CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

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723.01 SCOPE

This specification covers the requirements for the installation of permanent and temporary energy attenuators and relocation of temporary energy attenuators.

723.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be according to the Contract Documents.

723.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

723.02 REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314 Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 510 Removal
OPSS 705 Flexible Delineator Posts
OPSS 740 Concrete Barriers
OPSS 904 Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A780/A780M-20	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D4956-19	Retroreflective Sheeting for Traffic Control
F3125/F3125M-19e2	High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

723.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Dual Duty means a new high exposure energy attenuator that is supplied and installed in a temporary configuration during construction, temporarily relocated as required, and then relocated to its permanent location prior to the end of the Work.

High Exposure means an energy attenuator that is installed in a location where the risk of impact is expected to be high such as in gore areas at exit ramps and express - collector transfers.

Reduced Exposure means a temporary energy attenuator that is installed in a location where the risk of impact is expected to be low. These energy attenuators should be specified in a location where they will be required for short duration of less than four months, are frequently relocated, and where they are not required during seasonal shutdown.

723.04 DESIGN AND SUBMISSION REQUIREMENTS

723.04.01 Design Requirements

The energy attenuator manufacturer shall complete the design of any non-standard details (e.g., a connection or transition to a rigid object other than a concrete barrier or temporary concrete barrier) at locations specified in the Contract Documents.

723.04.02 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings shall be submitted to the Contract Administrator.

Installation of the energy attenuator shall not commence until the Contract Administrator has received the copy of the instructions and Working Drawings.

723.04.02.01 Submission Requirements for Non-Standard Details

Three copies of Working Drawings, prepared by the manufacturer, for any non-standard details shall be submitted to the Contract Administrator prior to the commencement of construction. The Working Drawings shall show full details of the materials and installation procedures. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents. The submission of Working Drawings shall be accompanied by three copies of a letter that has been signed by the manufacturer, on company letterhead, summarizing the details of the proposed design.

Installation of the energy attenuator shall not commence until the Contract Administrator has received and accepted the copy of the letters and Working Drawings.

723.05 MATERIALS

723.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

723.05.02 Energy Attenuator Systems

The names of systems acceptable for the Energy Attenuator - Permanent items are shown in Table 1.

The names of systems acceptable for the Energy Attenuator - Temporary items are shown in Table 2.

The Contractor shall have the option of supplying and installing any of these approved systems shown for the appropriate tender item.

When a specific energy attenuator system is specified in the Contract Documents, there shall not be an option of substitution for the energy attenuator system.

723.05.03 Concrete

Concrete for pads and anchor blocks shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

723.05.04 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

723.05.05 Anchor Bolts

Anchor bolts shall be supplied and installed according to energy attenuator manufacturer recommendations.

723.05.06 Bolts for Connection of BB-BEAT System to Concrete Barrier

Bolts used to connect the BB-BEAT system to the concrete barrier shall be according to ASTM F3125 and shall be hot dip galvanized according to ASTM A123.

723.05.07 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A123.

723.05.08 Flexible Delineator Posts

Flexible delineator posts shall be according to OPSS 705. The post colour shall be orange.

723.05.09 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D4956, Type IV; white colour; and to the dimensions specified in the Contract Documents.

723.05.10 Reuse of Materials

Notwithstanding subsection GC 5.02, Quality of Material, paragraph 01 of the General Conditions of Contract, the reuse of materials is permitted for temporary energy attenuator installations and relocations, provided the components have not been damaged to affect the safety performance of the system.

723.07 CONSTRUCTION

723.07.01 General

Permanent and temporary energy attenuators shall be installed according to manufacturer's instructions at locations specified in the Contract Documents. A reference for energy attenuator Contract Drawing Notation is shown in Table 3.

Energy attenuators shall not be placed on surfaces with a crossfall greater than 6%.

723.07.01.01 Foundation for TAU-M Systems

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the TAU-M energy attenuator for permanent and temporary installations. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts. Braces and anchoring for asphalt shall be used when the TAU-M system is installed on asphalt over granular according to manufacturer's specifications.

723.07.02 Permanent Installation

723.07.02.01 New Concrete Pads

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad. The concrete pad shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904.

The granular base below new concrete pads shall be a minimum depth of 150 mm of existing or new Granular A and shall be according to OPSS 314.

723.07.02.02 Existing Concrete Surfaces and Pads

When specified in the Contract Documents, existing 200 mm thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.02.03 Connection of BB-BEAT and QuadTrend Systems to Concrete Barrier

When the BB-BEAT or QuadTrend system is connected to new concrete barrier, the adjacent 4.0 m of concrete barrier shall be according to OPSS 740 and the Contract Documents.

When the BB-BEAT or QuadTrend system is connected to existing concrete barrier, the adjacent 4.0 m of existing concrete barrier shall be removed according to OPSS 510 and a new 4.0 m section of concrete barrier shall be installed according to OPSS 740 and the Contract Documents.

723.07.02.04 Rear Cable Anchor Blocks for QuadTrend Systems

Rear cable anchor blocks shall be as specified in the Contract Documents. In both earth and rock fills, rear cable anchor blocks shall be placed on slopes 3H:1V or flatter. The cable supplied with the unit shall be used to determine the proper location of the rear cable anchor block.

In porous or crumbly soils, forms for cast-in-place anchor blocks shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

The top of the concrete block shall be flush with the embankment slope and the rear cable anchor assembly shall not protrude more than 100 mm above ground.

723.07.02.05 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

723.07.02.06 Posts for BB-BEAT Systems

All posts shall be set to the alignment specified in the Contract Documents, regardless of the material encountered. Permissible tolerance for plumb shall be 20 mm maximum over the post length above the ground. The driving of posts shall be accomplished with methods and equipment that leave the posts free of distortion, burring, and any other damage.

All lower end posts shall be installed so that not more than 100 mm is exposed above finished grade.

723.07.03 Temporary Installation

723.07.03.01 New Concrete Pads

The concrete pad shall be as specified by the manufacturer.

723.07.03.02 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.03 Asphalt Over Concrete

Existing or new 75 mm minimum thick asphalt over 75 mm minimum thick concrete pavement may be used to support the energy attenuator.

723.07.03.04 Asphalt Over Compacted Granular

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the energy attenuator. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts.

723.07.03.05 Reduced Exposure

When water filled energy attenuator systems are in use, the temperature shall be monitored on a daily basis. When the temperature is predicted to fall below freezing, antifreeze agents according to manufacturer recommendations shall be added to the water. The use of a water filled energy attenuator system when frozen is not permissible.

Water filled energy attenuator systems shall not be left in place during a seasonal shutdown period without approval from the Contract Administrator. When approval from the Contract Administrator is not granted, water filled energy attenuator systems shall be replaced with another approved energy attenuator listed for the reduced exposure tender item for the duration of the seasonal shutdown period.

Disposal of liquid materials shall be managed according to the Contract Documents.

723.07.03.06 Dual Duty

A new high exposure energy attenuator shall be supplied and installed in a temporary configuration during construction at the locations specified in the Contract Documents.

723.07.03.07 Relocation

Temporary energy attenuators, object markers, oversize snowplow markers, object marker posts, and flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchor bolts and mounting hardware.

Prior to completion of the Contract, dual duty energy attenuators and associated object markers, oversize snowplow markers, and object marker posts including the replacement of anchor bolts and mounting hardware, shall be relocated to their permanent locations as specified in the Contract Documents and in accordance with the General and Permanent Installation subsections.

723.07.03.08 Permanent and Temporary Concrete Barriers

Temporary concrete barriers shall be modified and installed as specified in the Contract Documents and the modified surfaces shall be smooth. Temporary concrete barriers shall be anchored as specified in the Contract Documents.

Permanent existing concrete barriers shall be modified as specified in the Contract Documents and the modified surfaces shall be smooth.

723.07.04 Delineation

723.07.04.01 Object Markers and Oversize Snowplow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snowplow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snowplow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90° from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snowplow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations specified in the Contract Documents.

723.07.04.02 Flexible Delineator Posts

Flexible delineator posts shall be installed according to OPSS 705 at locations specified in the Contract Documents.

723.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

723.09 MEASUREMENT FOR PAYMENT

723.09.01 Actual Measurement

723.09.01.01

Energy Attenuator - Permanent, Narrow
Energy Attenuator - Permanent, Wide
Energy Attenuator - Permanent, Extra Wide
Energy Attenuator - Permanent, Super Wide
Energy Attenuator - Permanent, High Exposure
Energy Attenuator - Permanent, Single-Sided
Box Beam Bursting Energy Absorbing Terminal System - Permanent
Quadguard M10 System - Permanent
Quadguard Wide System - Permanent
Quadguard M10 Wide System - Permanent
Quadguard Extra Wide System - Permanent
Quadguard Super Wide System - Permanent
QuadTrend System - Permanent
Smart System - Permanent
TAU-M System - Permanent
TAU-II Wide System - Permanent
TAU-II Extra Wide System - Permanent
Hercules System - Permanent

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed.

723.09.01.02

Energy Attenuator - Temporary, Narrow
Energy Attenuator - Temporary, Wide
Energy Attenuator - Temporary, Extra Wide
Energy Attenuator - Temporary, Super Wide
Energy Attenuator - Temporary, Reduced Exposure
Energy Attenuator - Temporary, Dual Duty
ABSORB 350 System - Temporary
ABSORB-M System - Temporary
ACZ-350 System - Temporary
Quadguard M10 System - Temporary
Quadguard Wide System - Temporary
Quadguard Extra Wide System - Temporary
Quadguard Super Wide System - Temporary
SLED System - Temporary
Smart System - Temporary
TAU-M System - Temporary
TAU-II Wide System - Temporary
TAU-II Extra Wide System - Temporary
Hercules System - Temporary

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed and removed, up to the maximum number of systems required to be in place at any one time during the Contract.

723.09.01.03

Energy Attenuator - Relocation, Narrow
Energy Attenuator - Relocation, Wide
Energy Attenuator - Relocation, Extra Wide
Energy Attenuator - Relocation, Super Wide
Energy Attenuator - Relocation, Reduced Exposure
Energy Attenuator - Relocation, Dual Duty

ABSORB 350 System - Relocation
ABSORB-M System - Relocation
ACZ-350 System - Relocation
Quadguard M10 System - Relocation
Quadguard Wide System - Relocation
Quadguard Extra Wide System - Relocation
Quadguard Super Wide System - Relocation
SLED System - Relocation
Smart System - Relocation
TAU-M System - Relocation
TAU-II Wide System - Relocation
TAU-II Extra Wide System - Relocation
Hercules System - Relocation

For measurement purposes, a count shall be made of the number of complete energy attenuator systems relocated. Systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

723.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

723.10 BASIS OF PAYMENT

723.10.01

Energy Attenuator - Permanent, Narrow - Item
Energy Attenuator - Permanent, Wide - Item
Energy Attenuator - Permanent, Extra Wide – Item
Energy Attenuator - Permanent, Super Wide – Item
Energy Attenuator - Permanent, High Exposure - Item
Energy Attenuator - Permanent, Single-Sided - Item
Box Beam Bursting Energy Absorbing Terminal System - Permanent - Item
Quadguard M10 System - Permanent - Item
Quadguard Wide System - Permanent - Item
Quadguard M10 Wide System - Permanent - Item
Quadguard Extra Wide System - Permanent - Item
Quadguard Super Wide System - Permanent - Item
QuadTrend System - Permanent - Item
Smart System - Permanent - Item
TAU-M System - Permanent - Item
TAU-II Wide System - Permanent - Item
TAU-II Extra Wide System - Permanent - Item
Hercules System - Permanent - Item
Energy Attenuator - Temporary, Narrow - Item
Energy Attenuator - Temporary, Wide - Item
Energy Attenuator - Temporary, Extra Wide - Item
Energy Attenuator - Temporary, Super Wide - Item
Energy Attenuator - Temporary, Reduced Exposure - Item
Energy Attenuator - Temporary, Dual Duty - Item
ABSORB 350 System - Temporary - Item
ABSORB-M System - Temporary - Item
ACZ-350 System - Temporary - Item
Quadguard M10 System - Temporary - Item
Quadguard Wide System - Temporary - Item

Quadguard Extra Wide System - Temporary - Item
Quadguard Super Wide System - Temporary - Item
SLED System – Temporary - Item
Smart System - Temporary - Item
TAU-M System - Temporary - Item
TAU-II Wide System - Temporary - Item
TAU-II Extra Wide System - Temporary - Item
Hercules System - Temporary - Item
Energy Attenuator - Relocation, Narrow - Item
Energy Attenuator - Relocation, Wide - Item
Energy Attenuator - Relocation, Extra Wide - Item
Energy Attenuator - Relocation, Super Wide - Item
Energy Attenuator - Relocation, Reduced Exposure - Item
Energy Attenuator - Relocation, Dual Duty - Item
ABSORB 350 System - Relocation - Item
ABSORB-M System - Relocation - Item
ACZ-350 System - Relocation - Item
Quadguard M10 System - Relocation - Item
Quadguard Wide System - Relocation - Item
Quadguard Extra Wide System - Relocation - Item
Quadguard Super Wide System - Relocation - Item
SLED System - Relocation - Item
Smart System - Relocation - Item
TAU-M System - Relocation - Item
TAU-II Wide System - Relocation - Item
TAU-II Extra Wide System - Relocation - Item
Hercules System - Relocation - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor’s responsibility at no additional cost to the Owner.

TABLE 1
Energy Attenuator, Permanent

Energy Attenuator	NCHRP Report 350 or AASHTO MASH Crash Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single-Sided (SS)
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Quadguard M10 System (Note 1)	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System (Note 3)	Yes	Yes	No	Yes	No	No	No	No
Quadguard M10 Wide System (Notes 1 and 2)	No	Yes	No	Yes	No	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Super Wide System	No	Yes	No	No	No	Yes	No	No
QuadTrend	No	Yes	No	No	No	No	No	Yes
Smart System	Yes	Yes	Yes	No	No	No	Yes	No
TAU-M System (Note 1)	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Hercules System (Note 1)	No	Yes	Yes	No	No	No	No	No

Notes:

1. AASHTO MASH crash test compliant system.

2. The Quadguard M10 Wide (meeting AASHTO MASH TL-3) shall be used for Permanent Unidirectional configurations requiring a TL-3 crash test compliant system. For Permanent Unidirectional configurations requiring a TL-2 crash test compliant system and for all Bidirectional configurations of Energy Attenuator, Wide, systems listed on Table 1 and meeting NCHRP Report 350 shall be used.

3. Bidirectional only.

TABLE 2
Energy Attenuator, Temporary

Energy Attenuator	NCHRP Report 350 or AASHTO MASH Crash Test Level		Temporary Installation					
	TL-2	TL-3	Reduced Exposure (RE) (Note 2)	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	Dual Duty (DD)
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
ABSORB-M System (Note 1)	Yes	Yes	Yes	No	No	No	No	No
ACZ 350 System	Yes	Yes	Yes	No	No	No	No	No
Quadguard M10 System (Note 1)	Yes	Yes	No	Yes	No	No	No	No
Quadguard Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
Quadguard Super Wide System	No	Yes	No	No	No	No	Yes	No
SLED System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
TAU-M System (Note 1)	Yes	Yes	No	Yes	No	No	No	No
TAU-II Wide System	Yes	Yes	No	No	Yes	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
Hercules System (Note 1)	No	Yes	No	Yes	No	No	No	No

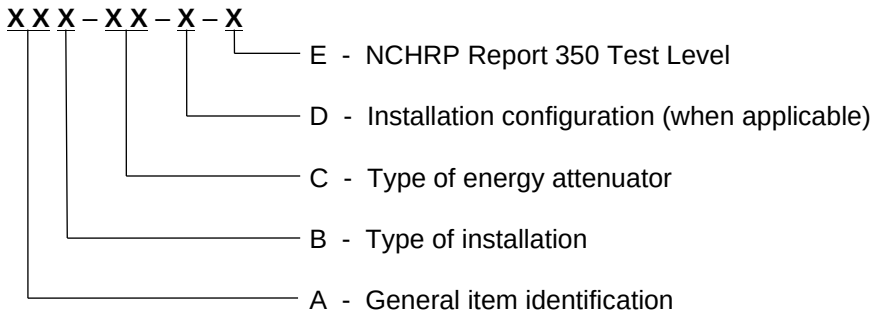
Notes:

1. AASHTO MASH crash test compliant system.

2. ABSORB 350 energy attenuator system shall be used when Movable Temporary Concrete Barrier is specified.

TABLE 3
Contract Drawing Notation

A	**EA** - Energy Attenuator
B	**P** - Permanent **T** - Temporary **R** - Relocation
C	**NA** - Narrow **WI** - Wide **EW** - Extra Wide **SW** - Super Wide **HE** - High Exposure **SS** - Single-Sided **RE** - Reduced Exposure **DD** - Dual Duty
D	**U** - Unidirectional **B** - Bidirectional **N** - Not applicable
E	**2** - NCHRP Report 350 TL-2 **3** - NCHRP Report 350 TL-3



Appendix 723-A, November 2021
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

The designer should specify the following in the Contract Documents:

- Energy attenuator system locations using the notation shown in Table 3. (723.07.01)

- Relocation of energy attenuators using the notation shown in Table 3. (723.07.01 and 723.07.03.06)

The designer should specify whether each system is TL-2 or TL-3 configuration. TL-2 configurations are required for low-speed installations with posted speeds of less than 70 km/h. TL-3 configurations are required for high-speed installations with posted speeds of 70 km/h and greater. Single-sided systems are only available in a TL-3 configuration. (723.07.01)

A permanent energy attenuator installation should include a new concrete pad (723.07.02.01). If an existing concrete surface or pad can be used to support the system, it should be specified in the Contract Documents (723.07.02.02). The designer should confirm that the existing concrete surface or pad is in good condition and will provide a smooth operating surface for the system.

The designer should confirm that one of the following foundation options is available for each temporary energy attenuator installation (723.07.03):

a) Existing concrete surface:
   - minimum 200 mm deep, 28 MPa minimum compressive strength

b) Asphalt over compacted granular:
   - minimum 150 mm asphalt over 150 mm minimum compacted granular
   - the asphalt must extend a minimum of 500 mm beyond the anchor bolts

c) Asphalt over concrete
   - minimum 75 mm asphalt over 75 mm minimum concrete, 28 MPa minimum compressive strength

The designer should confirm that the existing surface is in good condition and will provide a smooth operating surface for the system.

When a single-sided system is connected to existing concrete barrier as specified in the Contract Documents, the designer should include payment in the Contract Documents for the removal of the 4.0 m section of existing concrete barrier and placement of a new 4.0 m section adjacent to each system. (723.07.02.03)

Single-sided systems shall be installed with grading according to OPSD 202.033. Single-sided systems should not be installed in a location where backside hits towards the concrete barrier are possible (e.g., in gore areas), or in a narrow median where backside opposite direction hits are possible. The area behind and beyond the end terminal should be traversable and free of fixed objects. The minimum recommended rectangular area should be 6 m wide, measured behind and perpendicular to the back of the rail, by 22 m long, measured from the front face of the system and parallel to the system.
(723.07.02.03)

Appendix 723-A

When the reduced exposure tender item is selected, the designer should confirm that the following requirements for water filled energy attenuator systems are satisfied (723.07.03.04):

a) Water filled energy attenuator systems shall be installed at an offset of not less than 1.0 m from the edge of the travelled way.

b) When installed adjacent to an existing guide rail system, the clearance shall be less than or equal to 0.3 m or greater than or equal to 3.0 m. Otherwise, the area behind and beyond the water filled energy attenuator system shall be traversable and free of fixed objects. The minimum recommended rectangular area shall be 6 m wide, measured behind and perpendicular to the back of the system, by 22 m long, measured from the front face of the system and parallel to the system.

c) At a minimum, the first 16 m of temporary concrete barrier shall be placed tangential to the water filled energy attenuator system.

When the item for payment is Energy Attenuator, the designer should not include any drawings for specific energy attenuators in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter in advance of and along the length of end treatments and crash cushions. See MTO Roadside Design Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 202.033	Roadway Widening, Single Sided Energy Attenuating Terminals, Approach End
OPSD 922.131	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Barrier
OPSD 922.133	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Pad and Rear Cable Anchor Block
OPSD 923.001	Energy Attenuator, Crash Cushion, Narrow Systems, Component - Reinforced Concrete Pad
OPSD 923.002	Energy Attenuator, Crash Cushion, Component - Anchor Assembly
OPSD 923.004	Energy Attenuator, Crash Cushion, Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.005	Energy Attenuator, Crash Cushion, Extra Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.006	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Component - Reinforced Concrete Pad
OPSD 923.007	Energy Attenuator, Crash Cushion, Quadguard M10 Wide System, Component, Reinforced Concrete Pad
OPSD 923.008	Energy Attenuator, Crash Cushion, Hercules System, Component, Reinforced Concrete Pad
OPSD 923.010	Energy Attenuator, Crash Cushion, Narrow Systems, Component – Reinforced Precast Concrete Pad for Permanent Installation
OPSD 923.011	Energy Attenuator, Crash Cushion, Component – Reinforced Precast Concrete Pad for Modified Temporary Concrete Barrier
OPSD 923.141	Energy Attenuator, Crash Cushion, Quadguard M10 Wide System, Installation – Permanent, Unidirectional
OPSD 923.187	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Permanent, Bidirectional

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OPSD 923.188	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Unidirectional
OPSD 923.189	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Bidirectional
OPSD 923.190	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Permanent, Unidirectional
OPSD 923.191	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Permanent, Bidirectional
OPSD 923.192	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Temporary, Unidirectional
OPSD 923.193	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Temporary, Bidirectional
OPSD 923.194	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Permanent, Unidirectional
OPSD 923.195	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Permanent, Bidirectional
OPSD 923.196	Energy Attenuator, Crash Cushion, Quadguard M10 System, Installation – Temporary, Unidirectional
OPSD 923.197	Energy Attenuator, Crash Cushion, Quadguard M10 System, Installation – Temporary, Bidirectional
OPSD 923.198	Energy Attenuator, Crash Cushion, Quadguard M10 System, Installation – Permanent, Unidirectional
OPSD 923.199	Energy Attenuator, Crash Cushion, Quadguard M10 System, Installation – Permanent, Bidirectional
OPSD 923.384	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Temporary, Unidirectional
OPSD 923.385	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Temporary, Bidirectional
OPSD 923.386	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Unidirectional
OPSD 923.387	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Bidirectional
OPSD 923.388	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Unidirectional
OPSD 923.389	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Bidirectional
OPSD 923.390	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Unidirectional
OPSD 923.391	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Bidirectional
OPSD 923.392	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Unidirectional
OPSD 923.393	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Bidirectional
OPSD 923.394	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Unidirectional
OPSD 923.395	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Bidirectional
OPSD 923.396	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Temporary, Unidirectional
OPSD 923.397	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Temporary, Bidirectional

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OPSD 923.398	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Permanent, Unidirectional
OPSD 923.399	Energy Attenuator, Crash Cushion, TAU-M System, Installation – Permanent, Bidirectional
OPSD 923.480	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Unidirectional
OPSD 923.481	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Bidirectional
OPSD 923.482	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Unidirectional
OPSD 923.483	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Bidirectional
OPSD 923.501	Energy Attenuator, Crash Cushion, Hercules System, Installation – Temporary, Unidirectional and Bidirectional
OPSD 923.502	Energy Attenuator, Crash Cushion, Hercules System, Installation – Permanent, Unidirectional and Bidirectional
OPSD 923.530	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Layout
OPSD 923.531	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Impact Head and Post
OPSD 924.131	Energy Attenuator, Crash Cushion, ABSORB 350 System, Installation - Temporary Concrete Barrier
OPSD 924.132	Energy Attenuator, Crash Cushion, ABSORB-M System TL-2, Installation – Temporary Concrete Barrier
OPSD 924.133	Energy Attenuator, Crash Cushion, ABSORB-M System TL-3, Installation – Temporary Concrete Barrier
OPSD 924.135	Energy Attenuator, Crash Cushion, ACZ-350 System, Installation - Temporary Concrete Barrier
OPSD 924.141	Energy Attenuator, Crash Cushion, SLED System, Installation – Temporary Concrete Barrier
OPSD 984.203	Energy Attenuator, Crash Cushion, Delineation, Installation - Temporary
OPSD 984.204	Energy Attenuator, Crash Cushion, Delineation, Installation - Permanent