



## HOW IT WORKS

### Tube Bursting Technology

The TTMA-100 uses a patented tube bursting technology to dissipate the energy of the impacting vehicle. The basic concept is quite simple. When a tapered mandrel with a square cross-section is forced into a square tube with smaller inside dimensions, the mandrel pushes against the inside of the tube. The outward forces on the inside of the tube concentrate stresses in the corners, creating a controlled cracking of the steel. As the mandrel proceeds forward, the tube is split into four flat straps of metal that are curled outward by the flared portion of the mandrel. The graphics shown in figure 1 illustrate this bursting process.

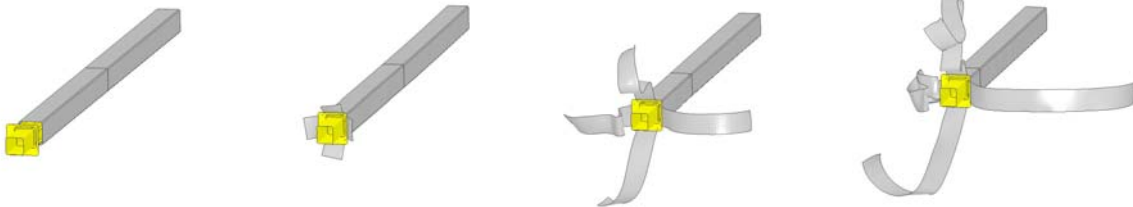


Figure 1. Tube Bursting Process

The setup of the mandrel and the actual bursting process are demonstrated in the photographs shown in Figure 2.



Tapered and over-sized mandrel inserted into the energy absorbing tube.



The mandrel cracks the energy absorbing tube at the corners and split it into four flat straps of metal.



Close-up of mandrel and energy absorbing tube.

Figure 2. Photographs Illustrating the Bursting Process

This bursting process, i.e., cracking of the tube at the corners and splitting it into four straps of flat metal, dissipates the energy of the impacting vehicle. The level of energy dissipation can be regulated by using different thickness of tubing and scoring of the tube, i.e., cutting grooves into

the tubes at the corners reduce the energy dissipated during cracking. By adjusting the level of energy dissipation and the lengths of the energy absorbing tubes, the amount of energy dissipation and the rate of vehicle deceleration can be controlled to bring the impacting vehicle to a gradual and safe stop.

Tube bursting technology allows the TTMA-100 to use the trailer frame as the energy absorber, thus eliminating the need for a separate energy absorbing material. This simplifies the design and reduces the costs of the TTMA-100. Also, the straps of metal have no structural strength and curl up and away from the impacting vehicle, thus eliminating any hazard posed to the impacting vehicle. Furthermore, the straps of metal remain securely attached to the un-bursted section of the tube. Thus there are no detached elements that can be thrown forward and pose hazard to workers and adjacent traffic.

### **Pintle Hook Attachment:**

Another major improvement in TMA safety technology is the TTMA-100's ability to rotate. While competing trailer attenuators utilize rotational restraints to prevent the attenuator from rotating, the TTMA-100 allows the trailer to rotate in order to keep the system aligned with the impacting vehicle to maximize energy dissipation. It is this innovative approach to energy management that has allowed the TTMA-100 to become the only TMA system to successfully pass NCHRP Report 350 optional offset and angled tests when attached to a support truck blocked against forward motion.

The primary concern about allowing a trailer to rotate is that the impacting vehicle could push the trailer out of its path and directly strike the rear of the support truck. However, as shown in Figure 3, an impacting vehicle must slide along the trailer's impact face in order to disengage from the trailer.

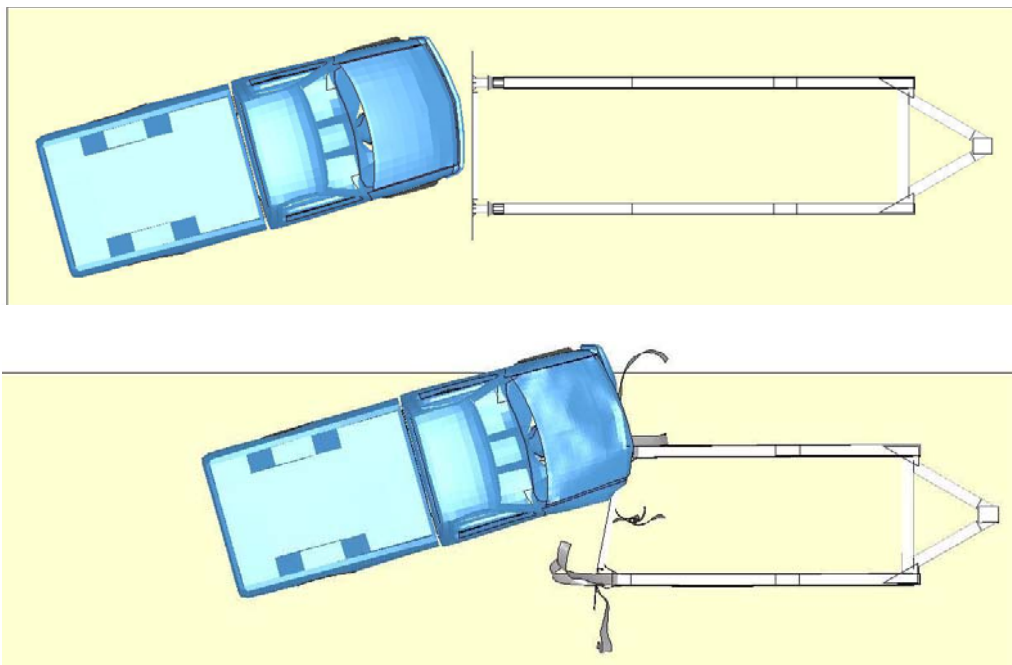


Figure 3. Simulation of Vehicle Disengaging from a Trailer.

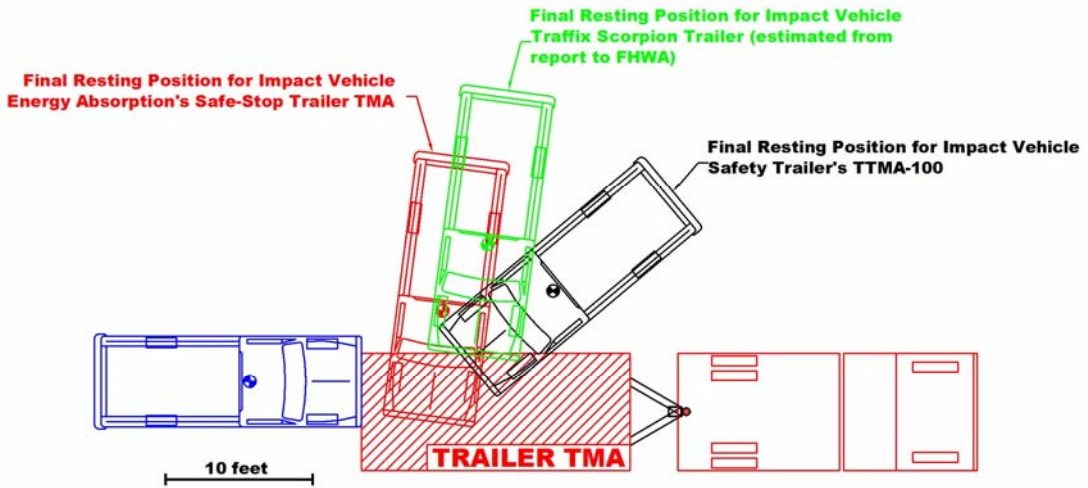
The patented innovation that eliminates this risk is the way the TTMA-100 engages an impacting vehicle. The TTMA-100's impact plate is designed to capture the front of a vehicle and lock the trailer between the impacting vehicle and the tow vehicle. The TTMA-100's impact head, shown in Figure 4, utilizes vertical steel angles to prevent impacting vehicles from sliding horizontally along the face of the trailer. The impact head also utilizes steel channels with the legs oriented toward traffic to prevent vertical motion on the front of an impacting vehicle to eliminate the risk of diving under or riding over the attenuator.



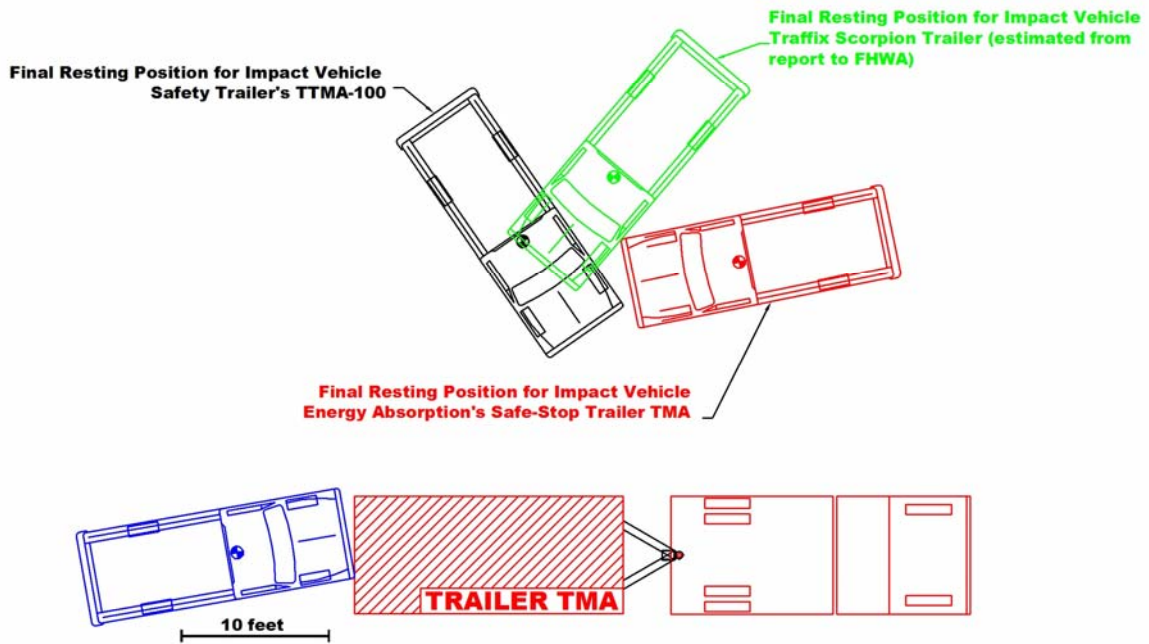
Figure 4. TTMA-100 Impact Head.

The effectiveness of this mechanical interlock system can be illustrated by comparing final rest locations from NCHRP Report 350 pickup truck offset and angled tests (tests 3-52 and 3-53, respectively) for the three trailer TMA systems that have received FHWA approval. Note that only the TTMA-100 was tested under the much more stringent conditions of blocking the support truck against any forward motion. The other two trailer TMA systems were tested with 20,000-lb support trucks which were allowed to roll ahead during the crash. Figure 3, shown below, was developed from FHWA approval letters and shows the final rest locations of the three trailer TMA systems for the optional offset and angled tests recommended by NCHRP 350. This figure clearly shows that the final rest locations for the three designs are not substantially different, even though the TTMA-100 was tested under the more severe condition with the support truck blocked against forward movement. Figure 5 clearly demonstrates that the TTMA-100's simple pintle hook attachment and its vehicle capturing impact head are able to perform very well during offset and angled impacts, even when attached to an infinitely heavy support truck.

In fact, the combination of the simple pintle hook attachment and the trailer's connection with the support vehicle, forces the trailer to rotate and align itself with the impacting force, which would in turn maximize energy dissipation. Hence, the TTMA-100 provides maximum energy dissipation for impacts at any angle to provide maximum safety to both motorists and construction workers.



**NCHRP Report 350 Optional Test 3-52**



**NCHRP Report 350 Optional Test 3-53**