shall be subjected to a speed bump test to determine durability of the TMA. The results of the bump test program will be documented in a detailed test

report.

The bump test shall consist of mounting the TMA to a support vehicle and traversing two 1 ½" speed bumps anchored 50 feet apart at various speeds. The TMA is to be towed at the worst case speed over the speed bumps 100 times.

