



## **TTMA-100 GENERAL SPECIFICATIONS**

### **I. Scope**

These general specifications present product information for the Trailer Truck Mounted Attenuator, herein referred to as model TTMA-100, manufactured and distributed by Gregory Industries, Inc.. The specifications include the following sections:

- Intended applications
- Support truck guidelines
- Product description
- Product approvals
- Product durability
- Mounting of optional equipment
- Dimensions and weight

### **II. Intended Applications**

The TTMA-100 is designed to protect motorists and workers in both moving shadow vehicle and stationary barrier vehicle applications. The TTMA-100 has been successfully crash tested with both small car and pickup truck test vehicles impacting at speeds up to 62 mph. When properly deployed, the TTMA-100 will:

1. Reduce the severity of impact for occupants of errant vehicles that collide with the rear of a shadow or barrier vehicle.
2. Reduce crash severity for occupants of shadow vehicles.
3. Minimize or prevent damage to the shadow or barrier vehicle.
4. Reduce the time required to clear the accident scene and restore traffic flow.

The TTMA-100 utilizes the patented tube bursting technology to dissipate the energy in vehicular impacts. The structural tube rail members of the trailer also function as energy absorbers, thus simplifying the attenuator design and keeping the costs low.

Figure 1 illustrates the patented tube bursting process. An over-sized mandrel is inserted into the energy absorbing tube and held in place with a restraining or shear bolt. In a crash, the impacting vehicle would push the mandrel forward and shear off the restraining bolt. As the over-sized mandrel is pushed into the energy absorbing tube by the impacting vehicle, cracks would develop at the corners of the tube, splitting the tube into four straps, thus dissipating the energy.

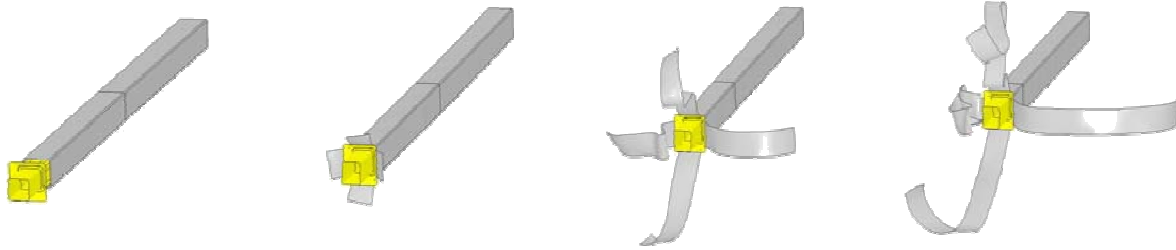


Figure 1. Tube Bursting Process

The straps would remain attached to the tube, thus there are no detached elements. Also, the straps have no structural strength and do not pose any hazard for the impacting vehicle, the shadow vehicle, or workers and others in the immediate vicinity of the impact. The level of energy dissipation is controlled by the tube thickness, the length of the tube sections, and scoring of the tubes. This allows the TTMA-100 to be designed to provide a smooth deceleration to the impacting

### III. Support Truck Guidelines

The TTMA-100 may be attached directly to the work truck or to a support truck that serves as a barrier or moving shadow vehicle. In either case, the minimum weight of the tow vehicle should be 10,000 lbs. FHWA does not recommend the use of any TMA (Truck Mounted Attenuator) system with the support truck weighing less than 10,000 lbs due to concern over the potential for high roll-ahead distance that could pose a hazard to workers and others in the path of the support truck. In general, lighter support trucks would increase the risk to shadow vehicle operators and the vehicle roll-ahead distance during an impact. Note that support truck drivers should utilize an adequate head rest, lap belt, and shoulder harness at all times, regarding of the support truck weight.

On the other hand, heavier support trucks would increase the deceleration rate and the impact force on the occupants of the impact vehicle. A support weight of 20,000 lbs is used in all of the NCHRP Report 350 required and optional crash tests. The TTMA-100 is the only TMA design that has utilized a support truck blocked against forward motion to simulate an infinitely heavy vehicle in all of the NCHRP Report 350 required and optional crash tests. All other trailer and conventional TMA systems have utilized a 20,000 lb truck in at least some of their crash tests. Therefore, the TTMA -100 is the only system that can be safely used on support trucks weighing more than 20,000 lbs. In fact, there is no upper limit on the acceptable support truck weight for the TTMA-100.

The distance between the shadow vehicle and work zone activities should be maintained at acceptable minimums to prevent the support truck from rolling into workers or other

construction equipment. Support truck roll-ahead distance is a function of the weight and speed of both the shadow truck and the impacting vehicle. Table 1 shows calculated shadow vehicle roll-ahead distances for a variety of shadow and impacting vehicle weights and impact speeds. Roll-ahead calculation procedures were adapted to include the weight of the TTMA-100 and are based upon a shadow vehicle speed of 15 mph.

Table1. Calculated Roll-Ahead Distances for Shadow Vehicles (Moving at 15 mph).

Support Truck Weight, lb	Traffic Operating Speed, mph	Impact Vehicle Weight, lb			
		4500	10000	15000	24000
10,000	65	119'	205'	261'	333'
	55	97'	158'	198'	247'
	45	77'	118'	143'	174'
15,000	65	93'	161'	211'	278'
	55	78'	127'	162'	209'
	45	65'	97'	120'	150'
24,000	65	71'	118'	157'	215'
	55	62'	97'	124'	165'
	45	54'	77'	96'	122'
40,000	65	56'	86'	112'	155'
	55	50'	73'	92'	123'
	45	45'	61'	74'	95'
60,000	65	48'	68'	86'	118'
	55	44'	60'	73'	96'
	45	41'	52'	61'	77'
80,000	65	44'	59'	73'	97'
	55	41'	53'	63'	81'
	45	39'	47'	54'	67'

Calculated roll-ahead distances for stationary barrier vehicles utilizing a Trailer TMA are shown in Table 2. When the TTMA-100 is attached to a stationary barrier vehicle, the support truck should be placed in second gear with the parking brake fully engaged. In order to minimize barrier truck roll-ahead distance, the vehicle's parking brake should be maintained in good operating condition.

Table 2. Calculated Roll-Ahead Distances for Barrier Vehicles.

Support Truck Weight, lb	Traffic Operating Speed, mph	Impact Vehicle Weight, lb			
		4500	10000	15000	24000
10,000	65	38'	103'	152'	216'
	55	27'	74'	109'	155'
	45	18'	50'	73'	104'
15,000	65	22'	68'	108'	166'
	55	16'	49'	77'	119'
	45	11'	33'	52'	80'
24,000	65	11'	38'	65'	111'
	55	8'	27'	47'	80'
	45	6'	18'	32'	54'
40,000	65	5'	18'	34'	64'
	55	4'	13'	24'	46'
	45	3'	9'	16'	31'
60,000	65	3'	10'	19'	38'
	55	2'	7'	13'	27'
	45	2'	5'	9'	18'
80,000	65	2'	6'	12'	25'
	55	1'	5'	9'	18'
	45	1'	3'	6'	12'

The TTMA-100 is attached to the tow vehicle using a standard pintle hook rated at 8 tons or more. Otherwise, no other modification is needed for the tow vehicle for use with the TTMA-100. The pintle hook must be securely mounted to an appropriately strong structural component on the frame of the support truck. The pintle hook should be mounted at a nominal height of approximately 28 in. The pintle hook height, after ballast is added to the support truck, must be maintained between 20 and 32 in. The lunette ring should be placed in the lower mounting holes when the pintle hook is mounted between 20 and 26 in. and in the upper mounting holes when the pintle hook is mounted between 26 and 32 in. The support truck must be equipped with a standard wiring connector to power the TTMA-100 marker and brake lights. The trailer can be supplied with any standard 4, 6, or 7 pin connector.

Connecting the TTMA-100 to a tow vehicle is a simple task that involves the following steps and takes only a few minutes:

1. Move the tow vehicle or the trailer so that the lunette ring on the trailer is lined up with the pintle hook on the tow vehicle. Note that, when the TTMA-100 is not in use, the trailer is kept at a horizontal position with a trailer jack located on the cross member of the A-frame.
2. Place the lunette ring in the truck's pintle hook and close the hook.
3. Connect the trailer lighting connector and attach the safety chains.
4. Raise the trailer jack to a horizontal position and the trailer is ready for operation.

The light weight of the TTMA-100 at 1,450 lbs and its very low tongue weight of approximately 200 lbs make the connection process very quick and easy. Even with the addition of the optional arrow board and mount, the tongue weight is still below 500 lbs, thus not significantly affects the load carrying capacity of the support truck,

#### **IV. Product Description**

##### **A. Major Components**

The TTMA-100 incorporates the following major components:

1. A-frame assembly
2. Energy absorbing tubes
3. Axle assembly with push rods
4. Fender, wheel and tire assembly
5. Mandrels
6. Impact Head

##### **B. General Assembly**

The two energy absorbing tubes are attached to the A-frame assembly with a special splice connection. The A-frame and the two energy absorbing tubes serve as the primary longitudinal frame elements as well as the primary energy dissipation system. The axle assembly is bolted onto the energy absorbing tube and includes: the axle, fenders, and wheels and tires. There are also two push rods welded to the axle. The impact head would contact these push rods and break away the axle prior to the impact head reaching the axle. Two over-sized mandrels are inserted into the two energy absorbing tubes on one end and attached to the impact plate on the other end. A lunette ring is attached to the end of the A- frame assembly for connection to the tow vehicle equipped with a standard 8 ton or larger pintle hook.

##### **C. TTMA-100 Function**

The TTMA-100 is designed to safely attenuate passenger vehicle impacts on the rear of the trailer. When a vehicle strikes the rear of the trailer, the impact head is forced forward and it drives the tube bursting mandrels into the bursting tubes. Energy dissipation by the bursting tubes provides a controlled deceleration of the impacting vehicle. As the tube bursting mandrels continue forward, they contact axle shear

connectors and fracture the bolts holding the trailer axle to the bursting tubes. Shortly thereafter, the trailer's impact head contacts the axle push tubes and moves the axle toward the front of the trailer. For high energy impacts, the impact head will continue forward until the bursting tubes are completely ruptured. If needed, the side rails of the trailer frame assembly will then begin to burst and the energy dissipation will continue until the impacting vehicle is brought to a safe stop.

During high energy impact testing, the TTMA-100 proved to be capable of attenuating all of the impact energy without producing any damage to undercarriage, suspension, or tires of the tow vehicle. Structural components of the TTMA-100 should be not forced under the support vehicle during high energy passenger vehicle impacts.

During moderate energy impacts, trailer damage should be limited to the two bursting tubes which can be easily replaced. This process involves removing the impact head, tube bursting mandrels, and the axle assembly from the trailer by removing four bolts and pulling the system apart. The damaged bursting tubes will then need to be replaced and the axle, tube bursting mandrels and impact head can be re-attached. Note that the trailer wiring and light system must be carefully inspected and any needed repairs made before placing the restored trailer back into service. Complete repair should be accomplished with simple hand tools and the appropriate replacement parts.

The trailer is capable of absorbing low-speed impacts up to 5 mph without sustaining any damage.

#### D. Lights and Visibility

The TTMA-100 is equipped with the following items to enhance the visibility and conspicuity of the trailer:

- An integrated light bar bolted to the top of the impact head,
- Side lights and markers,
- Reflective tapes on the sides, and
- Chevron panels on the face of the impact head. The chevron panels have highly reflective sheeting and may be ordered in the following color combination: yellow/black, white/orange or white/red stripes.

The lighting assembly meets, and actually exceeds, the lighting requirements set forth under FMVSS No. 108, "Lamps, Reflective Devices, and Associated Equipment." It should be borne in mind that FMVSS 108 represents a minimum requirement. Any modification or additions to the lighting, marker, and reflectivity should conform to these specifications.

#### E. Corrosion Protection

All components of the energy dissipation system, including the impact head, tube bursting mandrels, bursting tubes, and trailer frame assembly are hot-dip galvanized to

prevent corrosion. Bolts and other exposed attachment hardware are also galvanized where possible to prevent corrosion.

## **V. Product Approvals**

The TTMA-100 was approved by the Federal Highway Administration (FHWA) as a Test Level-3 (TL-3) Trailer Truck Mounted Attenuator (TMA) in a letter dated April 15th, 2005. It has also been recognized by FHWA as meeting the TL-3 optional tests set forth in NCHRP Report 350 in a letter dated September 18th, 2006. Many states do not require individual approval of TMA systems and rely only on FHWA approval. The TTMA-100 is now fully qualified for use in all of these states.

Gregory Industries, Inc. is pursuing approval in every state where a separate approval process is required. If your state requires individual approval of TMA's and the Trailer TMA is not listed on the appropriate approved product list, please call Gregory Industries, Inc. at (330) 477-4800 for information regarding approval status in your state.

## **VI. Product Durability**

The TTMA-100 has been subjected to extensive road testing at both high and low speed operations on both paved and unpaved roadways. This testing has shown no evidence of fatigue failure of any components of the TTMA-100. Gregory Industries, Inc. is also conducting vibration testing of the trailer to assure that no fatigue problems develop. If your state requires special testing of TMA durability, please contact Gregory Industries, Inc. for help in testing the TTMA-100 to meet any state standards and gaining the needed state approval.

## **VII. Optional Equipment**

The TTMA-100 is designed to accommodate optional flashing arrow boards and variable message signs attached to the front of the trailer. A specially designed arrow board support mount is available as optional equipment.

Note that the TTMA-100 has not been crash tested with an arrow board and Gregory Industries, Inc. has not sought FHWA approval. Supports for an arrow board or variable message sign support are only subjected to impact loads when the TTMA-100 and the support truck are accelerated forward during a crash. All crash tests of the TTMA-100 were conducted with the support truck blocked to simulate infinite weight. Hence, the TTMA-100 was not subjected to high accelerations that would cause problems for an arrow board or VMS. However, design loads for the TTMA-100's sign mounting system were obtained from the highest sustained accelerations measured during test 3-51. This maximum acceleration was converted to an equivalent force that was then applied to the lightest allowable support truck and trailer combination, a 10,000-lb truck with a 1,400-lb trailer. The trailer acceleration resulting from this level of applied force was then used as a design load when analyzing the stresses in the sign mounting system.

It is important to note that this procedure for estimating sign support loading is very conservative. Forces applied to an impacting vehicle are greatly reduced when the support truck

is allowed to roll ahead. Therefore, when attached to a lighter support truck, actual accelerations on the trailer and support truck combination are much lower than those used in the sign support design process and the loading of the sign support system would be much lower. Users wishing to supply a different mounting system must design it to withstand a 10 g acceleration with the sign in the maximum height configuration without collapse.

Note that the wiring harness supplied with the TTMA-100 provides a convenient power source for an arrow board, VMS sign, or other warning device.

The TTMA-100 should not be used to carry any equipment other than the optional arrow board or variable message sign. It is recommended that the users contact Gregory Industries, Inc. for additional advice if additional equipment is attached to the trailer.

### **VIII. Dimensions and Weight**

The TTMA-100 has an overall length of 23 ft-6 in. and an overall width of 8 ft-0 in. The trailer has a very low profile, with a maximum height of 31 in. to the top of the impact head and 37 in. to the top of the integrated light bar. The ground clearance to the bottom of the impact head is 13 in. This low profile allows excellent visibility for any optional equipment, such as a flashing arrow board attached to the front of the trailer.

The weight of the TTMA-100 without any optional equipment is approximately 1,450 lbs with a tongue weight of 190 lbs. With the optional arrow board and mount, the total weight is still under 2,000 lbs and the tongue weight is under 500 lbs.

### **IX. Warranty**

There is a one-year warranty against defects in material and workmanship.