To: SUPERSEDED BY EB 06-057 EFFECTIVE 5/3/07		*New York State Department of Transportation* ENGINEERING INSTRUCTION	EI 04-004
Title: **Impact Attenuator, Thrie Beam Type with Expendable Modules (Tau II)**			
Distribution: ☐ Manufacturers (18) ☑ Local Govt. (31) ☑ Agencies (32) ☐ Surveyors (33) ☑ Consultants (34) ☑ Contractors (39) ☐ _____( )		Approved: Philip J. Clark, P.E., Deputy Chief Engineer Design Division	02/17/04 Date

ADMINISTRATIVE INFORMATION:

- Effective Date: This Engineering Instruction (EI) is effective with projects submitted for the letting of September 9, 2004.
- Superseded Issuances: No issuances are hereby superseded.
- Disposition of Issued Materials: The revisions included in the attached shelf note will be included in the next revision of the *Standard Specifications, January 2, 2002*. The Interim Design Guidance will be included in the next revision to Chapter 10 of the *Highway Design Manual*.

PURPOSE: This instruction issues new Standard Specification Section 712-21 Impact Attenuator, Thrie Beam Type with Expendable Modules, revises Section 654 Impact Attenuators, and provides interim design guidance for the use of the new items created.

TECHNICAL INFORMATION:

- **New Interim Guidance.** Barrier Systems Inc. manufactures the proprietary Tau II system that represents 712-21 Impact Attenuator, Thrie Beam Type with Expendable Modules. Details of the Tau II, including drawings of the crash tested systems and recommended design configurations, are available on the Internet at http://safety.fhwa.dot.gov/fourthlevel/hardware/term_cush.htm (FHWA letter, codes CC-75, CC-75A and CC-75B). The following are some design considerations:
  - These impact attenuators may be used in a parallel configuration to protect objects up to 700 mm wide. Flared transitions may be used to treat wider objects up to 2440 mm and a 110 km/h configuration is available to treat objects up to 2600 mm.
  - These attenuators are available in several configurations up to 12 bays. The systems are designed for impact velocities up to 110 km/h. They are considered to meet all pertinent NCHRP 350 evaluation criteria and are federally approved for use on the NHS. The 10-bay unit was successfully tested to a modified NCHRP 350 test 3-31 (head-on impact) at 112.6 km/h. The overall length of the 4-bay, Test Level 2 unit is 4.7 m. The length increases by approximately 0.9 m (0.885 m actual) for each additional bay (refer to table below). Additional lengths may be needed for transitions or for the concrete backup structure.
  - Units may be installed as "stand-alone" or may transition to safety-shape concrete barriers, thrie beam, or the standard corrugated beam (using an intermediate thrie beam transition).
  - The following table provides the manufacturer's recommended parallel unit configurations for several design speeds, its corresponding length and Contractor cost. These costs are based on data provided by the downstate distributor for units provided with a steel backstop. For units using a concrete back up structure, base costs need to be increased by the cost of the backup structure and reduced by the cost of the steel backup. Steel backup estimates for parallel units are $2,500 for the 10-bay unit and $1,500 for the others.

Designers need to recognize this is only the distributor's pricing for the parallel units and will need to include additional costs in their estimates including installation and markup.

	Design Speed (km/h)				
	70	80	90	100	110
# of Bays	4	5	7	8	10
Length, m	4.7	5.6	7.3.	8.2	10.0
Contractor Cost	$10,000	$11,500	$14,500	$16,000	$20,000

- Any curbing from the backup structure to a point 15 m in front of the unit must either be reduced in height to 100 mm or less or removed, preferably the latter.
- On the nonapproach traffic side of bidirectional highways, the backup structure must not protrude beyond the article being protected by the impact attenuator. The specifications require transitions on the nonapproach side to avoid snagging of the backup structure.
- The plans should clearly identify the required transition to guide rail, concrete barrier, or concrete backup. The transition and/or concrete backup are included in the item for payment. Note: The lengths above do not include the necessary transition or concrete backup structure lengths.
- Cross slopes of up to 1 on 12 may be tolerated. Differential cross slope (twist) from front to back may not exceed two percent.
- Additional design guidance may be obtained from the manufacturer and vendors.

- **Policy.** Policy concerning Impact Attenuators for permanent installations is described in the Highway Design Manual, Chapter 10. Note that Chapter 10 does not yet include the new proprietary attenuating systems announced by EI since its latest revision. Those "New Specifications" under "Implementation" identified with an asterisk (*) are proprietary and require justification for their use. The following information may be useful in making these justifications:
  - When objects 610 mm or less in width need impact attenuators, five types are available. These are the thrie beam type described herein, the quadbeam type, the HDPE cylinder type, the corrugated beam type with metal tearing strips, and the sand barrels. Of the five, only sand barrel arrays are nonproprietary.
  - To avoid 'coffin-corner' impacts, sand barrel arrays are desirably 1.8 m wider than the protected object in gores and other situations where approaching traffic may pass on both sides of the unit.
  - Sand barrels may require more frequent maintenance as they are more easily damaged by minor impacts, such as snow-plow brushings.
  - Beam-style and HDPE cylinder-type, impact attenuators provide good redirection in side impacts, and therefore would be good choices if side hits are the more likely hits. Impacts on the sides of sand barrel arrays may result in vehicle capture and higher occupant-impact decelerations.
  - Beam-styles require only moderate replacement of parts on impact, but nonetheless, more than would be required for the HDPE cylinder-type.
  - Because of rebound, the HDPE cylinder-type may not provide as good post-collision trajectories on head-on impacts as beam-types, but should prove to need less maintenance and have more "uptime" than other types.
  - The HDPE cylinder-type and beam-style units require foundations and back up structures. Sand barrel arrays require neither.

- **Other Information.** The vendor should be contacted if drainage units, buried culverts, or expansion joints are present at the installation location and they cannot be relocated.
- **Actions (by particular units).** EICs should provide shop drawings, and copies of installation and maintenance manuals to the Residency that will be responsible for maintaining the units.
- **Cost Impact.** We expect there will be a minimal cost impact as a result of this instruction. Some projects may experience lower unit bid prices due to the increase in competition.

IMPLEMENTATION:

- Designers may include the new specifications items in proposals submitted for lettings with an effective date of September 9, 2004, or later.
- Disapproved Specifications. None.
- New Specifications (* indicates the specification is proprietary (refer to Policy)).

*Item 654.40xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, New Foundation Slab
*Item 654.41xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Existing Foundation
Item 654.42 M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Remove and Dispose
Item 654.43 M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Remove and Store
Item 654.44xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Relocate to & Construct New Foundation Slab
Item 654.45xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Relocate to Existing Foundation
Item 654.46xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Refurbish

xx = width class; 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96 yy = number of bays; 03-12

TRANSMITTED MATERIALS: A shelf note covering revisions to the Standard Specifications is attached.

BACKGROUND: A number of impact attenuators were included in the 2002 edition of the *Standard Specifications*. They include the HDPE cartridge, quadbeam, corrugated beam, and sand barrel arrays. Each has slightly different means of attenuating impacts; HDPE cartridges are integrated with anchored guide cables; quadbeam type uses expendable cartridges; corrugated beam type uses metal tearing strips; and the barrel arrays contain loose sand.

A thrie beam-type system recently passed NCHRP 350 testing and is now available. This unit makes use of expendable cartridges within an anchored cable guiding system to attenuate impacts. As the thrie beam type impact attenuators had not been successfully crash tested to NCHRP 350 TL-3 at the time HDM Chapter 10 was issued or revised, the HDM includes no policy information pertaining to the thrie beam-type attenuator.

VENDOR: Vendor information for the TAU II may be obtained directly from Barrier Systems, Inc.

Barrier Systems, Inc
180 River Road
Rio Vista, California, 94571

Internet: www.barriersystemsinc.com.

Contact: Ron Keener (888) 800-3691

CONTACT: Marc Connolly, Design Quality Assurance Bureau, Room 5-410, (518) 457-5440 or by e-mail at mconnolly@dot.state.ny.us.

Impact Attenuator, Thrie Beam Type with Expendable Modules

Make the following changes to the **STANDARD SPECIFICATIONS of January 2, 2002.**

In Volume II,
Page 6-169, between lines 35 and 36. (§654-2) ***add*** the following:
Impact Attenuator, Thrie Beam Type with Expendable Modules 712-21

Page 6-171, line 18 ***delete*** the entire subheading (§654-3.05) and ***replace*** with the following:
654-3.05 Impact Attenuator, Thrie Beam Type or Quadbeam Type with Expendable Modules.

Page 6-171, line 21 (§654-3.05) ***delete*** the words "Quad Beam" and ***replace*** with "Thrie Beam Type or Quadbeam".

Page 6-171, lines 25 thru 29, ***delete*** entire paragraph (2nd paragraph under 654-3.05) and ***replace*** with the following:

The manufacturer's steel backup assemblies shall be used, except when protecting concrete piers, concrete parapets, concrete walls, or other rigid objects. In these excepted cases, either the manufacturer's steel backup assembly or the manufacturer's recommended concrete backup assembly may be used at the option of the Contractor, unless directed otherwise on the plans or by the Engineer. The Contractor shall furnish and install the appropriate standard transition piece. If there is no appropriate standard transition piece available, a manufacturer's approved special transition piece shall be furnished and installed."

Page 6-175, after line 3 (§654-5, list of pay items.) ***add*** the following:

654.40xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, New Foundation Slab	Each
654.41xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Existing Foundation	Each
654.42 M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Remove and Dispose	Each
654.43 M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Remove and Store	Each
654.44xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Relocate to & Construct New Foundation Slab	Each
654.45xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Relocate to Existing Foundation	Each
654.46xxyy M	Impact Attenuator, Thrie Beam Type w\Expendable Modules, Refurbish	Each

xx = width class; 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96 yy = number of bays; 03-12

In Volume III, after Page 7-143, Line 40. (Following §712-20), ***add the following:***

712-21 IMPACT ATTENUATOR, THRIE BEAM TYPE WITH EXPENDABLE MODULES

SCOPE. Impact Attenuators, Thrie Beam Type With Expendable Modules are manufactured, NCHRP 350 crash tested products intended for the protection of objects having widths of up to 2.6 m. These attenuators are configured with a varying number of bays (4-12), and may transition to vertical walls, safety-shape concrete barriers, thrie beam corrugated barrier, and corrugated beam (when using an intermediate thrie beam transition).

MATERIAL REQUIREMENTS. Each Impact Attenuator, Thrie Beam Type with Expendable Modules shall contain all external and internal parts necessary to give satisfactory performance at the indicated site. Components shall meet the following requirements:

Modules. The module shall be Type A and Type B and shall be of the number and arrangement indicated by the manufacturer for the intended application. The modules shall be manufactured from a weather-resistant, high-density, cross-linked, polyethylene plastic material. The modules shall be designed to collapse under a manufacturer-defined critical loading consistent with the designed system requirements.

Front Support and Diaphragms. The diaphragms and front supports shall be rectangular frame structures constructed of ASTM A36 M steel C 75 x 7 channels, or equal. They shall include centrally-located, horizontal

and vertical cross bracing. They shall have provisions to retain and support the modules.

A. Diaphragms. The top width of each interior diaphragm shall vary based on the design configuration and shall include 13 mm lips on both sides to reduce fender panel ride up during and immediately after an impact. Attached to the bottom horizontal support channel shall be two support legs connected to a ski-shaped base plate with turned up ends. The diaphragms shall include cable guide mounts for the anchor cables.

B. Front Support. The top width of the front support shall vary based on the design configuration. Two rubber or polyurethane support legs shall be attached to the bottom horizontal channel

Fender Panels. Fender panels shall be fabricated from 10-gage, steel thrie beam guide rail sections. Each fender panel shall be factory drilled and slotted for field assembly. The front end shall be fastened to a diaphragm using 20 mm stainless steel hex bolts. The back end of each thrie beam fender panel shall overlap and be connected to the fender panel of the next bay using sliding mushroom bolts inserted through the long horizontal slot in the forward fender panel and the short vertical slot in the overlapped fender panel, thus permitting movement, front to back, of one set of fender panels relative to the panels in the following bay. The rear panel is fixed to the rear support using a through bolt connection, through a 150 mm diameter, 6 mm thickness, steel pipe with cut out conical sections on the front end.

Cable. Two cables, of the length required for the particular installation according to the manufacturer's instructions, shall provide tension in the system to support the diaphragms and guide them during and immediately after impact. The cables shall be 25 mm diameter steel wire rope, galvanized in accordance with ASTM A603. Both cable ends shall have steel reinforcement eyes formed using a swaged steel connector. A threaded eye bolt shall be connected to one of these eyes during its fabrication for field connection to the rear anchor lugs. The cable tension is adjusted by rotating the nut attached to this bolt.

Front Anchor Plate. The front cable anchor shall consist of a rectangular ASTM A36 steel plate, 25 mm thickness, 508 mm x 305 mm, with welded 100 mm lugs to connect to fasteners to cables. Eight holes, four along each longitudinal edges, shall be provided to accept anchor bolts.

Rear Diaphragm. The rear diaphragm shall be constructed of fabricated C 75 x 7 channels, or equal, with both horizontal and vertical bracing. The height shall be approximately 800 mm. The width of the support will vary based on the design configuration.

The diaphragm shall be attached to the rear support structure in accordance with the manufacturer's drawings.

Rear Support Structure and Cable Anchorage for Transitions to Concrete Barriers and Concrete Structures. When the attenuator is transitioned to a concrete barrier, the barrier may provide rear structural support. In such a case, the cables shall be anchored to a built-up steel plate connection bolted to the barrier. The transition to the concrete barrier shall be in accordance with the manufacturer's details. The attenuating system shall be in accordance with the manufacturer's details when protecting concrete piers, concrete parapets, concrete walls, or other rigid objects.

Rear Anchor Plate and Backstop. For designs using steel backup structure, the fabricated steel support structure shall be as detailed on the manufacturer's drawings.

Nose Cover. The nose cover shall be made from a polyurethane material of the color indicated in the contract documents. The cover shall be bolted to the front support.

Metal Work. All metal work, except transition panels, shall be fabricated from ASTM A36M steel. After fabrication, all metal work shall be hot-dip galvanized in accordance with §719-01 Galvanized Coatings and Repair Methods. Welding shall be in accordance with the *New York State Steel Construction Manual.*

Fasteners. All bolts shall be ANSI Standard Regular Bolts, unless indicated otherwise in the plans.

A. Anchor Bolts. Anchor bolts shall be 20 mm diameter, ASTM A193, Grade B7 grouted into the concrete slab with polyester grout. The length of the anchor bolts shall be 210 mm for installations.

B. Front Cable Fastener. A shackle with screw pin shall attach the cable to the front anchor.

Transitions. Transition panels shall be standard AASHTO fabricated panels from steel conforming to ASTM A36 M and hot-dip galvanized in accordance with ASTM A123. Transitions can be made directly to thrie beam guide rail; to corrugated beam using a thrie beam transition to corrugated beam; and to safety-shape concrete barrier and vertical walls using an additional thrie beam section and a thrie beam bridge shoe.

Reflectorization. Reflectorization, consisting of Class B (High-Intensity) sheeting conforming to §730-05 directly applied to aluminum sheeting, shall be affixed to the nose cover of the Thrie Beam Type Impact Attenuator. Aluminum sheeting shall be 6061T6, 0.81mm thick. The pattern and color of the reflectorization shall be as indicated in the contract documents.

If no pattern is provided, the pattern shall be approximately square, 450 mm on a side. Whenever approaching traffic is allowed to pass on both sides of the unit, the pattern shall be upward-pointing chevrons formed with alternating 100 mm reflectorized stripes and black opaque nonreflectorized stripes. When traffic will be permitted on only one side, the pattern shall be diagonal 100 mm stripes, downward pointing to the side traffic is to be permitted, formed as indicated above. Unless otherwise noted, the color shall be yellow.

BASIS OF ACCEPTANCE. Impact Attenuator, Thrie Beam Type With Expendable Modules will be accepted at the site of the work on the basis of appearance of the product on the Approved List, conformance of the delivered article with the manufacturer's drawings, and the manufacturer's certification that the product delivered is in conformance with these specifications.