

Safe-Stop™ TMA (Truck Mounted Attenuator)  
GENERAL SPECIFICATIONS

I. GENERAL

- A. All Safe-Stop Truck Mounted Attenuators (Safe-Stop TMA) shall be designed and manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois, in accordance with this specification.
- B. The Safe-Stop TMA is an attenuator system designed for installation at the back of trucks with gross vehicle weight (GVW) ranges between 7300 kg (16,090 lb.) and 12 000 kg (26,460 lb.). To achieve optimum TMA performance, the traveling mass of the vehicle should be between 7300 kg (16,090 lb.) and 9000 kg (19,845 lb.). (Note: Any added ballast must be adequately anchored to the truck so that it will not move during impacts.) Because the back end of the truck supports the weight of the rearward protruding TMA, care must be taken not to exceed the manufacturer's published maximum axle loads. To ensure that the driving characteristics of the vehicle are maintained, the manufacturer's recommended center-of-gravity zone should also be adhered to.
- C. A minimum 7300 kg (16,090 lb.) truck equipped with a Safe-Stop TMA shall have a forward skid distance of less than 6 m (20 ft) during an impact by either an 820 kg (1,808 lb.) or 2000 kg (4,410 lb.) vehicle traveling at a design speed of 100 km/h (62 mph). The minimum forward skid distance is dependent on the truck's transmission being in second gear, and the parking brake set with the truck situated on clean, dry pavement.

II. DESCRIPTION OF SYSTEM

- A. The Safe-Stop TMA shall consist of the following basic components: A Safe-Stop bi-folding, articulating frame assembly, a Safe-Stop Type I Cartridge, a Safe-Stop Type II Cartridge, a support structure, an impact face and an underride designed for attaching the system to the truck. Both of the Safe-Stop cartridges shall be contained in the frame assembly. A hydraulic system shall also be included in the system to raise the frame assembly and cartridges to a vertical position. When the system is in a horizontal position, the frame assembly shall be

capable of collapsing when impacted by an errant vehicle. No portion of the system shall protrude forward under the truck during an impact. The total mass of the system shall be approximately 910 kg (2000 lb.). The complete Safe-Stop TMA shall be designed to make attachment or detachment from the truck simple and fast, with the major components listed above remaining together when detached from the support vehicle.

- B. The Safe-Stop™ TMA shall have a standard trailer lighting system per FMVSS No. 108 “Lamps, Reflective Devices, and Associated Equipment”. This system shall include brake lights, taillights, turn signals, and an ICC bar light. The wiring for the rear lights shall be routed and secured on the articulating frame. This system shall have additional lights so that the lighting system meets FMVSS No. 108, whether the system is in its horizontal or vertical orientation.
- C. Four hand crank jacks with swivel casters shall be attached to the system to facilitate removing it from a truck for storage.
- D. The rear impact surface of the articulated frame assembly, when in the horizontal position, shall display a black on yellow inverted “V” chevron pattern with 100 mm (4 in.) wide color bands.
- E. All welding shall be done by, or under the direction of, a certified welder. Metal work shall be made in America.
- F. All exposed steel surfaces on the TMA shall be primed and painted black.
- G. The TMA shall be assembled with Commercial Quality bolts, nuts, and washers conforming to “American National Standard” unless otherwise specified.
- H. The hydraulic system shall consist of a pump with a 12 or 24 volt DC motor, cylinders, hoses, switches, wiring, and necessary sub-components to tilt the frame assembly to a 90° position from horizontal. The hydraulic system shall hydraulically lock to secure the frame assembly in the 90° position. A manual mechanical lock mechanism shall also be provided to secure the frame assembly in this position. The Safe-Stop TMA system shall be capable of tilting 5° from the horizontal when the bottom edge of the rear impact surface contacts rigid curb or pavement.

The complete hydraulic system, including the pump and hoses, shall be

factory assembled and mounted to the TMA.

### III. PERFORMANCE CRITERIA

- A. The Safe-Stop™ TMA, when mounted to a truck weighing up to 9,000 kg (19,845 lb.) situated on clean dry pavement with the transmission in second gear and the brakes locked shall perform as follows:
1. 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 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 350, Test 3-50 evaluation criteria. The truck shall be placed against a non-moving wall during this test.
  2. 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 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 350, Test 3-51 evaluation criteria.
  3. 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 350, optional Test 3-53 evaluation criteria.
  4. Vehicles with a mass of 2000 kg (4,410 lb.) impacting straight into the rear of the TMA at 100 km/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 350 optional Test 3-52 evaluation criteria.
  5. To minimize potential damage to the truck, no portion of the TMA's structure or energy absorbing elements shall protrude forward of the underride during an impact.

Certified test results and associated test reports and films produced in compliance with NCHRP 350 procedures shall be submitted showing that the TMA system conforms with all test and performance criteria in this specification.

B. The Safe-Stop™ TMA cartridges shall successfully perform to accelerated vibration, moisture and corrosion tests conducted in the following sequence:

1. Vibration Test:

The standard TMA cartridges shall be subjected to two 40 hour vibration tests. The vibration test fixture will be free of springs or dampeners, and shall have a vertical pivot point that is located  $3.53 \pm .23$  m ( $139 \pm 9$  inches) from the TMA cartridge and capable of inducing the required frequency and excursion into the attenuator through a mechanically positive system. Photos of the TMA cartridges mounted to the test fixture in the horizontal operating position and the 90° position must be submitted with the bid.

The frequency of the vibration will be 5 Hz to 8 Hz for a period of 40 hours in each test position (80 hours total). Excursion is to be  $15.25 \pm 1.25$ mm ( $.60 \pm .05$  inch), measured peak to peak vertically at the location where the attenuator is attached to the back support. Measurements prior to, at 20 hours, and on completion of the vibration tests will be recorded with the TMA cartridges mounted in the normal operating position, and mounted in the 90° elevated position. A variance of 13 mm (.50 inches) of any component dimension, damage to the energy absorbing cells that would affect their performance, or damage to the back support, exterior skin, light bracket attachment, or rear jack attachment, will constitute failure of the device. Extra tie-downs, dampeners, supports, etc. will not be allowed unless they are included in the production model. Vibration data forms and vibration test time log forms are to be used for recording the data required and shall be submitted with the bid. Certified TMA assembly weights shall be recorded prior to and after each vibration test and submitted.

- a. Test No. 1: The TMA cartridges shall be mounted to the vibration apparatus in the normal horizontal operation position. The indicated measurements shall be recorded prior to, at 20 hours, and on completion of this vibration test and recorded on vibration data forms.
- b. Test No. 2 The TMA cartridges shall be mounted to the vibration apparatus in an elevated position 90° to the horizontal. The indicated measurements shall be recorded prior to, at 20 hours, and on completion of this vibration test and recorded on vibration data forms.

2. Moisture Test:

The moisture test shall be conducted with the complete TMA cartridges equipped as per paragraph 1 of the Vibration Test of these specifications. The complete TMA cartridges shall be weighed prior to and after the moisture test, utilizing a certified scale. These TMA cartridge weights will be a part of the test data submitted with the bid. The cartridges will be placed in the normal horizontal operating position and subjected to precipitation equivalent to 150 mm (6 inches) of water per hour 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. After a period of 24 hours, the cartridges will be turned over on the top side 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 and then weighed. The weight after the test shall be the same as initially  $\pm 2.3$  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.

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.

Attenuator cells showing excessive retention of moisture or any damage whatsoever will constitute failure of the device.

3. Corrosion Test:

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.

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 will be submitted with the corrosion test results.

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.

All of the above tests shall be conducted prior to bidding. A written copy of test results shall accompany the bid. Failure to provide thorough test procedures, test data and prints traceable to the tested TMA assembly and components, shall be cause for rejection and/or cancellation of the order.