

# MEMORANDUM

DATE: April 2, 2009

TO: David Streb, Chief of Engineering

FROM: Harold Smart, P.E., Chief Traffic Engineer

SUBJECT: Guidelines for Impact Attenuators

Attached is the Oklahoma Department of Transportation's "Guideline for Crash Cushions (Impact Attenuators)" dated March 9, 2009.

The guideline was developed by ODOT Traffic Engineers and Federal Highway Administration staff. This guideline serves as a decision tool for designers in selecting appropriate impact attenuators. There are many impact attenuators available on the market and they all met the National Cooperative Highway Research Program Report 350 (NCHRP-350) requirements. However, some attenuators are classified as fully "redirective" or "nongating" devices, which indicate the device will safely redirect a vehicle that impacts at any location along the face of the device while others are classified as "nonredirective" or gating devices, which will either capture a vehicle or allow it to pass through when hit along the face of the device.

The basis for selection of acceptable devices was based on the following three principles:

1. Traffic volume
2. Location of hazardous object with respect to the travel lanes
3. The safety of workers who are going to repair or replace the damaged impact attenuator.

For example, the guideline recommends using an impact attenuator, which can reset itself, be repaired quickly at locations close to the travel lanes and high traffic volume. Thus, the use of the guideline will minimize the workers' exposure to unsafe conditions while repairing the damaged attenuator. Also, because of the opportunity for quick repairs, the exposure of the traveling public to an unsafe condition will be minimized.

The Department is requesting FHWA's concurrence to allow the usage of the above guideline on all Federal-aid projects. Concurrence of the guideline will also allow the Department to specify products name and phrase "or approved Equal within the same category". Categories are defined as High Risk, and Low Risk. Should you have any question or concerns, please feel free to contact Mr. Faria Emamian at 405-521-2867

Please sign front cover of Guidelines and return to Traffic Engineering Office for copying and distribution.

**OKLAHOMA DEPARTMENT OF TRANSPORTATION**  
**Guidelines for Crash Cushions**  
**(Impact Attenuators)**



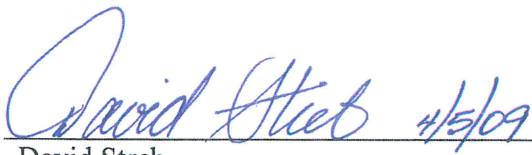
**Prepared by the Traffic Engineering Division**

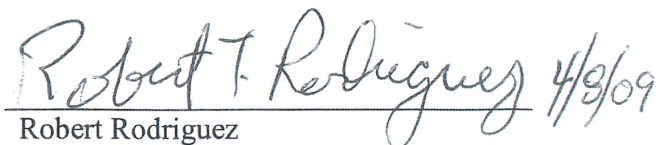
**Group Members**

Faria Emamian – Group Leader  
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FHWA Safety Engineer  
Division IV (Urban) Traffic Engineer  
Division VIII Traffic Engineer

**March 9, 2009**

  
David Streb  
Director of Engineering  
Oklahoma Department of Transportation

  
Robert Rodriguez  
Engineering & Operations Team Leader  
Federal Highway Administration

## **Introduction**

ODOT has adopted National Cooperative Highway Research Program Report 350 (NCHRP 350) criteria Test Level 3 (TL-3) as the standard for impact attenuators and all roadside hardware appurtenances. Testing is done using a minimum of two types of production model vehicles, a small car and a pickup truck at a nominal speed of 60 MPH. Each device must pass a minimum number of tests in order to receive Federal Highway Administration acceptance letter. More information about the testing requirements can be found in NCHRP Report 350 Part A and Part B on the Federal Highway Administration website ([http://safety.fhwa.dot.gov/roadway\\_dept/road\\_hardware/nchrp\\_350.htm](http://safety.fhwa.dot.gov/roadway_dept/road_hardware/nchrp_350.htm)), "Recommended Procedures for the Safety Performance Evaluation of Highway Features." All systems listed in this guide have been approved for use on the State and National Highway Systems.

This guideline serves as a decision-tool for designers in selecting appropriate impact attenuators for a highway project. There are many impact attenuators available on the market and they all met the National Cooperative Highway Research Program Report 350 (NCHRP-350) requirements. However, some attenuators are classified as fully redirective or non-gating devices while others are classified as non-redirective or gating devices. A fully redirective or non-gating device will safely redirect a vehicle that impacts at any location along the face of the device. Whereas, a non-redirective or gating device will either capture an impact vehicle or allow it to pass through when hit along the face of the device.

The basis for selection of acceptable devices was based on the following three principles: traffic volume, location of hazardous object with respect to the traveling lane, and the safety of workers who are going to repair or replace the damaged impact attenuator. For example, the guideline recommends using a "resettable" impact attenuator, which can be repaired quickly, at locations close to the traveling lane and high traffic volume. Thus, the use of the guideline will minimize the workers' exposure to unsafe conditions while repairing the damaged attenuator. Also, because of the opportunity for quick repairs, the exposure of the traveling public to an unsafe condition will be minimized.

The following Table 1.1 provides five different categories for selecting appropriate attenuators. The categories were High Risk Narrow, Low Risk Narrow, High Risk Wide, , Narrow Risk Wide, and Non-Redirective. The definition for each category is defined in the Table 1.2. High risk is defined as hazardous object on a facility with ADT of greater or equal 40,000 and it is located within the clear zone. Low risk is defined as hazardous object on a facility that has ADT of 40,000 or less.

Impact attenuators vary greatly. Some products could protect a hazardous object ranging from 24" to 90" while others required some sort of transition hardware to connect themselves to standard w-beam guardrail and to larger abutment object. For those impact attenuators that require additional transition hardware, it is crucial that the flare rate of the impact attenuators, and its transition hardware are the same.

In addition, because of variations of impact attenuators, only those listed in this guideline are accepted in the State of Oklahoma. For any new products or variation of existing product to be included in the list, it is the responsibility of the supplier to demonstrate that the product has met all NCHRP-350 TL-3 requirements and has been evaluated for Oklahoma Qualified Product List (QPL).



All high risk category attenuators are suitable to be used in low risk categories. However those attenuators classified in the low risk are not acceptable replacement for high risk locations. Same application is true for low risk attenuators they can not be substitute for high risk category.

**Table 1.1 - ODOT Guideline for Roadside Attenuators**

		Fully Redirective Non Gating				Non-Redirective
		Narrow ≤30"		Wide >30"		
Note	Product Name	High Risk	Low Risk	High Risk	Low Risk	
1	Quadguard II		X		X	
2	Quadguard Elite	X	X	X	X	
3	TAU-II Family		X		X	
4	TRACC Family		X		X	
5	SCI-100 GM (Smart Cushion)	X	X	X	X	
6	H.E.A.R.T **	X	X	X	X	
7	Compressor System **	X	X	X	X	
8	Energite III					X
9	Big Sandy Sand Barrels					X
10	Fitch Universal Module System					X

**\*\* Needs to meet all requirements of Oklahoma Qualified Product List (QPL)**

- 1 [www.energyabsorption.com/products/products\\_quadguard\\_crash.asp](http://www.energyabsorption.com/products/products_quadguard_crash.asp)
- 2 [www.energyabsorption.com/products/products\\_quadguard\\_elite.asp](http://www.energyabsorption.com/products/products_quadguard_elite.asp)
- 3 [www.barriersystemsinc.com/products/product.asp?key=3&nav\\_family=2](http://www.barriersystemsinc.com/products/product.asp?key=3&nav_family=2)
- 4 [www.highwayguardrail.com/products/tracc.html](http://www.highwayguardrail.com/products/tracc.html)
- 5 [www.workareaprotection.com/attenuator.htm](http://www.workareaprotection.com/attenuator.htm)
- 6 [www.highwayguardrail.com/products/heart.html](http://www.highwayguardrail.com/products/heart.html)
- 7 [www.energyabsorption.com/products/products\\_energite\\_iii.asp](http://www.energyabsorption.com/products/products_energite_iii.asp)
- 8 [www.traffixdevices.com/cgi-local/SoftCart.exe/bigsandy.htm?L+scstore+dwjm0394ffd0a5d0+1200696346](http://www.traffixdevices.com/cgi-local/SoftCart.exe/bigsandy.htm?L+scstore+dwjm0394ffd0a5d0+1200696346)
- 9 [www.energyabsorption.com/products/products\\_universal\\_barrels.asp](http://www.energyabsorption.com/products/products_universal_barrels.asp)
- 10 [www.barriersystemsinc.com/products/product.asp?key=4&nav\\_family=2](http://www.barriersystemsinc.com/products/product.asp?key=4&nav_family=2)

(Revised October 24, 2011)



**Table 1.2**

DESCRIPTION	TYPICAL APPLICATION
Narrow Hazardous Object Width ( $\leq 30$ inches)	
Fully Redirective Non Gating, (Low Risk)	To be installed on highways where the ADT is $< 40,000$ . The location of the hazard to be protected is within the clear zone as described in the Roadside Design Guide. Typical installation include by not limited to: median, narrow hazard, barrier or narrow pier.
Fully Redirective Non Gating, (High Risk)	To be installed on highways where the ADT is $\geq 40,000$ . The location of the hazard to be protected is within the clear zone as described in the Roadside Design Guide. Typical installation include but not limited to: narrow median, narrow hazard, barrier or narrow pier, outside of curve, area near weaving or lane drops, near highway entrance, exit on freeway/expressway, gore area, or left hand exit.
Wide Hazardous Object Width ( $>30$ inches) ***	
Fully Redirective Non Gating, (Low Risk)	To be installed where the object needing protection is up to 90" wide on highways where the ADT is $< 40,000$ . The location of the hazard to be protected is within the clear zone as described in the Roadside Design Guide. Typical installation include by not limited to: Sign Base, Pier, narrow Gap Between Bridges.
Fully Redirective Non Gating, (High Risk)	To be installed on highways where the object needing protection is up to 90" wide ADT is $\geq 40,000$ . The location of the hazard to be protected is within the clear zone as described in the Roadside Design Guide. Typical installation include but not limited to: outside of curve, area near weaving or lane drop, near highway entrance, exit on freeway / expressway, Sign Base, Pier, narrow Gap Between Bridges, left hand exit.
Non-Redirective	Installation in locations where the vehicle is not likely to hit a hazard should it go through the attenuator at an angle. Typical installation locations include: where there is a wide separation of lanes and terrain behind the attenuator is not a hazard (slope 4:1 or flatter) or lanes that are moving in the same direction. It is not recommended to be used on the outside of curve, area near weaving or lane drop, near highway entrance, exit on freeway / expressway, narrow Gap Between Bridges, left hand exit.

Use of standard barrier sections & approved flare rates may allow installation of narrow impact attenuator in advance of wide hazards, depending on space available.

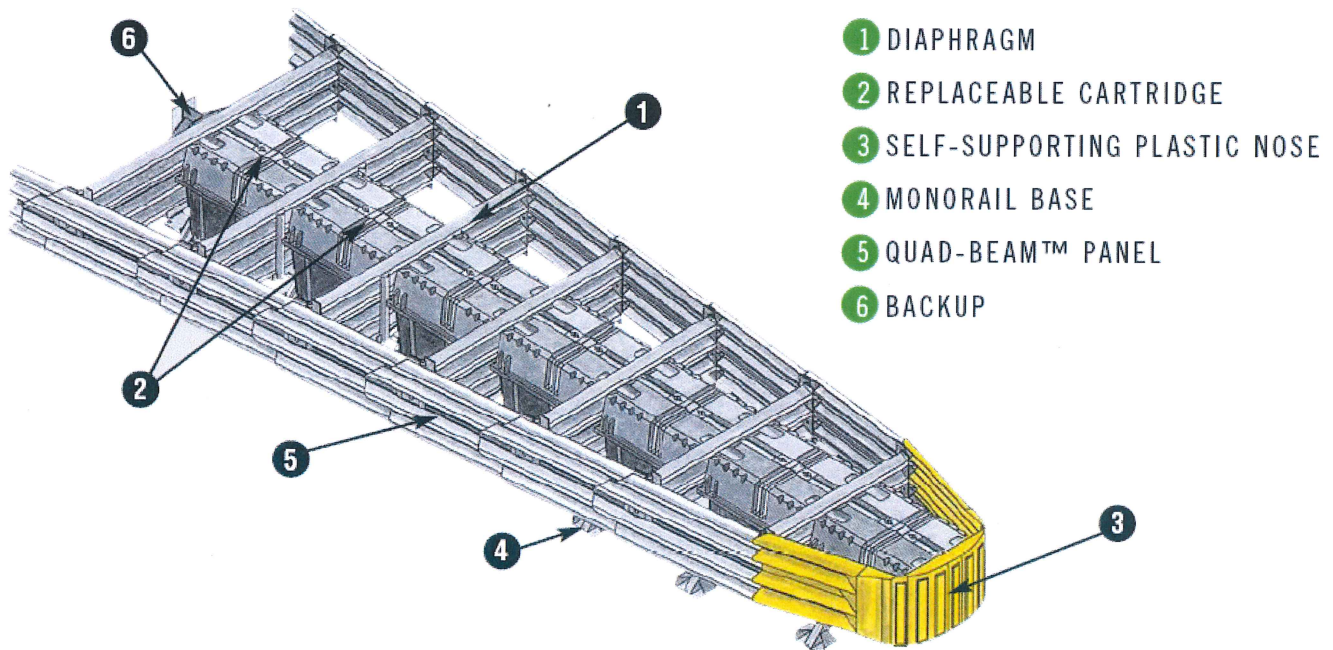
\*\*\* Any transition flare angle must meet NCHRP 350 TL-3 crash criteria, and provide an approval letter to ODOT from FHWA.

**SYSTEM TYPES**  
**AND**  
**DESCRIPTION**

<b>Name</b>	QuadGuard II™ Wide
<b>Manufacturer</b>	Energy Absorption Systems, Inc.
<b>Website</b>	<a href="http://www.energyabsorption.com/products/products_quadguard_crash.asp">http://www.energyabsorption.com/products/products_quadguard_crash.asp</a>
<b>FHWA Acceptance Letter</b>	HSA-10/CC42-A ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc42a.htm">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc42a.htm</a> )

**General Characteristics (wide):**

- 6 bay (excluding the nose section bay). First 3 bays use Type I cartridge and last 3 bays use Type II cartridges.
- 10 degree maximum side flare.
- 2 standard backup widths 60 and 90 inches
- Replaceable/crushable cartridges
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- 20 feet 9 inches long
- This system is not resettable and should be used in areas where minimal impacts are anticipated.



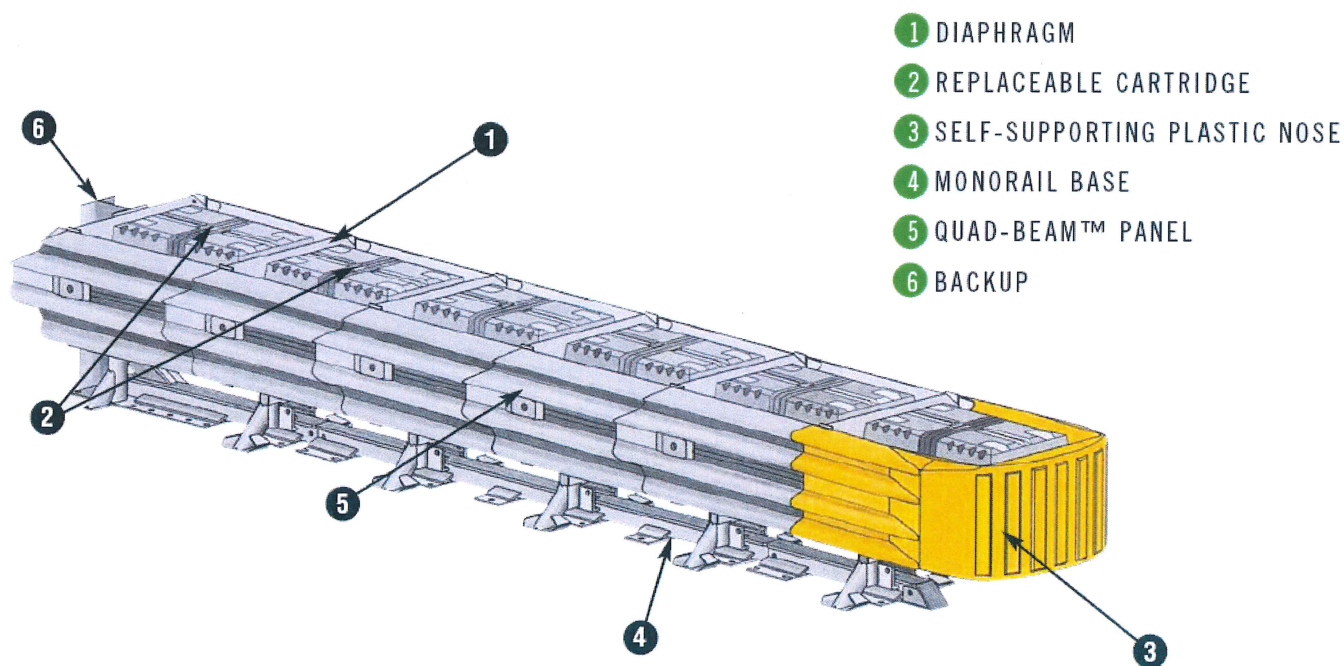
(Revised October 24, 2011)



<b>Name</b>	QuadGuard II™ Narrow
<b>Manufacturer</b>	Energy Absorption Systems, Inc.
<b>Website</b>	<a href="http://www.energyabsorption.com/products/products_quadguard_crash.asp">http://www.energyabsorption.com/products/products_quadguard_crash.asp</a>
<b>FHWA Acceptance Letter</b>	HNG/CC-35 and CC-35B ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-35.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-35.pdf</a> ) ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-35b.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-35b.pdf</a> )

**General Characteristics (narrow):**

- 6 bay (excluding the nose section bay). First 3 bays use Type I cartridge and last 3 bays use Type II cartridges.
- Backup width is 90 inches
- Replaceable/crushable cartridges
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- 22 feet long
- This system is not resettable and should be used in areas where minimal impacts are anticipated.

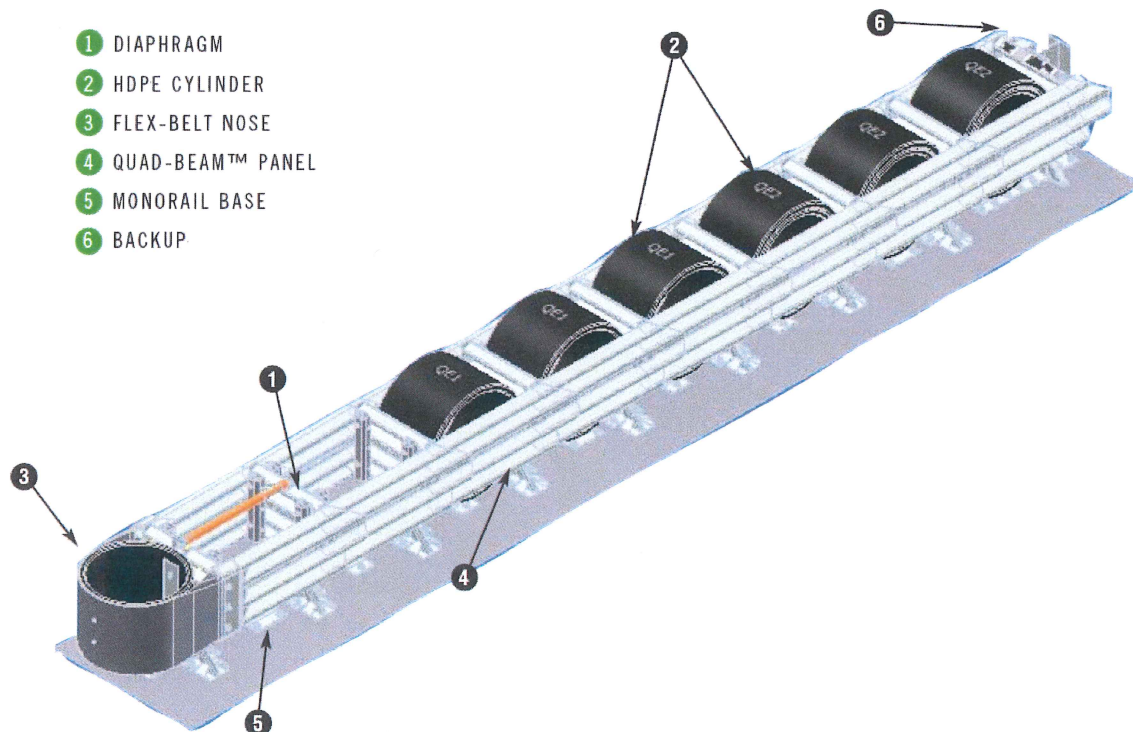


(Revised October 24, 2011)

<b>Name</b>	QuadGuard™ Elite
<b>Manufacturer</b>	Energy Absorption Systems, Inc.
<b>Website</b>	<a href="http://www.energyabsorption.com/products/products_quadguard_elite.asp">http://www.energyabsorption.com/products/products_quadguard_elite.asp</a>
<b>FHWA Acceptance Letter</b>	HNG-14 /CC-57 and CC-57B ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-57.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-57.pdf</a> <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc57b.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc57b.pdf</a> )

#### General Characteristics:

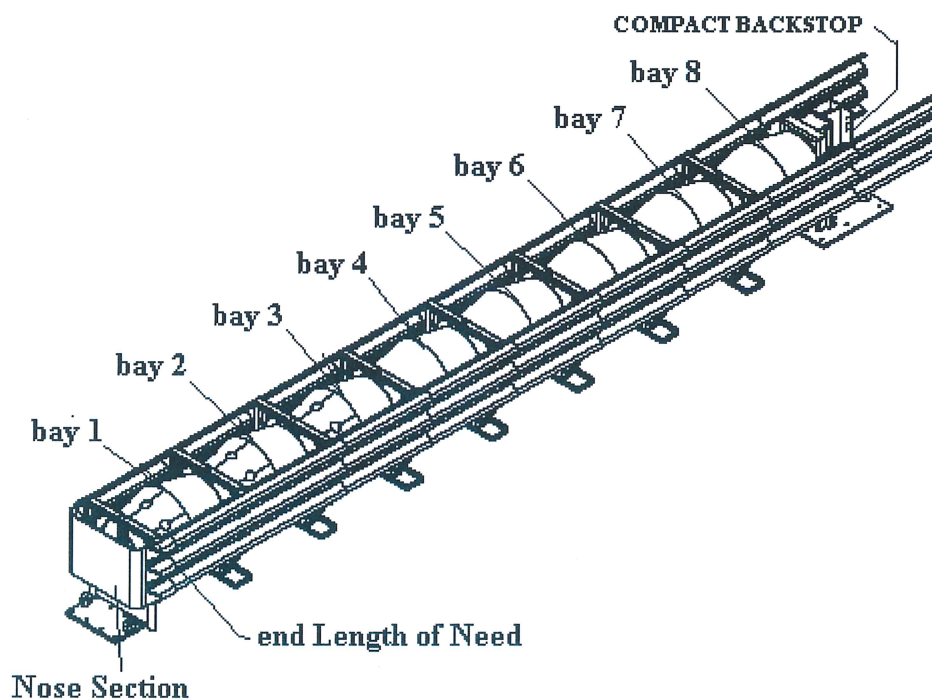
- 11 bay (no cylindrical in the first 2 bays). New approved 8-bay is acceptable.
- Backup widths available in 24, 30, 36, 69, or 90 inches. The 60 and 90 inch system flare out to obtain the required width at backup
- HDPE cylinders
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- This system can withstand multiple impacts with minimal repair
- This resettable system because High Density Poly Ethylene will return to their original shape
- 33 feet 4 inches long (11-bay)
- 26.6 feet (8-bay)



<b>Name</b>	TAU-II™ Family (Parallel, Taper, or Combination)
<b>Manufacturer</b>	Barrier Systems, Inc.
<b>Website</b>	<a href="http://www.barriersystemsinc.com/products/product.asp?key=3&amp;nav_family=2">http://www.barriersystemsinc.com/products/product.asp?key=3&amp;nav_family=2</a>
<b>FHWA Acceptance Letter</b>	HSA-10/CC-75 for Narrow or Parallel System ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc75.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc75.pdf</a> ) HSA-10/CC-75B for Combination (variable width) ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc75b.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc75b.pdf</a> )

**General Characteristics (For Parallel or Narrow Systems):**

- Backup widths are available in 24, 30, and 36 inches
- 8 bay with 2 types crushable/replace cartridges. First 3 cartridges are Type A and last B cartridges are Type II.
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- 26.9 feet long
- This system is not resettable and should be used in areas where minimal impacts are anticipated.

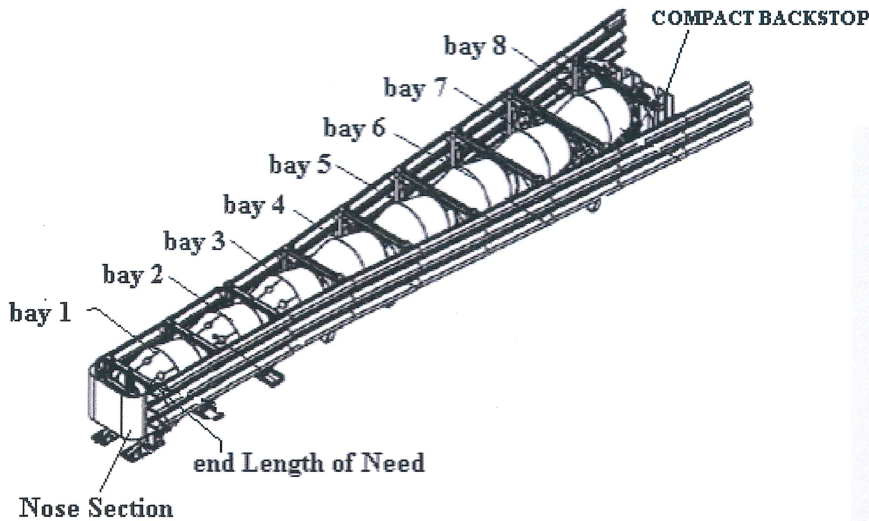


UNIVERSAL TAU II  
TL-3 SYSTEM shown



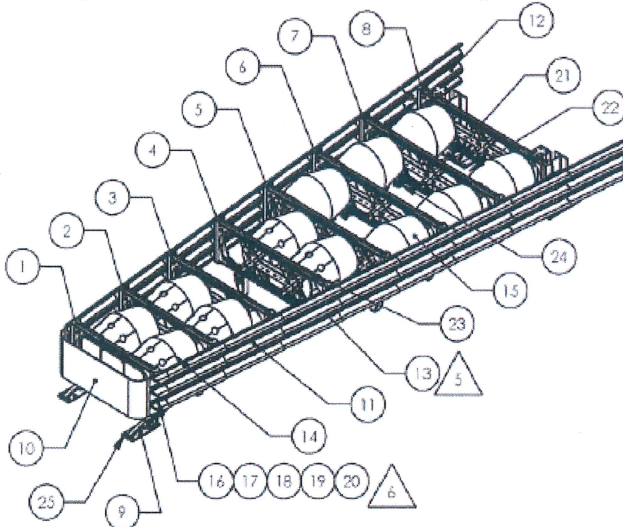
### General Characteristics (Combination Systems):

- Backup widths could accommodate up to 60 inches
- 8 bay with 2 types crushable/replace cartridges. First 3 rows are Type A cartridges and remainders are Type B cartridges.
- 26.9 feet long
- 5 degree outward flare rate.
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- This system is not resettable and should be used in areas where minimal impacts are anticipated.



UNIVERSAL TAU II Wide  
TL-3 System shown

- Variations for TAU-II (Taper systems):
- Backup widths could accommodate up to 96 inches

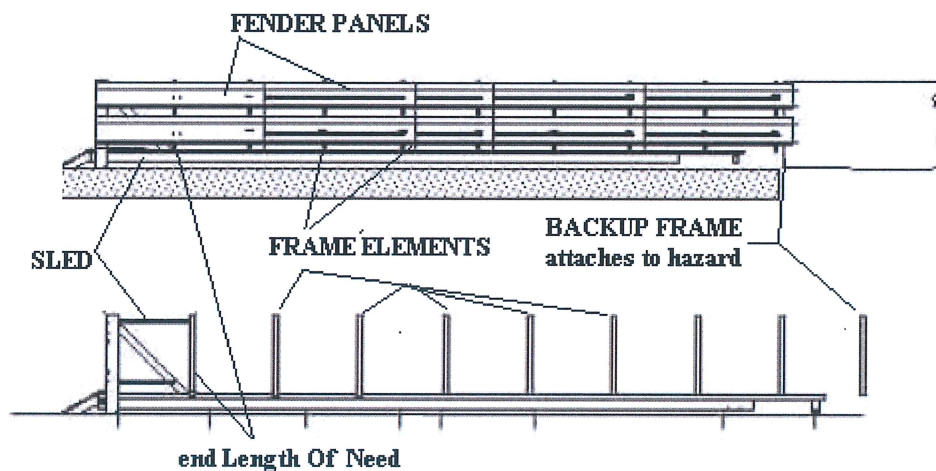


60+ mph* (100 km/h) Test Level-3	
UP TO 30" [700 mm]	B B B B B A A A
36" [90 mm]	B B B B B A A A
42" [1060 mm]	B B B B B A A A
48" [1220 mm]	B B B B B A A A
54" [1370 mm]	B B B B B A A A
60" [1520 mm]	B B B B B A A A
66" [1680 mm]	B B B B B A A A
72" [1830 mm]	B B B B B A A A
78" [1980 mm]	B B B B B A A A
84" [2130 mm]	B B B B B A A A
90" [2280 mm]	B B B B B A A A
96" [2440 mm]	B B B B B A A A

<b>Name</b>	TRACC Family (FasTRACC™ and WideTRACC™)
<b>Manufacturer</b>	Trinity Highway Products, LLC.
<b>Website</b>	<a href="http://www.highwayguardrail.com/products/tracc.html">http://www.highwayguardrail.com/products/tracc.html</a>
<b>FHWA Acceptance Letter</b>	HNG-14/CC-54 (for FasTRACC) ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-54.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-54.pdf</a> ) HSA-10/CC-54D (for WideTRACC) ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc54d.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc54d.pdf</a> )

**General Characteristics (FastTRACC or TRACC):**

- Length 21 feet
- Backup width is available in 24 inches
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- This system is not resettable and should be used in areas where minimal impacts are anticipated.
- No cartridges.
- Consisted of impact “sled”, 2 guidance tracks, and steel frames.



**TRACC**

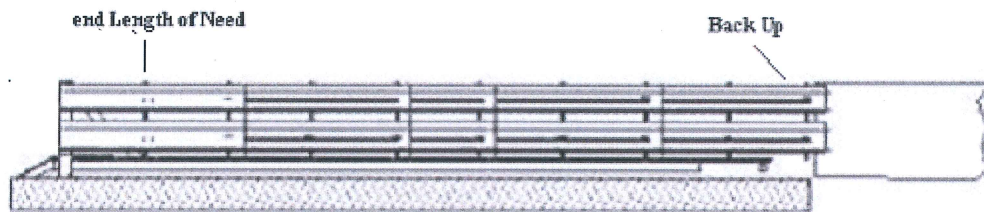


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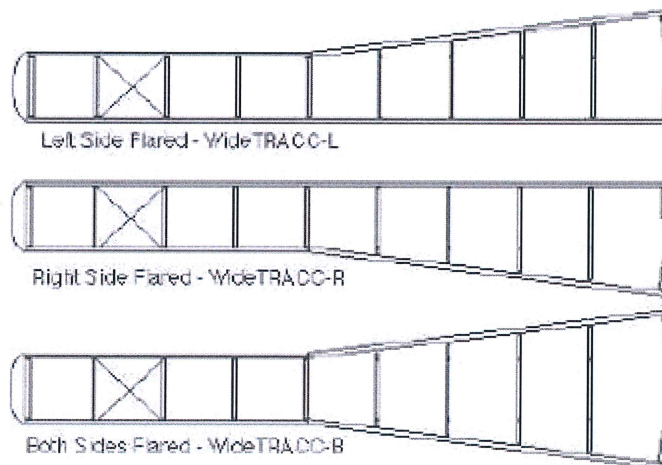


### General Characteristics (WideTRACC):

- Length 21 feet
- At 9.5 feet from beginning, the side panels begin to flare outward at 7 degrees. At the length of 21 feet, it could shield the hazardous object of up to 58 inches. To accommodate for larger objects, the attenuators need to move forward and maintaining 7 degrees until it covers the hazardous object.
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- This system is not resettable and should be used in areas where minimal impacts are anticipated.
- No cartridges.
- Consisted of impact “sled”, 2 guidance tracks, and steel frames



### TRACC



Basic WideTRACC configurations.

(ISO Drawing is not available)

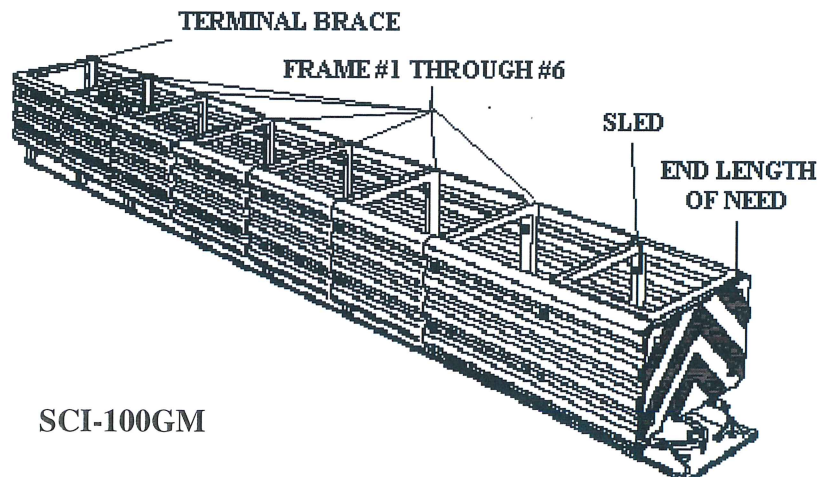




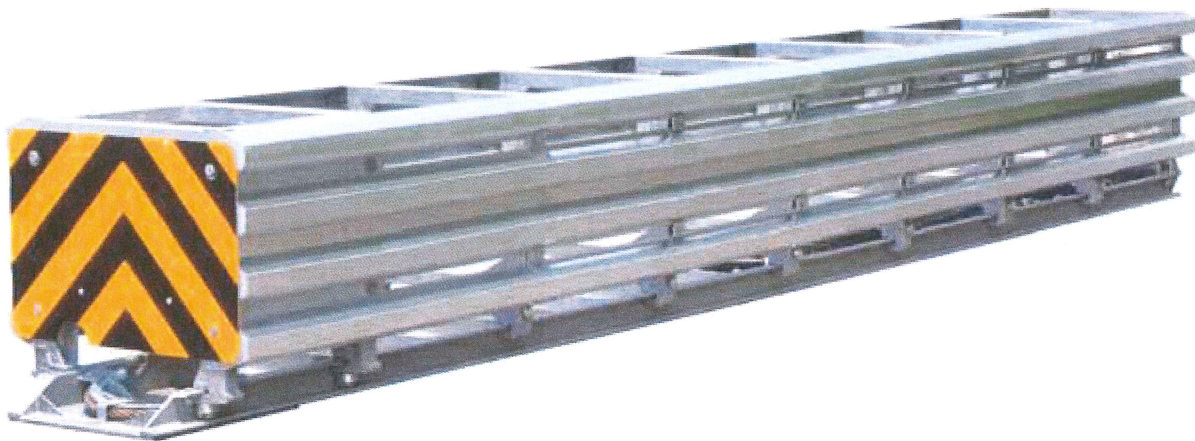
<b>Name</b>	SCI-100GM™ (Smart Cushion)
<b>Manufacturer</b>	Work Area Protection Corp.
<b>Website</b>	<a href="http://www.workareaprotection.com/attenuator.htm">www.workareaprotection.com/attenuator.htm</a>
<b>FHWA Acceptance Letter</b>	HSA-10/CC-85 ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc85.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc85.pdf</a> )

**General Characteristics:**

- Length 21.5 feet
- Backup width 24 inches. With approved transition, the unit could be attached to the flare guardrail at 10 degree starting from the rear to accommodate larger backup width.
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- This system can withstand multiple impacts with minimal repair
- This resettable system because of its shock arresting cylinder and telescoping backward panels.



**SCI-100GM**



<b>Name</b>	HEART™
<b>Manufacturer</b>	Trinity Highway Products, LLC.
<b>Website</b>	<a href="http://www.highwayguardrail.com/products/heart.html">http://www.highwayguardrail.com/products/heart.html</a>
<b>FHWA Acceptance Letter</b>	HSA-10/CC-89 ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc89.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc89.pdf</a> )

#### General Characteristics:

- Length 26 feet
- Backup width 26"
- The HEART attenuator consists of three deformed (hinged) High Molecular Weight/High Density Polyethylene (HMW/HDPE) panels along each side connected to steel diaphragms mounted on tubular steel tracks.
- Re-directive, bi- and unidirectional, non-gating, non-pocketing
- Require further evaluation.



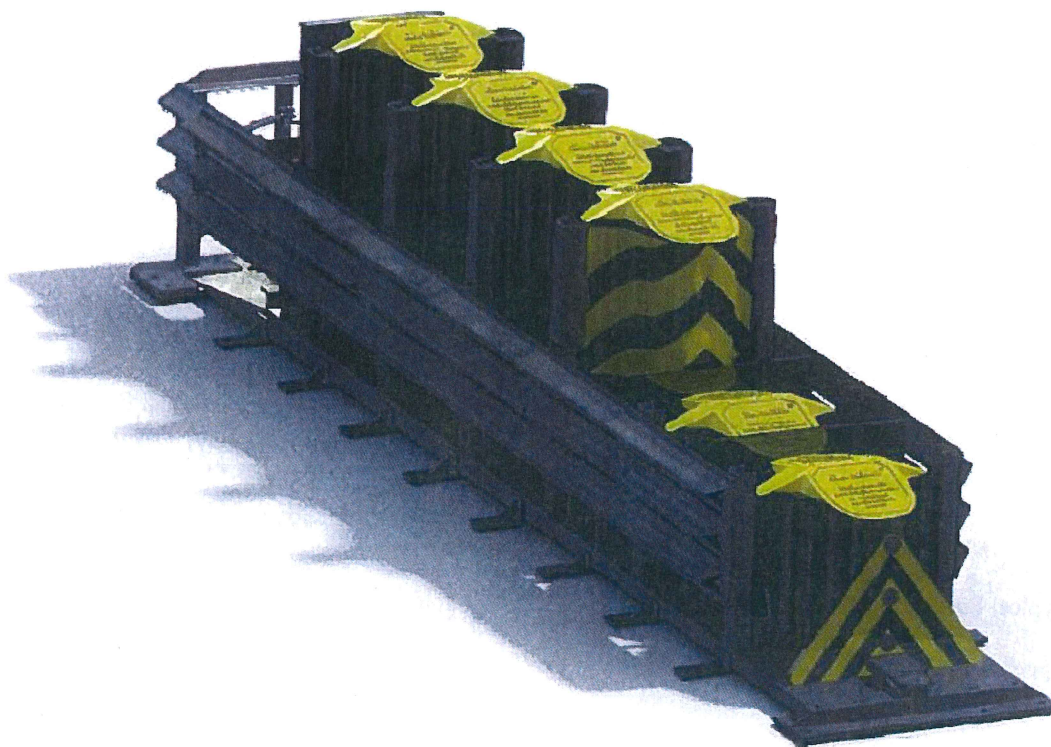
(ISO Drawing is not available)



<b>Name</b>	Compressor <sup>®</sup> System
<b>Manufacturer</b>	TraFix Devices, Inc.
<b>Website</b>	<a href="http://www.trafficcixdevices.com">http://www.trafficcixdevices.com</a>
<b>FHWA Acceptance Letter</b>	HSSD/CC-95, -95A, HSST/CC-95B <a href="http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/cc95.htm">http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/cc95.htm</a> <a href="http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/cc95a.pdf">http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/cc95a.pdf</a> <a href="http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/cc95b.pdf">http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/pdf/cc95b.pdf</a>

#### General Characteristics:

- Length 21 feet 3 inches.
- Width 53 inches.
- Galvanized structural steel Uni-Base<sup>™</sup> Platform which does not need to be placed against a rigid object to support itself. The Compressor requires 14 bolts to secure to concrete and 30 bolts to secure to asphalt.
- Compressor is a self-restoring attenuator designed to take repeated impacts with minimal or no repairs.
- Contains six (6) self-restoring plastic modules of varying Material thickness and heights.
- Re-directive, bi- and unidirectional, non-gating.
- Requires further evaluation.



(ISO Drawing is not available)

(Revised October 24, 2011)



## NON-REDIRECTIVE ATTENUATORS

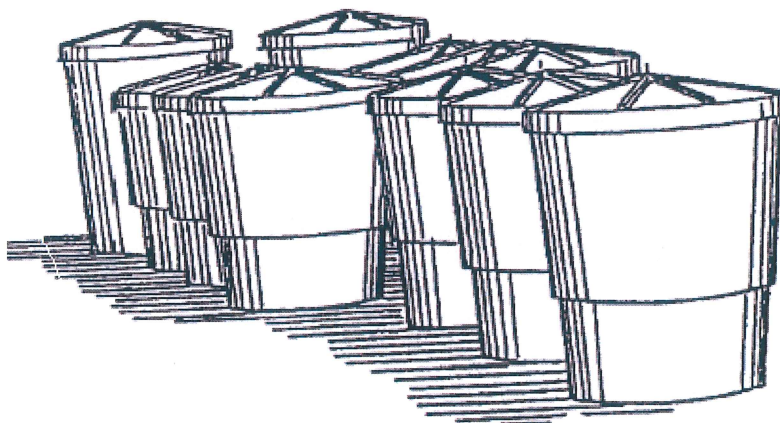
<b>Name</b>	“Big Sandy”™
<b>Manufacturer</b>	TraFFix Devices, Inc.
<b>Website</b>	<a href="http://www.traffixdevices.com/cgi-local/SoftCart.exe/bigsandy.htm?L+scstore+dwjm0394ffd0a5d0+1200696346">www.traffixdevices.com/cgi-local/SoftCart.exe/bigsandy.htm?L+scstore+dwjm0394ffd0a5d0+1200696346</a>
<b>FHWA Acceptance Letter</b>	HNG-14/CC-52 ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-52.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-52.pdf</a> )

<b>Name</b>	Energite III™
<b>Manufacturer</b>	Energy Absorption Systems, Inc.
<b>Website</b>	<a href="http://www.energyabsorption.com/products/products_energite_iii.asp">http://www.energyabsorption.com/products/products_energite_iii.asp</a>
<b>FHWA Acceptance Letter</b>	HNG-14/CC-29 ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-29.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-29.pdf</a> )

<b>Name</b>	Fitch Universal Barrels™
<b>Manufacturer</b>	Energy Absorption Systems, Inc.
<b>Website</b>	<a href="http://www.energyabsorption.com/products/products_universal_barrels.asp">http://www.energyabsorption.com/products/products_universal_barrels.asp</a>
<b>FHWA Acceptance Letter</b>	HNG-14/CC-28 ( <a href="http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-28.pdf">http://safety.fhwa.dot.gov/roadway_dept/road_hardware/barriers/pdf/cc-28.pdf</a> )

### General Characteristics:

- Length & Width varies depending on different system
- Non-directive, bi- and unidirectional, gating, pocketing
- Sand barrels are interchangeable with other systems.



**Sand Barrels**