

Missouri Department of Transportation



Truck Mounted Attenuators

October 2012



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Introduction to Truck Mounted Attenuators (TMA's)

The Need for Training

As the driver of a truck-mounted attenuator vehicle, your job is one of the most important on the crew. You are responsible for making sure that all other employees are adequately protected from errant vehicles in or around a work zone. It is the goal of MoDOT to provide consistent use of TMA's statewide.

Truck-mounted attenuators are designed to safely absorb the energy of an errant vehicle that crashes into it. Your job is to make sure that you are in the proper location to protect the crew, to provide ample roll-ahead distance, and to provide adequate warning to your co-workers and traveling public, when possible.

Training

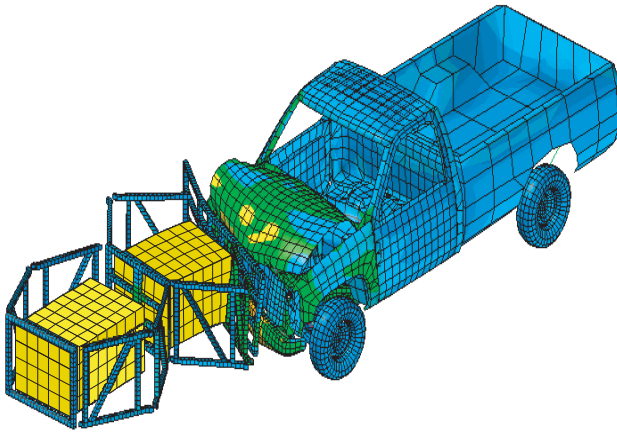
All employees that drive a vehicle equipped with a TMA must be trained in the proper methods of installation, transporting, setup, operations, and preventative maintenance of the unit. Prior to operating any equipment employees shall complete the appropriate required training. To ensure that an employee understands his/her responsibility, every operator must successfully demonstrate the proper methods of attaching a TMA to a truck and perform operational and preventative checks and maintenance on the unit.

Course Objectives

After completing this training, you should know:

- ✓ The qualifications of the TMA driver
- ✓ Your responsibility as a protective truck/TMA/truck driver
- ✓ What tests are used to determine a TMA's crashworthiness and the importance of these tests

- ✓ The roll of a protective vehicle and be able to define its purpose
- ✓ What “roll-ahead” distance is and when you should adjust those distances
- ✓ MoDOT’s policy on equipment usage in the cab while the truck is in operations
- ✓ Installation, removal, and performance of preventative maintenance on a TMA
- ✓ The difference between stationary and mobile TMA operations



Section I – Driver Characteristics

Protective Vehicles



A protective vehicle is defined as any vehicle, other than a farm type tractor, used to protect workers or work equipment from errant vehicles. Farm type tractors are not allowed as protective vehicles because of their low gross weights and high center of gravity.

Protective vehicles are used to safeguard the work space from errant vehicles. In some operations, these devices also serve as platforms for signs and other devices used to warn traffic of upcoming conditions or inform them of needed corrective actions. For increased motorist, driver, and worker safety, the protective vehicle may be equipped with a TMA as noted in the following section.

Protective vehicles should provide sufficient warning to approaching traffic and maximum protection to workers and equipment. This means the protective vehicle should be positioned so that it is clearly visible to approaching traffic, and minimizes any vehicular encroachment into the work space. To minimize encroachment, it is recommended the protective vehicle should maintain a minimum of 150-foot clear roll ahead distance between the vehicle and the work space.

Qualifications of a Protective Vehicle/TMA Driver

To be a successful TMA driver, you must:

1. Be trained in TMA operations and procedures
2. Be alert, aware, observant, and able to react to surrounding conditions
3. Be familiar with daily tasks and be able to apply appropriate Work Zone typical applications.

The Responsibility of a TMA Driver

It is the responsibility of the TMA driver to make sure the TMA or protective vehicle is in the proper position to protect crew members from errant vehicles. The driver needs to remain alert, attentive, and observant to the surrounding traffic and roadway conditions. The driver should constantly check his/her mirrors and be able to communicate effectively with the crew members, using approved MoDOT communication devices.



TMA Positioning

Proper positioning of the TMA vehicle within the work zone is critical to its effectiveness. The TMA vehicle location should provide sufficient warning to approaching traffic and maximum protection for workers. It should:

- ✓ Maintain a minimum 150 ft. roll-ahead distance
- ✓ Be parallel to the traffic at all times
- ✓ Have its wheels aligned with traffic

Equipment/Materials Stored in Bed of Host Vehicle. Loads may be moved to and from work areas in the bed of the host vehicle, but must be removed when TMA is deployed for protection or has the possibility of deployment prior to getting to the work area. Loads or cargo are not allowed to be carried on trailer type TMA's.

Truck/Trailer-Mounted Attenuators

Truck-mounted attenuators are energy absorbing designed to protect and reduce the severity of injury to the motorist and the TMA operator in the even of impact. The TMA is generally attached to the rear of the trucks protective vehicle. Most TMA's are attached to HD dump trucks, but some TMA's can be mounted on smaller vehicles. The TMA manufacturer sets the

specifications on the size and type of vehicle their TMA can be mounted or used on.

In general, the guidelines for the use of these devices are shown in the following table and can be found in the EPG in table 612.1 Use of TMA's:

Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Recommended	Recommended
Multi-lane Divided	Required	Required	Recommended

Note: Recommended may be changed to required depending on road conditions and situations, see page 29/30 for examples.

Section 1 - Review Questions

1. The qualifications of a TMA driver are:
 - a. Average intelligence, over 18 years of age, responsible
 - b. Have a CDL, on probation, and over 18 years of age
 - c. Be trained in TMA operations and procedures, alert, aware, and observant of the surrounding conditions. Be familiar of daily tasks and be able to apply typical applications
 - d. Be seat belted in, familiar with the truck, and sleeping at the wheel
2. All TMA's should:
 - a. Meet federal crash standards for Truck-mounted attenuators
 - b. Be able to be safely mounted to the rear of a dump truck
 - c. Be able to withstand a side impact collision
 - d. Be red and white in color
3. The recommended minimum roll ahead distance of a protective vehicle is:
 - a. 100 feet
 - b. 150 feet
 - c. 200 feet
 - d. 250 feet

Section II – Equipment/Safety Concerns

A TMA is designed to absorb the energy of an errant vehicle. A protective vehicle equipped with a TMA will increase your safety, protect your coworkers, as well as the traveling public. Cell phone use is not recommended by the TMA operator.

Seat Belts

Whenever possible, TMA dump trucks should have a high back seat for the operator. Seat belt usage is mandatory in a MoDOT owned or leased vehicles. It is extremely important that the driver of a TMA not only wears his/her seat belt, but also must have it adjusted properly.



Properly adjusted seat belts may minimize or reduce injuries. A seat belt should be secured in the manufacturer's locking device and should be snug across the chest, not under armpit.

If the truck has been involved in a serious crash, the unit should be inspected by a mechanic. This inspection should include the seat belt system.

Storage of Equipment

A clean truck is vital to the operator's personal safety. The operator of the protective vehicle is responsible for making sure that the cab of the vehicle is cleaned before use. Removing all trash and debris and securing all loose items may help prevent injury to the operator in the case of a traffic crash.



Important Note: It may be necessary to store your lunch or other personal items in the cab of the truck. Make sure items are secured inside the cab and not placed on the dashboard, where they can become a projectile.

Enter/Exiting Traffic With a TMA

When you have arrived at the job location, you may be required to switch lanes or move into the desired location.



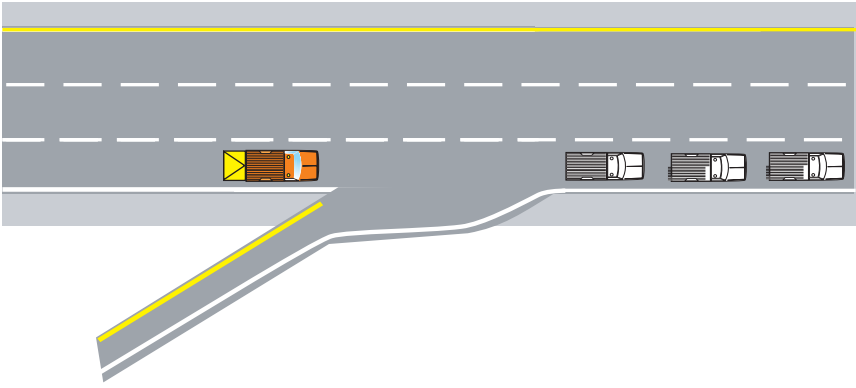
Always try to have the TMA in the lowered position while in the desired lane, but you may have to have the TMA in the up position until you reach the desired location, then lower the TMA. Make sure no person or objects are directly behind you while you are lowering the TMA. The TMA should be visible in the mirrors when it is fully in the down position.

When entering a lane of traffic, the operator should reach the traveling speed and then get into the desired lane of traffic. Once they've reach the desired lane, they should begin to reduce their speed until they reach operational speed or come to a complete stop. For operations where they must come to a complete stop, the operator should be aware of all motorists behind them, in front of them, and those trying to switch lanes.

It may also be required for the TMA truck to get into a desired location and then allow work vehicles, slow moving vehicles, or other work equipment to enter the desired lane in front of them. This will allow traffic to slow down behind the TMA in order for the work vehicle to get to the desired location safely.

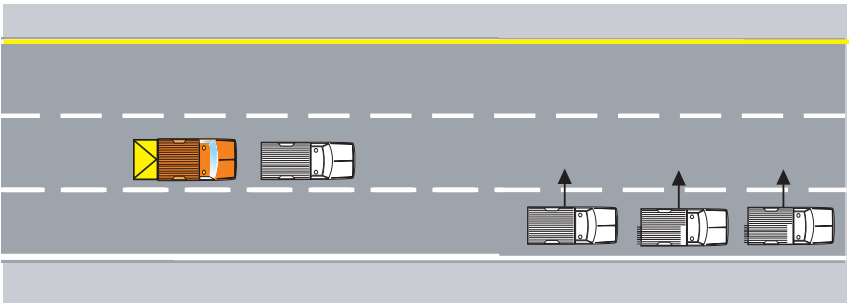
To exit the area or work zone, check your mirrors to see if any traffic is approaching from behind. When it is safe, begin driving forward while simultaneously raising the TMA. If the TMA has an arrow board attached, do not attempt to raise the TMA until you have maintained a safe speed and you can verify there are no vehicles directly behind you. Do not switch lanes until you know the TMA is in the full upright position.

Diagram 1



When entering a multi-lane highway during high traffic situations, it might be necessary to have a TMA truck positioned so that work vehicles can move in front of the TMA truck.

Diagram 2



The protective vehicle/TMA truck should be the first vehicle to get into the desired lane and then allow all other work vehicles to enter the lane.

Stationary Operation

The wheels of the protective vehicle should be aligned with traffic at all times. In addition, the emergency brake shall be set and the transmission put into neutral.

If you are operating a TMA truck, your job is to protect the crew and yourself. If you notice an errant vehicle coming towards your TMA truck DOT NOT leave your lane of traffic. This would expose the crew to a crash and possible injury. If possible, you should try to alert the crew.

Mobile Operations

During mobile operations, operate your protective vehicle as you would any other vehicle. Keep the vehicle in gear and the wheels following the centerline. Maintain your speed to provide a minimum roll-ahead space of 150 feet. Pay attention to hills, curves, or other sight distance items that might be present.

Checking Mirrors

Mirrors are vital to the safe and successful operation of a commercial vehicle since they allow the driver to see behind the vehicle. Scan your mirrors constantly or at least every 7 seconds.



Auxiliary or convex mirrors give a larger field of view; however, they may distort the driver's perspective by making objects appear smaller and farther away than they actually are.

Important Note: As a TMA driver, you should be aware of the activity going on in front of you, to the sides of you, and behind you. Continuously checking the mirrors will ensure your safety as well as the safety of your crew members, and the traveling public.

Rotation of Drivers

When practical, drivers should be rotated throughout the day. Inattention, mental fatigue, and daydreaming may occur when a driver is in the TMA for long periods of time.

Supervisors need to be aware of these variables and rotate drivers when feasible to eliminate some of the human factors. Having fresh, attentive employees in the TMA truck during moving operations will maximize the driver's safety as well as the employees working in or around the TMA truck.

Emergency Planning

Having an emergency plan should be a priority each time you start a new task or move to a new job location. Things that you should know:

- ✓ Who will you call if someone hits the TMA or truck?
- ✓ Who is responsible for all crew members?
- ✓ Is someone trained in First Aid/CPR?
- ✓ Is the scene safe or am I creating another hazard?
- ✓ Are incident/accident forms located within the TMA truck?



If an Incident/Accident Occurs

Your first call should be to your District's Customer Service Center, the second to your supervisor. Be sure to give the customer service representative:

- ✓ Your exact location
 - Use mile markers
 - Exit ramps/numbers
 - Direction you were traveling
 - County in which you are located in
- ✓ Description of incident or traffic crash
- ✓ Number of vehicles involved
- ✓ Type of emergency services needed (EMT, Paramedic, Fire Department, HazMat Crew, etc.)
- ✓ Complete all required Risk Management forms
- ✓ Let them know if there are any injuries. If injuries are known, let them know how serious they may be.



Removing a Damaged TMA from the Scene

When preparing to remove a damaged TMA from the scene, consider the following:

- ✓ Is additional equipment needed to cleanup the scene?
- ✓ Can the TMA cartridge be loaded onto a trailer or into the back of another truck bed?
- ✓ Strap the TMA together using MoDOT's approved slings/straps to secure the load.

Important Note: Drivers should use extreme caution when moving a wrecked TMA out of the lane of traffic. The unit may not be adequately attached at the anchor points and should be inspected prior to moving. Loose or broken parts should be secured before the TMA unit is moved.

Section II - Review Questions

1. Lunch boxes, cell phones, and personal belongings are to be:
 - a. Stored on the dash board of the truck
 - b. On the seat next to the driver
 - c. Secured inside the truck or on the floor board of the truck
 - d. On the bed of the truck

2. The wheels of the TMA truck should be:
 - a. Aligned with traffic
 - b. Turned to the right
 - c. Turned to the left

3. The driver of the TMA truck should:
 - a. Check his/her mirrors and be aware of activity going on around you
 - b. Check his/her mirrors for vehicles speeding
 - c. Check his/her mirrors for potholes
 - d. Check his/her mirrors for the supervisor to show up on the job site

4. Driver's rotation should occur:
 - a. When the driver falls asleep
 - b. Every 15 minutes
 - c. When practical, throughout the day
 - d. After an incident

Section III – Operational Issues

Storage of the TMA

When the TMA is not en route to a location or is not in use, the safety chains or safety straps should be used to prevent the unit from accidental deployment.



While the unit is in use, the chains or straps should be stowed away in the manufacturer's approved location. This will prolong the life expectancy of the TMA and the cartridges.

The operator should inspect the safety chains and/or nylon straps prior to each use.

Markings and Lighting

When a TMA is used during nighttime operations, the Work Zone Supervisor shall ensure that all lighting has been dimmed according to the MUTCD section 67.61.

The supervisor assign an individual to perform routine inspections of the work zone. This person is responsible for ensuring:

- ✓ Clear and simple messages are provided to the traveling public via message boards
- ✓ All signs are retroreflective and in operational condition
- ✓ A safe work environment is provided for employees
- ✓ Adequate roll-ahead distance is provided – at least 150 feet
- ✓ The traveling public is doing what we expect/intend for them to do (i.e., merge, move into/out of lanes, proceed with caution, etc.)

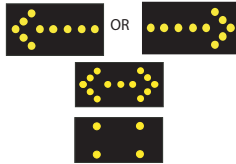
Flashing Arrow Panels

Flashing arrow panels are temporary traffic control devices that provide warning and directional information to assist drivers through or around a temporary traffic control zone.



Flashing arrow panels may be operated in one of three operating modes:

- Arrow
- Double arrow
- Caution



The **arrow mode** is used when traffic has no choice but to go left or right.

The **double arrow mode** is used when traffic has a choice to go right or left.

The **arrow and double arrow modes** are used for stationary or moving lane closures on multi-lane highways.

The **caution mode** is to be used for shoulder work, blocking the shoulder, for roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway.

Important Note – Check TA TCFO manual for correct arrowboard lighting due to your given work area.

Important Note – The flashing arrow panel should be in the caution mode until the TMA truck has reached its desired location or lane. Once the TMA truck has reached the desired lane, the directional arrow should be displayed.

For moving lane closures on two-lane, undivided highways, the panel shall be deployed within the lane to be closed.

For moving lane closures on multi-lane highways, one panel should be deployed on the shoulder and another shall be deployed within the lane to be closed. Where adequate space does not permit deployment of the unit on the shoulder, the unit may be positioned partially in the lane to be closed.

When an interior lane is being closed by itself, two units shall be deployed within the lane to be closed. When closing multiple lanes, a separate unit shall be used to close each lane.

When roading a flashing arrow panel to the work location, the unit should be in the down position, if the unit can be lowered.



Section III – Review Questions

1. Who should inspect chains and/or nylon straps prior to each use:
 - a. Driver
 - b. Supervisor
 - c. Maintenance Supervisor
 - d. Qualified person

2. When an arrow board is used it should be:
 - a. Sighted and aligned with approaching traffic
 - b. Turned off or covered
 - c. Dimmed during daytime operations

Section IV – Truck-mounted TMA Installation, Removal and Preventative Maintenance

1. Jacks may be used to support the TMA when it is **off the truck**.

The jacks must be stored while the **TMA is attached to the truck**. The jacks can be stored on the brackets provided on the support frame.

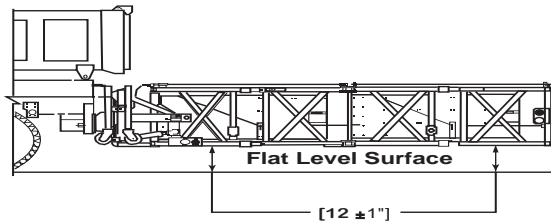


2. Be sure all persons and objects are clear before raising or lowering the TMA. Be sure the system is stopped and in full up position with safety chains securing the unit before allowing anyone to walk behind it.
3. Ballast and other heavy objects **must be adequately anchored** to the truck to prevent shifting during an impact. (The force on the tie-down straps should be 20 times the weight of the ballast.)
4. MoDOT's absolute minimum host Gross Vehicle Weight (GVW) is 16,090 pounds to a maximum of 60,000 pounds, but should not exceed manufacturer's recommendations.

The truck should be parked on a level surface. The truck should be as close to the final driving weight as possible. Check the manufacturers recommended weight for the vehicle. If ballast must be added to achieve the manufacturers recommended weight, add it at this time. Ballast must be properly anchored or contained in the truck to keep it in place during an impact. Most TMA cartridges are heavy. Care must be taken not to exceed the truck's maximum axle load as specified in the owner's manual.

Important Note: For truck-mounted TMA's, such as the Safe Stop 180, manufactured by Energy Absorptions Systems, Inc., the minimum Gross Vehicle Weight (GVW) of the protective (host) vehicle is 16,090 pounds to a maximum of 60,000 pounds. This weight includes the truck, the TMA, and any additional ballasts. Contact General Services if you have questions regarding the GVW.

When installing a hitch TMA, you need to make sure that all contact areas are properly greased.

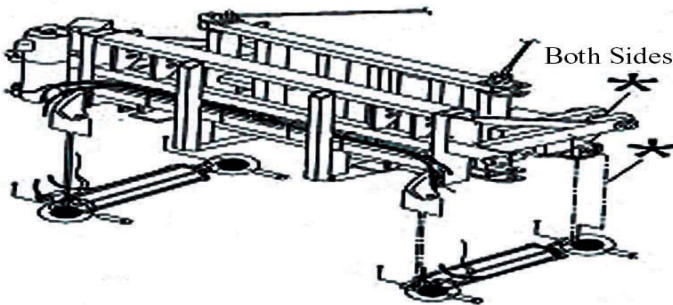


Important Note: The TMA should be securely fastened to the truck. In the horizontal position, the bottom of the TMA is approximately 12” off of the ground when at a level, flat surface.

5. Regular maintenance of the TMA is important for safe use. When the TMA is not in use, chains or straps should be in place to secure the TMA in the upright position so injury and/or damage will not occur.
6. Grease friction points (moving steel parts) every 6 months.

Grease Friction Points

Grease friction points (moving steel parts) every 6 months.



* Grease these friction points using bearing grease

○ Oil these friction points using light machine oil

7. Oil swivel jacks every six months, or as needed.
8. Change hydraulic fluid every 2 years or 50,000 miles.

9. Fasteners – Check the tightness of the fasteners daily. See the drawings for the locations of the fasteners located in the Operator’s Manual. Be sure to check the bolts that attach the cartridges to the support structure. Lock washers should be fully compressed.
10. Cables – Check the tension in the cartridge support cables. With the system in the horizontal position, tighten the first nut on one cable until all slack has been removed. Then, tighten the first nut until the tension springs have been compressed to 1 ¼” in height. Lock this first nut in place with the second jam nut. Repeat this procedure with the other cables. Check and adjust the cables monthly or when loose.

Important Note: Do not store tools, attach signs or any other equipment on top of the cartridges. Damage to the cartridges may allow dirt and water into the system causing it to malfunction.

Trailer mounted TMA

In 2006, MoDOT began using several trailer-type TMA’s. These TMA’s are pulled by the host vehicle as opposed to being loaded in or on the vehicle. The trailer-type TMA’s comply with NCHRP 350/MASH standards for crashworthiness.

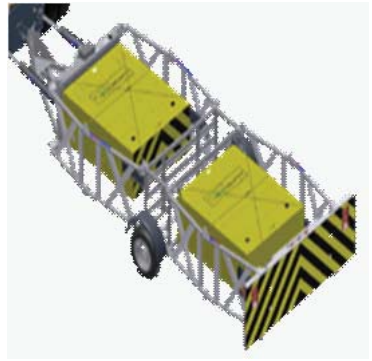
MoDOT employs 3 specific towable TMA’s:

1. Safe Stop 9000 (Scorpion)
2. TTMA-100
3. Vorteq VTQ-TL-3

As with any piece of equipment, please read and abide by the manufacturers manual for specific maintenance criteria.

Safe Stop 9000

The SST TMA is an innovative new concept that is changing how TMA's are used. Speedy attachment mechanisms and heavy duty axle/wheels instead of typical TMA mounting hardware make for easy attachment and back in service after a crash quicker with lower maintenance costs.



The SST TMA meets all standard and optional NCHRP 350/MASH TL-3 test requirements to provide optimum protection to drivers, equipment, and the public.

The SST TMA equipped truck shall have a maximum skid distance of 8 m (25ft) when impacted at NCHRP Report 350/MASH 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.

The SST TMA can be used with any weight vehicle over 4500 kg (9,920 lbs). The SST TMA uses a hydraulic cylinder dampener system to minimize rotation during an offset impact, thus helping to minimize possible secondary accidents. This system will allow the trailer to act like a normal trailer when trailering and resist rotation when impacted.

The complete SST TMA shall be designed to make attachment or detachment from the truck simple and fast. The major components stay together when detached from the support vehicle.

The TMA frame 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.

The TMA shall not protrude over, into or under the truck. Further, the 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.

The SST TMA features antirotational dampeners that are designed to lock the TMA in place during an angled impact to minimize the TMA from rotating into adjacent traffic lanes. The anti-rotational dampeners do not affect drivability of the host vehicle.

TTMA-100

The TTMA-100 is an attenuation trailer that attaches directly to a standard pintle hook and trailer wiring harness. This simple connection allows the trailer to be attached or removed from a tow-vehicle in minutes.



The TTMA-100's rear impact plate is designed to capture the front of a vehicle such that, the trailer becomes locked between the impacting vehicle and the support truck. The pintle hook connection allows the trailer to rotate to remain aligned with the impacting vehicle.

The TTMA-100 utilizes tube bursting technology to allow the trailer's frame elements to be used as the primary energy absorbers. As a result, the entire attenuator is manufactured from heavy gage steel to prevent fatigue.

Vorteq VTQ-TL-3

The Vorteq TL-3 Trailer TMA is an innovative attenuator efficiently designed to meet both mandatory & optional NCHRP 350/MASH, Test Level 3 requirements.



The easy to own and operate Vorteq TL-3 Trailer TMA is lightweight and attaches to most host vehicles with a 20 ton pintle hook and 7 pin electrical connector. Acceptable host vehicle weight is 9960 lbs. to infinite weight. Super fast attachment means you have full TMA protection in less than a minute. The open frame design means inspection and maintenance is quick & easy.

The Vorteq TL-3 Trailer TMA implements innovative multi-stage, tube-in-tube energy absorbing technology that inwardly shapes the steel tubing. This significantly reduces debris scatter thus reducing the potential for secondary accidents. The tube-in-tube design, along with the collapsible forward X-Brace improves structural stability.

NOTE: Regular maintenance of all TMA's is important for safe use. Refer to the maintenance section of the respective manuals for additional information.

Table 612.1 Use of TMA's

Highway Type	Operation Location and Duration		
	In Lane		On Shoulders and Ramps and at Intersections
	Mobile	Stationary	
Two-Lane Undivided	Recommended	Recommended	Recommended
Multi-lane Undivided	Required	Required	Recommended
Multi-lane Divided	Required	Required	Recommended

Section IV – Review Questions

1. When installing a TMA, you need to make sure that it is on a flat and level surface and when the unit is in the lowered position it is:
 - a. 9 to 11 inches from the ground level
 - b. 6 to 8 inches from the ground level
 - c. 11 to 13 inches from the ground level
 - d. 15 to 20 inches from the ground level

2. When the unit is in use the wheels jacks should:
 - a. Be attached to the unit in the removal locations
 - b. Stored inside the cab of the truck
 - c. Stowed on the manufacturers approved location
 - d. Thrown in the bed of the truck

3. The TMA should be mounted to a truck that has a GVW of:
 - a. 10,000 – 12,000 lbs. GVW
 - b. 11,000 – 13,000 lbs. GVW
 - c. 6,000 – 9,000 lbs. GVW
 - d. 16,090 – 60,000 lbs. GVW

4. What does the manufacturers allow to be attached on top of the TMA cartridges:
 - a. Tools
 - b. Signs
 - c. Cones
 - d. None of the above

Notes:

A protective vehicle shall be used while work is in progress. The protective vehicle shall be equipped with a TMA and flashing arrow panel and positioned at least 150 feet in the advance warning area of the workspace. The protective vehicle may be eliminated if the roadway is posted at 45 mph or below. The work vehicle is equipped with a flashing arrow panel and uses activated rotating lights and strobe lights.

If the TMA is in a stationary operation, the wheels should be aligned with traffic and the truck should be in neutral with the parking brake set.

In mobile operations, the TMA truck operator should be positioned at least 150 feet in the advance warning area of the workplace and observant to all surrounding conditions. The wheels should be aligned with the traffic.

When working on hills, curves, or areas where sight distances may occur, the TMA operator should be far enough back to allow motorist to see that work is being performed and that they should proceed with caution. It is recommended that another protective vehicle be placed close to the work space to eliminate errant vehicles from re-entering the lane where work is taking place.

Where bridges, overpasses, or the sight distance restrictions are presented, the protective vehicle or TMA should stay behind the obstacle until the work has progressed past the blind spot.

An additional protective vehicle or TMA truck should be placed closer to the work space to keep errant vehicles from re-entering the work space.

