



## **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 provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

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

A 123/A 123M-13	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 325-14	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 780/A 780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-13	Retroreflective Sheeting for Traffic Control

### **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 3 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.

**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 A 325 and shall be hot dip galvanized according to ASTM A 123.

**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 A 123.

**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 D 4956, 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%.

### **723.07.02 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 A 780. 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 Existing Concrete Surface**

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

##### **723.07.03.02 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.

##### **723.07.03.03 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.

##### **723.07.03.04 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.

##### **723.07.03.05 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.

##### **723.07.03.06 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.

**723.07.03.07 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**

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**

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**

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**
- 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**
- 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**

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 (EAP)**

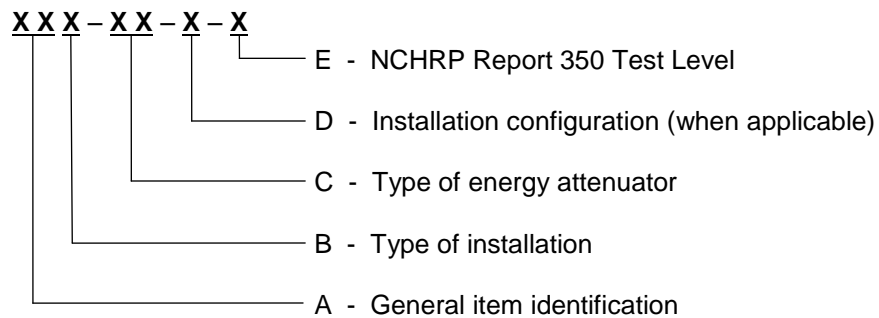
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single-Sided (SS)
TAU-II System	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard System	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System	Yes	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
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Smart System	Yes	Yes	Yes	No	No	No	Yes	No

**TABLE 2**  
**Energy Attenuator, Temporary (EAT)**

Energy Attenuator	NCHRP Report 350 Test Level		Temporary Installation					
	TL-2	TL-3	Reduced Exposure (RE)	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	Dual Duty (DD)
TAU-II System	Yes	Yes	Yes	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
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
Quadguard System	Yes	Yes	Yes	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
ACZ 350 System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
TRACC System	Yes	Yes	Yes	Yes	No	No	No	No

**TABLE 3  
Contract Drawing Notation**

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



**Appendix 723-A, November 2015  
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**

No information provided here.

**Related Ontario Provincial Standard Drawings**

No information provided here.