

Safe-Stop 180 TMA™
GENERAL SPECIFICATIONS

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 system provides impact protection during collisions into the rear of a truck in work zone operations. The system design dissipates the collision energy of standard passenger vehicles traveling at speeds up to 100 km/h (62mph).

The following primary benefits are projected:

1. Reduce impact severity for occupants of the barrier or shadow vehicle.
2. Reduce or eliminate damage to barrier or shadow vehicle.
3. Reduce incident management time.
4. Increase survival rate for the occupants of impacting vehicles.
5. Lower injury rate for the occupants of impacting vehicles.

II. PRODUCT:

All "Safe-Stop 180 TMA" Truck Mounted Attenuators [TMA's] shall be designed and manufactured by Energy Absorption Systems, Incorporated, a Quixote Company, of Chicago, Illinois, in accordance with this specification.

The Safe-Stop 180 TMA, when properly mounted, shall meet NCHRP (National Cooperative Highway Research Program) Report 350, Test Level 3 (TL-3) criteria.

The Safe-Stop 180 TMA equipped truck shall have a maximum skid distance of 8 m (25ft) when impacted at NCHRP Report 350 TL-3, test 3-51 impact conditions. The forward skid distance is dependent on the truck's weight, the truck's transmission being in second gear, and the parking brake set with the truck situated on clean, dry pavement.

III. DESCRIPTION OF SYSTEM:

A. General Assembly

The complete Safe-Stop 180 TMA shall be designed to make attachment or detachment from the truck simple and fast. The major components (listed in III. B.) stay together when detached from the support vehicle.

When the TMA is in an unfolded orientation, the assembly of frames shall be capable of collapsing when impacted by an errant vehicle. No portion of the TMA shall protrude forward under the truck damaging its vital elements during an impact.

When the TMA folds for transport, no portion of it shall protrude over, into or under the truck. Further, the folded TMA shall not impede the line-of-site of an Arrowboard or Message board mounted on the truck, installed per MUTCD (Manual on Uniform Traffic Control Devices) guidelines at a height of 2135mm (7'-0") to the bottom of board.

Following a design impact under NCHRP Report Test Level 3 conditions, the TMA shall remain less than 3650mm (12'-0") wide and retain its structure. This shall permit transport of the TMA by the impacted truck. The TMA shall be capable of refurbishment with hand tools. The TMA design shall allow for estimated reusability percentages near 100% for the hydraulic assembly and 70% for the steel framework.

B. Major Components:

The Safe-Stop 180 TMA™ shall consist of the following components:

1. Support Structure with Articulating Arms
2. Safe-Stop Type A and Type B Cartridges
Note: Both of the cartridges shall be contained within the framework created by the arms.
3. Rear Impact Frame
4. Hydraulic System -shall fold the rear half of the framework over the front half.
5. Underride - shall be designed for attaching the TMA to the truck.
Note: Part of this component remains on the truck. The TMA uses the same Underride supplied with many other TMA models.; consequently, the existing underride may be used if appropriate.

C. Lights & Visibility

The Safe-Stop 180 TMA shall have a trailer lighting assembly per FMVSS No. 108 "Lamps, Reflective Devices, and Associated Equipment." All components shall be appropriate for their intended purpose under any adoptions issued by the NHTSA, SAE and FMVSS. This is standard practice for electrical lighting. The Safe-Stop 180 TMA shall include brake lights, taillights, turn signals, reverse lights and an ICC bar light. Wires shall be routed in a protective, jacketed cable. The cable shall be routed and secured to the frames at 450 (18") maximum intervals. For repair or replacement, individual circuits shall be easily identified and accessible. Molded connectors shall be used where

individual wires would otherwise be exposed to the elements. A standard, single, 7 pin trailer connector shall make the connection for all lights to the back of the truck. The Safe-Stop 180 TMA™ shall have two sets of lights so that the lighting meets FMVSS No. 108, whether the TMA is in its folded or unfolded orientation. The folded TMA's forward-facing red lamps shall disconnect from the electrical system. Gravity flaps shall not be used to shield the light from forward-facing red lamps. Conspicuity tape and reflectors shall be installed following the same established standards as the lighting.

D. Jacks

Four hand crank jacks with swivel casters with a total rated load capacity of at least 3,500lb. (1600 kg) shall be supplied with the TMA to facilitate removing it from a truck for storage.

E. Striping

The surface of the Impact Frame facing oncoming traffic, when in the unfolded horizontal position, shall display a black on yellow inverted “V” chevron pattern with 100mm (4 in.) wide color bands. The colors shall meet the value and tolerance limits established by MUTCD. When folded, the lower cartridge surface facing oncoming traffic shall also display the chevron pattern.

F. Welding

All welding shall be done by, or under the direction of, a certified welder. Metal-work shall be made in America.

G. Paint

All exposed steel surfaces on the TMA shall be painted black. Paint shall be applied after the proper preparation of all steel and aluminum components. The metal preparation shall include treatment with either a conditioner or a conversion coating in combination with, or in addition to, coating with primer.

H. Hardware

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

I. Pump System

The hydraulic system shall consist of a pump with an electrical motor, cylinders, hoses, switches, wiring, and necessary sub-components to rotate the rear half of the assembly 180°. The Safe-Stop 180 TMA™ shall be capable of tilting 5° from the horizontal when the rearmost bottom edge contacts rigid curb or pavement. The complete hydraulic system, including the pump and hoses, shall be factory assembled and mounted to the TMA. Depressing a “Stop” button shall stop the TMA rotation at any stage of the cycle, whether the TMA is folding or unfolding. The hydraulic system shall be safe guarded to lock the TMA into place should there be a loss of fluid or electrical control, regardless of the TMA's position. When the TMA is completely folded or unfolded, the hydraulic system prevents rotation until the controls are activated. In the folded position, the lower half of the TMA system provides support for the upper half. Additional locking devices shall not be necessary. Prior to shipment, the hydraulic system shall be cycled a minimum of two times. The procedure shall assure proper operation, lubrication and proper alignment of the components for smooth operation. Note: The TMA is to be completely folded or unfolded during travel.

IV. WEIGHT AND DIMENSIONS:

		Max Height From Ground	Max Width (Impact Face)	Length	Weight
English Units	Folded	6'-10"	7'-9"	7'-10"	2070 lb.
	Unfolded	4'-2"		14'-5"	
Metric Units	Folded	2.08m	2.36m	2.4m	940 kg
	Unfolded	1.27m		4.4m	

V. CRASH TEST CRITERIA:

The Safe-Stop 180 TMA, shall have been tested to, and successfully passed, both the required and optional tests that fall under the guidelines of NCHRP Report 350 Test Level 3 for truck mounted attenuators. NCHRP Report 350 specifications for Test Level 3 TMA impact conditions and results are as follows:

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 the nominal occupant ridedown acceleration of 20 g's or less per NCHRP Report 350, Test 3-50 evaluation criteria. The front of the truck shall be restricted from forward movement by positioning it against a solid wall or concrete block for this

test.

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 the nominal occupant ridedown acceleration of 20 g's or less per NCHRP Report 350, Test 3-51 evaluation criteria.

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 the theoretical occupant impact velocity of 12 m/s (39 fps) or less and the occupant ridedown acceleration of 20 g's or less per NCHRP Report 350, optional Test 3-53 evaluation criteria.

Vehicles with a mass of 2000 kg (4,410 lb.) impacting straight into the rear of the TMA at 100km/h (62 mph), and an offset of W/3 with respect to the TMA centerline, shall remain upright with no significant roll pitch or yaw per NCHRP Report 350 optional Test 3-52 evaluation criteria.

Vehicles with mass of 2000 kg. (4,410 lb.) impacting straight into the rear of the TMA at 100 km/h (62 mph), shall remain upright. The test is a modified test 3-51 with the truck restricted from movement by positioning it against a solid wall or concrete block to simulate a truck of very heavy or infinite weight. This test had a theoretical occupant impact velocity of 12 m/s (39 fps) or less and the occupant ridedown acceleration of 20.7 g performance. The FHWA has acknowledged the Infinite weight test and the use of the Safe Stop 180 with heavier support vehicles at the discretion of the contracting authority.

The Safe-Stop 180 TMA™ shall be designed and constructed so no solid debris is present from the system that can create a hazard on the roadway after an impact.

To minimize potential damage to the truck, no portion of the TMA's energy absorbing elements shall protrude forward damaging the vital elements of the truck's underride during an impact.

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 TMA conforms to the performance criteria in this specification.

VI. DURABILITY TESTING:

A. Nuisance Impact Test:

The Safe-Stop 180 TMA shall be subjected to simulated nuisance impacts at 10 km/h (6 mph) minimum. The TMA shall be capable of withstanding these impacts without crushing any of the energy absorbing elements. The TMA shall retain all impact performance characteristics following these impacts.

B. Road Test:

The Safe-Stop 180 TMA shall be subjected to accelerated durability testing that simulates actual in-service use. Differences between the tested TMA and production units shall be noted in the report. The road tests shall cover a minimum of 4000 km (2,500 miles) on actual roadways in normal traffic. The testing shall be performed on a variety of roadways with an emphasis on poorly maintained 2 lane roads having design speeds of 80-100 km/h (50-60 mph). The record of the actual testing conditions shall provide evidence of intent to expose the system to maximized, demanding, real-world conditions. Portions of the road testing shall be video taped from another vehicle to show the interaction of the truck and TMA combination to the roadway and typical intersection conditions. Still photos of the truck and TMA during the course of the testing shall be included. The system shall be installed on an unloaded (i.e. no ballast permitted), large, dump truck with a Gross Vehicle Weight (GVW) rating of at least 18,000 kg (40,000lb.). The truck shall feature a dual rear axle arrangement and a stiff suspension that is intended to subject the TMA to considerably more stress loading than typical field use would impart. The combination truck and TMA weight shall be recorded. A record of the TMA's travel position and odometer mileage as well as the general roadway conditions shall be required. The TMA shall be regularly inspected and a record kept of any changes in system appearance. Any items showing signs of damage or loosening shall be noted and addressed. Replacement parts are to be listed. Recommended design changes shall be noted in the report. The Safe-Stop 180 TMA™ system shall incorporate the modifications and shall retain performance characteristics conforming to NCHRP Report 350 and this specification.

VII. ENVIRONMENTAL TESTING:

The cartridges of the Safe-Stop 180 TMA shall be made of the same corrosion resistant aluminum and use the construction methods of the Safe-Stop TMA® cartridges. Therefore, they shall perform successfully under the same moisture and corrosion tests:

A. Moisture Test:

1. The complete TMA cartridges shall be weighed prior to and after the moisture test, utilizing a certified scale. These TMA cartridge weights shall be a part of the test data submitted with the bid. The cartridges shall be placed in the normal horizontal operating position and subjected to precipitation equivalent to 150 mm (6 inches) of water per hour. Water shall be delivered from nozzles with spray cones mounted so that the required precipitation is evenly distributed over the entire area of the cartridge top, sides, and ends.
2. After a period of 24 hours, the cartridges shall be placed on their top sides and the same precipitation rate continued on the bottom side for 24 hours. The water shall be turned off, the cartridges returned to the normal operating position, and the cartridges will be allowed to drain for one hour before being weighed. The weight after the test shall be the same as the initial mass ± 2.3 kg (5 lb.). The cartridges will then be examined. The complete outer covering of the TMA cartridges shall be removed, the energy absorbing cells shall be examined and photographs of the energy absorbing cells shall be submitted with the moisture test data.
3. The cells shall be free of moisture and retain 100% of their energy absorbing qualities. The results of the examination of the energy absorbing cells for moisture retention shall be submitted on or before the scheduled bid opening.
4. Attenuator cells showing excessive retention of moisture or any damage whatsoever will constitute failure of the device.

B. Corrosion Test:

1. A sample of attenuator energy absorbing material shall be subjected to a salt spray (fog) test in accordance with ASTM B117-73, Method of Salt Spray (fog) Testing, for a period of 50 hours and consisting of two (2) periods. Each period shall consist of 24 hours exposure and one (1) hour drying time.
2. The sample of the structure shall consist of a section with a minimum dimension of 1050 cubic cm (4 cubic inches), and must include any adjacent bonding material. Photographs of the sample structure will be made prior to and after removal from the TMA cartridge assembly. Also, photographs will be made of this same sample prior to and after the corrosion test. All photographs listed above shall be submitted with the corrosion test results.
3. Immediately after the device has been subjected to the corrosion test, there shall be no evidence of corrosion that would effect the energy absorbing qualities of the sample.