Crash Cushion Inspection Training

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Office of Construction
Course Objective

• At the end of this course, you will be:
  – Able to identify common products and their components,
  – Aware of the installation requirements for common products, and
  – Able to recognize some common issues with Crash Cushion installation found in the field during MOT Process Reviews
Course Outline

Crash Cushion Inspection Training

- Identifying Common Products
  - Length of Need for Common Products
  - Truck/Trailer Mounted Attenuators (TMA’S)
- Installation of Common Products
- MOT Process Review Findings
Crash Cushions

• Redirective (Non-Gating)
  – The principle device to shield approach ends of barrier wall

9. A yellow Type I Object Marker shall be centered 3’ in front of the crash cushion nose. As an option, the contractor may install Retroreflective Sheeting on the nose of the crash cushion. The sheeting to be used must be solid yellow, Type IV or better and must be a product listed on the Department’s Approved Products List (APL). The sheeting to be applied to the nose of the crash cushion shall be a minimum of 360 square inches with a minimum height of 15 inches. Mounting hardware, Object Markers or Retroreflective Sheeting shall be in conformance with Section 993 of the Standard Specifications for Road and Bridge Construction.
Crash Cushions – Identifying Common Products

In this section, we will take a look at how to identify a few common products.
Crash Cushions (Impact Attenuators):

Quadguard (Narrow & Wide) - Proprietary Energy Absorption Systems, Inc.

Unique Feature:

A. Quadruple Corrugated Fender Panels
B. Rectangular Cartridges
C. Plastic Nose
D. Monorail Base

Quadguard
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):
  Quadguard II (Narrow & Wide) – Proprietary
  *(Shorter than the Original Quadguard)*

Energy Absorption Systems, Inc.

Unique Feature:
  A. Quadruple Corrugated Fender Panels
  B. Rectangular Cartridges
  C. Steel Nose
  D. Monorail Guide Stabilizers
Crash Cushions (Impact Attenuators):
Quadguard II (Narrow & Wide) – Proprietary
(Shorter than the Original Quadguard)
Energy Absorption Systems, Inc.
D. Monorail Guide Stabilizers
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):
- Quadguard II (Narrow & Wide) – Proprietary
  *(Shorter than the Original Quadguard)*
- Energy Absorption Systems, Inc.
  
  E. Shims
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):  
Quadguard Elite (Narrow & Wide) – Proprietary  
(Reusable Cylinders)  
Energy Absorption Systems, Inc.

Unique Feature:
A. Quadruple Corrugated Fender Panels  
B. HDPE Cylinders  
C. Monorail Base
Crash Cushions (Impact Attenuators):
REACT 350 – Proprietary
Energy Absorption Systems, Inc.
Unique Feature:
A. Large Diameter HDPE Cylinders
B. Redirective Cables
Crash Cushions (Impact Attenuators):

TRACC – Proprietary
Trinity Attenuating Crash Cushion (TRACC)
Trinity Highway Products, LLC.

Unique Feature:
A. Plastic Nose
B. No Cartridges
C. Stacked Modified W-Beam Fender Panels
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

TAU II – Proprietary

Lindsay Transportation Solutions/Barrier Systems

Unique Feature:

A. Plastic Nose
B. Conical Shaped Cartridges
C. Modified Thrie-Beam Fender Panels

TAU-II
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

TAU II – Proprietary

TAU II
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):

SCI Smart Cushion – Proprietary
Work Area Protection, Inc.

Unique Feature:

A. No Cartridges
B. Hydraulic Cylinder w/Cable
C. Blunt/Square Nose

SCI Smart Cushion
Crash Cushions – Identifying Common Products

Crash Cushions (Impact Attenuators):
X-MAS – Proprietary

(Double Faced Version of the X-Tension Terminal)
Lindsay Transportation Solutions/Barrier Systems

Unique Feature:
A. W-Beam Panels w/Slider Bracket
B. Standard Driven Posts
C. Forward Anchorage
D. Duel Tension Cables

X-MAS
**Length of Need (LON)** - the length of crash cushion needed in advance (upstream) of a fixed object hazard or a non-traversable terrain feature to prevent a vehicle that has left the roadway from reaching the shielded feature.
Crash Cushions - Length of Need for Common Products

QuadGuard

- Length of Need
- Departure Line
- First Displacement
- 18 for Speeds > 45 mph
- 15 for Speeds 30-70 mph
- LEFT
- RIGHT
Crash Cushions - Length of Need for Common Products

QuadGuard II

QuadGuard Elite
Crash Cushions - Length of Need for Common Products

**REACT 350**

- **Model #:** 6268035
- **System Length:** 21'-2"
- **Effective Length:** 18'-1 1/2"
- **Pad Length:** 22'-7"
- **Workzone Speed:** 60 mph
- **Design Length:** 18'-6"
- **Tested To:** TL-3

*For high speed facilities with a workzone speed of ≥ 60 mph, use a 6 cylinder REACT II system. Also see note 6.*

**X-MAS**

- **Beginning Length of Need**
- **Departure Line**
  - For Design Speeds < 45 MPH: 1:16
  - For Design Speeds > 50 MPH: 1:13

*Florida Department of Transportation*
Crash Cushions - Length of Need for Common Products

**TRACC**
- Departure Line
  - 1:16 For Speeds ≤ 45 mph
  - 1:13 For Speeds 50-60 mph
- Type I Object Marker

**TAU-II**
- Departure Line
  - 1:16 For Speeds ≤ 45 mph
  - 1:13 For Speeds ≥ 50 mph

Beginning Of Length Of Need

Florida Department of Transportation
Crash Cushions - Length of Need for Common Products

Length of Need

Type I Object Marker By Installer

SCI

Departure Line
1:16 For Speeds < 45 mph
1:13 For Speeds > 50 mph

Beginning of Length of Need

Unit Width 4'-0"
Truck/Trailer Mounted Attenuators (TMA’S)

- Truck or Trailer Mounted
  - Listed on APL
- Indexes 607 & 619
- Mounted by Manufacturer’s Recommendations
Crash Cushions – Installation of Common Products

In this section, we will take a closer look at some of the installation requirements for a few common products.

**Always** refer to the vendor product manuals listed on the APL for full installation requirements.
Crash Cushions – Installation of Common Products

TAU-II

UNIVERSAL TAU-II
FDOT APL 102-041-021
Crash Cushions – Installation of Common Products

TAU-II

Foundation Options

Chart is in APL 102-041-021 Vendor Drawings

FOUNDATION SPECIFICATIONS:

THE UNIVERSAL TAU-II CRASH CUSHION SYSTEM HAS BEEN DESIGNED TO ATTACH TO CONCRETE OR ASPHALT FOUNDATIONS. USE THE ANCHORAGE SPECIFIED BELOW DEPENDING ON THE FOUNDATION AT THE JOB SITE. REFERENCE TAU-II FOUNDATION DRAWINGS FOR FURTHER DETAIL.

1.) CONCRETE PAD

2.) ASPHALT OVER SUBBASE

3.) ASPHALT ONLY

4.) ASPHALT OVER P.C. CONCRETE

MATERIAL SPECIFICATIONS

PORTLAND CEMENT CONCRETE (PCC)

STONE AGGREGATE CONCRETE MIX 4,000 PSI 28 DAY, WITH 50% COMPRRESSIVE STRENGTH (SAMPLE FOR AS T844 AND ASTM C63, TESTING PER ASTM C63)

ASPHALTIC CONCRETE (AC)

ASPHALT CONCRETE TYPE SP 12.5 TRAFFIC LEVEL C OR HIGHER (FOOT SPECIFICATION 25K)

COMPACTED SUBBASE (DGA)

ROCK BASE (FDOT SPECIFICATION 28K) OR GRANULAR AGGREGATE 944 (FOOT SPECIFICATION 28K)

SCALE: FULL

DRAWN BY: JSJ DEC. 2005

TITLE: FOUNDATION SPECIFICATIONS

MODEL: A040113–FL–U

REV.: A
Crash Cushions – Installation of Common Products

TAU-II

Foundation Options
Examples of Concrete Foundations

8” threaded rod w/ 6” embedment
TAU-II

Foundation Options
Examples of Asphalt Foundations

18” threaded rod w/ 16” embedment
TAU-II

Anchor Embedment

- Chemical or mechanical anchors are acceptable.

- Most common method is using all-thread rod & epoxy.

- For a concrete pad, \( \frac{3}{4}'' \times 8'' \) threaded rod is used with an embedment depth of 6'' in the pad.

- For asphalt foundations, a \( \frac{3}{4}'' \times 18'' \) threaded rod is used with an embedment depth of 16'' in the asphalt.
Crash Cushions – Installation of Common Products

TAU-II

Anchor Embedment

- For any anchors in the concrete barrier wall, ¾” mechanical anchors (wedge bolts) are acceptable.
- Proper anchor installation procedures are key
- Dust is blown out of holes
- Generous amount of epoxy put into holes
- Epoxy given ample time to cure before tightening, etc.
- **Not all adhesives listed under QPL 937 HV Type are acceptable.**
- Manufacturer publishes periodic list of those evaluated and found acceptable per manufacturer’s requirements.
Crash Cushions – Installation of Common Products

**TAU-II**

**Anchor Embedment Depth**

Threads should not extend more than $\frac{1}{4}$ above the top of the nut when the nut is tight against the backstop ground plate.

$\leq \frac{1}{4}''$
TAU-II

Do’s and Don’ts - Anchor Embedment Depth

Nuts are not torqued down. No evidence of epoxy flooding out around bolt holes which could indicate not enough epoxy in holes.

Properly installed front cable anchor plate. Note some epoxy flowing out of holes. No more than ¼” of threads extending above nuts.
# Crash Cushions – Installation of Common Products

## TAU-II

### Cartridge Placement

Chart is in APL 102-041-021 Vendor Drawings

<table>
<thead>
<tr>
<th>BACKSTOP WIDTH</th>
<th>MAX HAZARD WIDTH</th>
<th>(TL-2) SYSTEM CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>30 MPH</td>
</tr>
<tr>
<td>Parallel up to 30”</td>
<td>30”</td>
<td>B B</td>
</tr>
<tr>
<td>36” Backstop</td>
<td>41”</td>
<td>B B</td>
</tr>
<tr>
<td>42” Backstop</td>
<td>47”</td>
<td>B B</td>
</tr>
<tr>
<td>48” Backstop</td>
<td>53”</td>
<td>B B</td>
</tr>
<tr>
<td>54” Backstop</td>
<td>59”</td>
<td>B B</td>
</tr>
<tr>
<td>60” Backstop</td>
<td>64”</td>
<td>B B</td>
</tr>
<tr>
<td>10” Backstop</td>
<td>67”</td>
<td>B B</td>
</tr>
<tr>
<td>10” Backstop</td>
<td>71”</td>
<td>B B</td>
</tr>
<tr>
<td>12” Backstop</td>
<td>71”</td>
<td>B B</td>
</tr>
<tr>
<td>10” Backstop</td>
<td>81”</td>
<td>B B</td>
</tr>
<tr>
<td>10” Backstop</td>
<td>84”</td>
<td>B B</td>
</tr>
<tr>
<td>30” Backstop</td>
<td>92”</td>
<td>B B</td>
</tr>
<tr>
<td>36” Backstop</td>
<td>101”</td>
<td>B B</td>
</tr>
</tbody>
</table>
Crash Cushions – Installation of Common Products

TAU-II

Cartridge Placement

Type A Cartridge – holes towards the front

Type B Cartridge
**TAU-II**

**Cartridge Placement**

The writing on the cartridge should face up and is to be legible when standing behind the crash cushion looking towards the nose.

The TAU Configuration chart is printed on the bottom side of each cartridge.
Slider and End Panels
The slider panels overlap the end panel so the slider panels can slide back and over the end panel when the crash cushion is hit.
TAU-II

Slider and End Panels
The rearward panel is “on top” of the forward panel. When impacted, the attenuator will telescope rearward.
TAU-II

Slider and End Panels

The gap between the slider panels should not exceed 3/4”.

If you can get your finger in the gap, it’s more than 3/4”!
TAU-II

Slider and End Panels
The end panel is needed even in unidirectional situations to adequately protect the backstop.
TAU-II

Bi-Directional Conditions
If traffic is approaching the TAU from the backside, a bi-directional transition wing is used to mitigate a reverse impact into the backstop.

A “kit” is available for this wing (pictured) or a piece of thrie-beam guardrail and end shoe can be used.
TAU-II

Bi-Directional Conditions

Drawing is in APL 102-041-021 Vendor Drawings
TAU-II

Barrier Wall Anchoring
The TAU-II uses two barrier wall anchor tabs – one on each side of the barrier. Whenever the PCB backstop is used on an asphalt foundation, even if not in a bi-directional configuration, the anchor tabs should be used.
TAU-II

Torque

Slider bolts: 20 ft-lbs
If the slider bolts are too tight, the system will not telescope rearward when impacted!
Crash Cushions – Installation of Common Products

**TAU-II**

**Torque**

- **Cables:**
  - On concrete pads – 500 ft-lbs
  - On asphalt pads – 120 ft-lbs

**Anchors in pad & barrier:**
- On concrete pads – 120 ft-lbs
- On asphalt pads – 5 ft-lbs
QuadGuard

QUARDGUARD SYSTEM
FDOT APL 102-041-018

![Diagram of QuadGuard system components: Tension Strut, Backup, Fender Panels, Monorail, Cartridges, Diaphragms, Nose]
QuadGuard

Installation and Maintenance Tips

Mix and pour the 2-part epoxy

Torque anchors to 120 ft/lbs
QuadGuard

Installation and Maintenance Tips

Fender Panel Gap should be ¾” or less.
QuadGuard

Installation and Maintenance Tips

Example of well nested panels.
QuadGuard

Installation and Maintenance Tips

Type I Cartridges are placed in the front of the System

Type II are in the rear of the System
QuadGuard

Installation and Maintenance Tips

Cartridges should be level.
QuadGuard

Common MOT Process Review Finding

The third cartridge in the QuadGuard crash cushion was a Type II – Per the APL Vendor Drawings, it should be a Type I.
QuadGuard
Installation and Maintenance Tips

Mushroom washers should nest flat

GOOD

BAD
QuadGuard

Installation and Maintenance Tips

Clear zones are still important with Redirective, Non-Gating Systems.
SCI Smart Cushion

SCI SMART CUSHION
FDOT APL 102-041-010

NCHRP 350 Approved
Test Level 213’6” L X 24” W X 34” H
Test Level 321”6” L X 24” W X 34”H
Fully Redirective
Non-gating, Bi-directional
Available for wide application
Low Cost Repair
30 Minute Reset (typical)
SCI Smart Cushion

Inspection for Proper Installation

Pad must be per specifications as found in the manufacturer’s Design and Installation Manual.
SCI Smart Cushion

Inspection for Proper Installation

The SCI SMART CUSHION® is shipped in one piece, fully assembled. During installation the unit only needs to be properly positioned on the pad. Once positioned, the holes in the base are used as a template to drill holes to accept the epoxy anchors.
SCI Smart Cushion

Inspection for Proper Installation

Unit should be centered on the barrier

Attenuator should be level and properly oriented on pad
Check to make sure all anchors are in place and nuts are tight.
Proper torque is 125 ft-lbs.

The manufacturer recommends RedHead A7 Fast Dispensing, Fast Curing Acrylic Adhesive epoxy or equivalent.
Proper care should be taken to make sure epoxy is within date code.
SCl Smart Cushion

Inspection for Proper Installation

On a full collapse, the last set of side panels will telescope 30” beyond the last terminal brace at the rear of the crash cushion.

All objects that may interfere with this motion can affect the performance of and cause undue damage to the crash cushion.
SCI Smart Cushion

Inspection for Proper Installation

Check that the front section is pulled out to within 1” of the front stop bolt.

Verify that shear bolts are installed on the mobile sheaves.
SCI Smart Cushion

Inspection for Proper Installation

The cables should be visually inspected for damage or any sign of deterioration, broken wires or localized wear. Inspect Side Keeper Bolts and Side Panels
SCI Smart Cushion

Inspection for Proper Installation

The SCI SMART CUSHION® is a 24” wide unit.

To protect a barrier wider than 24” a transition needs to be installed. If needed, insure that the transition is properly assembled and anchored per the specifications as found in the manufacturer’s Design and Installation Manual.
SCI Smart Cushion

Final Inspection

Walk the area to make sure all tools or other equipment have not been left within the SCI SMART CUSHION® structure.
TRACC

TRINITY ATTENUATING CRASH CUSHION
FDOT APL 102-041-011

Arrives Assembled
26 Anchor Rods
Resettable Design
No Cushions
TRACC

Attenuator Inspection
Foundation Anchoring

No more than 1/2” thread exposed.

TRACCs require flat and lock washer.
TRACC

Attenuator Inspection

Foundation Anchoring

Check the tightness of anchor hardware.
TRACC

Attenuator Inspection

Galvanized Steel Components
TRACC

Attenuator Inspection

Galvanized Steel Components

Units will have 1 to 4 rip plate stages.

Inspect for rip plate damage.
CRACC

Attenuator Inspection

Galvanized Steel Components

Overhead of base w/ rip plates installed

- TL-2 UNIT
  - 2ea Base Assembly
- TL-3 UNIT
  - 3ea Base Assembly
- TL-3+ UNIT
  - 4ea Base Assembly
Crash Cushions – Installation of Common Products

TRACC

Attenuator Inspection
Galvanized Steel Components

Look for damaged rip plates
TRACC

Attenuator Inspection
Galvanized Steel Components

A. Nosepiece
B. Sled
C. Frames
D. Fender Panels
CRASH CUSHIONS – INSTALLATION OF COMMON PRODUCTS

TRACC
Attenuator Inspection
Galvanized Steel Components

Sled slides on impact
Cutter bar slices thru rip plate
Friction slows vehicle

Florida Department of Transportation
TRACC

Attenuator Inspection
Galvanized Steel Components

Look for bent components...
Check for missing components
CRASH CUSHIONS – INSTALLATION OF COMMON PRODUCTS

TRACC

ATTENUATOR INSPECTION

Hardware

- Install 4 L-Brackets per TRACC Unit
- Install Barrier Straps per FDOT Design Standard Index 415

FLORIDA DEPARTMENT OF TRANSPORTATION
Crash Cushions – MOT Process Review Findings

In this section, we will take a look at some common issues with Crash Cushion installation found during MOT Process Reviews.
Common MOT Process Review Findings

Crash cushion cartridge is damaged/crushed –
Replace damaged cartridges per manufacturer’s requirements.
Common MOT Process Review Findings

Crash cushion nose support missing – Nose support is required per the manufacturer’s installation manual.
Loose nuts on anchor bolts for crash cushions installed on concrete – APL Vendor Drawing require 120 ft/lbs.
Debris/above ground hazard in clear zone – Index 600 requires 30 foot clear zone (runout) for 60-70 mph. The stockpiled debris is between the departure line and the clear zone, which shall be free of hazard.
Crash cushion foundation thickness questionable on shoulder – APL Vendor Drawings require minimum of 6 inches of asphalt.
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