ATTACHMENT 10

TECHNICAL SPECIFICATIONS

for

Safety Equipment & Products for Transportation & Public Works – Comprehensive Crash Mitigation (including Attenuators, Barricades, Bridge Rails, Crash Cushions and Guide Rails) (Statewide)

IFB # 23130

GENERAL

Should updates be made to specifications by the State during the course of the contract term, contractors are expected to update products as soon as possible in accordance with the provisions of the Solicitation. No changes or substitution of products or pricing is permitted without the express approval of OGS Procurement Services.

Specification Reference Chart	
Type 1 - Galvanized Steel Posts	Section 710-14, Section 710-13, , Section 710-17, Section 710-18, Section 710-19, Section 710-20, Section 710-21, Section 710-22, Section 710-23, Section 710-26
Type 1 - Box Beam Guide Rail	Section 710-21, Section 710-24
Type 1 - Corrugated Beam Guide Rail	Section 710-17, Section 710-18, Section 710-19, Section 710-19
Type 1 - Cable Guide Rail	Section 710-22
Miscellaneous Hardware	All chapters of Section 704 and 710
Road Systems Inc. (RSI) BEAT System Series Products	See Manufacturer's Information& Section 710-17, Section 710-18, Sections 710-19,
Road Systems Inc. (RSI) SKT Series Products	See Manufacturer's Information& Section 710-17, Section 710-18, Sections 710-19,
Trinity Highway Systems Products	See Manufacturer's Information & Section 710-17, Section 710-18, Sections 710-19, Section 710-26, Section 712-06, Section 729-10, Section 729-10, Section 729-11
Gregory GMS	See Manufacturer's Information & Section 710-14, Section 710-13, , Section 710-17, Section 710-18, Section 710-19, Section 710-20, Section 710-21, Section 710-22, Section 710-23, Section 710-26
Concrete Barriers	Section 704
Energy Absorption Systems Inc. Products	See Manufacturer's Information & Section 712-06, Section 712-07, Section 712-08, Section 729-10, Section 729-11, Section 729-12
Barrier Systems Inc. Products	See Manufacturer's Information & Section 710-17, Section 710-18, Section 712-06, Section 729-10, Section 729-11, Section 729-12
SCI System Products	See Manufacturer's Information & Section 712-08, Section 729-10, Section 712-18 through 22, Section 729-11
Renco System Products	See Manufacturer's Information & Section 729-12
Scorpion Attenuator System Products	See Manufacturer's Information, Section 729-11, Section 729-12
General Purpose Barricades, Parts & Accessories	See pages 22-23/27-30 of this document (Attachment 10 – Technical Specifications)
Gregory Highway Products Attenuators	See Manufacturer's Information & Section 729-12

TECHNICAL SPECIFICATION WEBLINKS:

The complete NYS Department of Transportation Standard Specification (January 2014) may be found at https://www.dot.ny.gov/main/business-center/engineering/specifications/english-spec-repository/espec1-9-14english_0.pdf Many entries found herein are excerpted and adapted from this document. Users shall note that while the NYSDOT document is the guiding technical specification steering this procurement, these specifications herein may not be verbatim and the terms and conditions of both the main Solicitation, these specifications and any subsequent contract award supersedes all administrative guidelines that are contained within the NYSDOT Specification Publication.

Specifications regarding applied reflected sheet are herein amended universally to exclude Engineering Grade materials, limiting offerings requiring reflective material to Hi-Intensity or Diamond, Super, Ultra-High Intensity grade material or above, or equal.

Links containing the standard sheets as well as the supporting Engineering Bulletins (EB) under which they were issued for Guide and Bridge Rail and Bridge Details as well as Concrete Barriers are available on the NYSDOT Web at:
https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/standard-sheets-us/606
and
https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/bridge-detail-sheets-usc - under the Group Identification Codes beginning with the letter “R”.

These EB’s and sheets contain the complete technical specifications for Type 1 Galvanized Steel Posts, Type 1 Box Beam Guide Rail, Type 1 Corrugated Beam Guide Rail, Type 1 Cable Guide Rail 5 in this procurement

Links listing some of the proprietary needs for the procurement may be found on the NYSDOT Web at
https://www.dot.ny.gov/main/business-center/engineering/specifications/details-of-proprietary-attenuators

TABLE 1: ENERGY ABSORBING END ASSEMBLIES

Name	Preferred Attachment	Manufacturer
BEAT	Box Beam	Road Systems
WYBET	Box Beam	Trinity Industries
ET 2000/2000+	HPBO (parallel or flare)	Trinity Industries
SKT 350	HPBO (parallel or flare)	Road Systems
CAT 350	HPBO Median	Trinity Industries
Brakemaster 350	HPBO Median +	Energy Absorption Systems
REACT 350	Concrete	Energy Absorption Systems
TRACC	Concrete+	Trinity Industries
ADIEM II	Concrete+	Trinity Industries
Multipurpose Attenuators		
TAU-II	Wide and Narrow Objects	Barrier Systems /Lindsay Corporation
QuadGuard Permanent	Wide and Narrow Objects	Energy Absorption Systems
SCI-GM	Wide and Narrow Objects	Work Area Protection
Energite III	Sand Barrels	Energy Absorption Systems
MAX-Tension	HPBO	Lindsay Transportation Solutions
MSKT-MASH	HPBO	Road Systems
SoftStop	HPBO	Trinity Highway Products
X-MAS	HPBO Median	Lindsay Transportation Solutions
MAX-Tension Median	HPBO Median	Lindsay Transportation Solutions

Additional applicable manufacturer links include:
http://www.nucorhighway.com/ for Nu-Cable and Nu-Guard Products
http://www.gregorycorp.com/highway_safety.cfm for Gregory Mini-Spacer System, Truck Trailer Mounted Attenuators, etc.
http://www.entwistleco.com/defense/danville/dragnet.htm for vehicle arresting barriers.
http://www.barriersystemsinc.com/ for ASORB 350, Tau-IIR, X-Tenuator, x-Mas Median, U-Mad, and movable barriers.

NYSDOT Links:

The directory of standard sheets for Guide Rail and Concrete Barriers are available on the NYSDOT Web at:
https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/standard-sheets-us/606

The directory of appropriate standard detail sheets for Bridge Rail which are available at
https://www.dot.ny.gov/main/business-center/engineering/cadd-info/drawings/bridge-detail-sheets-usc:

Section 704 – Masonry Units

This procurement seeks Concrete Barriers, temporary and permanent as drawn in standard sheet USC 606-36, and addressed by chapter 5 of Section 704 of the general specifications.

704-05 PRECAST CONCRETE BARRIERS

This specification covers the material and quality requirements for precast concrete barrier used in highway applications, precast concrete barrier for structures, and precast temporary concrete barrier.

MATERIAL REQUIREMENTS. The Material Requirements contained in '704-03 Precast Concrete - General shall apply except as noted herein. Concrete mixtures used under this specification shall have a maximum cement content of 750 pounds per cubic yard. Unless noted otherwise in the contract documents or approved fabrication drawings, the compressive strength of concrete used in precast concrete barrier shall be as follows:

Concrete Barrier 3,000 psi (minimum) @ 28 days
Concrete Barrier for Structures 5,000 psi (minimum) @ 28 days
Temporary Concrete Barrier 3,000 psi (minimum) @ 28 days

All reinforcing steel for Concrete Barrier and Concrete Barrier For Structures shall be epoxy coated meeting the requirements of '709-04 Epoxy Coated Bar Reinforcement, Grade 60. All reinforcing steel for Temporary Concrete Barrier shall meet the requirements of '709-01 Bar Reinforcement, Grade 60.

DRAWINGS. The drawing requirements contained in '704-03 Precast Concrete - General shall apply except as noted herein. Concrete Barrier and Temporary Concrete Barrier shall use dimensions as shown on the Standard Sheets. Concrete Barrier for Structures shall use dimensions as shown on the Bridge Design (BD) Sheets.

FABRICATION. The fabrication requirements contained in '704-03 Precast Concrete - General, as well as the following shall apply:

- Cross-sectional dimensions shall not vary from the dimensions shown by more than 1/4 inch.
- Barrier shall not be out of plumb by more than 1/4 inch.
- Longitudinal dimensions shall not vary from the dimensions shown by more than 1/4 inch per 10 feet of barrier.
- When checked with a 10 foot straight edge, irregularities shall not exceed 1/4 inch.

SAMPLING AND TESTING. Sampling and testing shall be done by the precast manufacturer in accordance with Materials Bureau requirements contained in the current Materials Procedure for precast concrete.

MARKING. All precast units shall be clearly marked with permanent waterproof paint. Concrete Barrier and Concrete Barrier for Structures shall be marked on one end of each barrier segment such that they will not be exposed to view after installation.
The following information shall be included on permanent installations: Name or trademark of the manufacturer, date of manufacture, unique piece identification number.
Temporary Concrete Barriers shall be marked with “NYSDOT” in place of a contract number. In addition, each Temporary Concrete Barrier segment shall be permanently marked with a manufacturer’s identification and a date of manufacture in a manner that will remain legible throughout its service life. The date, at a minimum, shall contain the month and year.
Permanent markings shall be placed in a consistent location on the top, bottom, or one end of each segment. Imprinting the required information a minimum of 1/4 inch into the concrete surface will be considered an acceptable permanent marking. Paint will not be considered a permanent marking. If permanent markings are located on the bottom of the segment, paint markings matching the permanent markings shall be placed on one end of each segment to facilitate field inspection.

FINAL PRODUCTION INSPECTION. A final production inspection shall be performed by the precast manufacturer on every precast unit produced for the NYSDOT. An inspection will be considered satisfactory when it verifies that the precast unit is in compliance with the appropriate NYSDOT specifications. The specific requirements and procedures for the inspection are contained in the precast manufacturer’s NYSDOT approved Quality Control Plan.

SHIPPING. Upon completion of a satisfactory final production inspection the precast unit may be shipped from the manufacturing location except that units produced between the dates of October 31st and April 1st shall not be shipped for a minimum of 72 hours following the completion of casting.

BASIS OF APPROVAL. Concrete Barrier designs other than those shown on the Standard Sheets will not be approved. Concrete Barriers for Structures designs may be proposed, and if found acceptable, they will be placed on the approved list. Evidence shall be provided that the proposed anchorage system has been successfully tested in accordance with the procedural directives issued by the DCES. Temporary Concrete Barrier designs other than those shown on the Standard Sheets may be proposed, and if found acceptable, they will be placed on the approved list. Evidence shall be provided that the temporary concrete barrier, with the proposed joint system, is NCHRP 350 or MASH approved.

SECTION 710 - FENCE AND GUIDE RAIL

NOTE: Guide and Bridge Rail are covered under this procurement, Fencing by design is a form of barricade, which is covered under the scope of the procurement. Fencing, its component and accessory parts may be included in a submitted catalog.

All material must be shipped secure and furnished in a clean condition, free of all foreign material including oil, dust, film, etc. and must have a material certification as meeting or exceeding these specifications. Buy America requirements apply to all metal fencing.

710-01 ALUMINUM FENCE FABRIC

This specification covers the requirements for aluminum alloy, chain link fence fabric.

MATERIAL REQUIREMENTS: Aluminum chain link fence fabric shall conform to the requirements of AASHTO M181, Chain Link Fence, Type III, except as modified herein.

A. *Wire.* The aluminum alloy wire shall be 6061-T94 conforming to the applicable chemical composition limits of ASTM B211.

B. *Mesh Size and Wire Diameter.* The size of the mesh and the wire diameter shall be 2 inches & 9 gage (0.148 inch) respectively unless otherwise specified in the plans or proposal.

710-02 GALVANIZED STEEL FENCE FABRIC

This specification covers the requirements for galvanized steel chain link fence fabric.

MATERIALS REQUIREMENTS. Galvanized steel chain link fence fabric shall conform to the requirements of AASHTO M181, Chain Link Fence, Type I, except as modified herein.

A. *Mesh Size Coated Wire Diameter.* The size of the mesh and the coated wire diameter shall be 2 inches and 9 gauge (0.148 inch) respectively unless otherwise specified in the plans or proposal.

B. *Zinc-Coating.* The 2 inch mesh shall be galvanized with a Class D coating (2 oz/sf) by the hot-dip process after weaving. When 1 inch mesh is specified, it shall be galvanized with Class D Coating (2 oz/sf) before weaving by the electrolytic process.

710-03 VINYL COATED STEEL FENCE FABRIC

This specification covers the material requirements for Class A-Extruded Polyvinyl Chloride (PVC)-Coated Steel Fence Fabric, and Class B-Bonded Polyvinyl Chloride (PVC)-Coated Steel Fence Fabric.

MATERIAL REQUIREMENTS. Vinyl coated steel chain link fence fabric shall conform to the requirements of AASHTO M181, Chain Link Fence, Type IV, except as modified herein.

A. *Mesh Size.* The size of the mesh shall be 2 inches unless otherwise specified in the contract documents.

B. *Wire Diameter.* The wire diameter shall be as follows unless specified otherwise in the contract documents:

1. Class A- Extruded Polyvinyl Chloride (PVC)-Coated Steel shall have a 9-gage (0.148 inch) metallic coated core wire.

2. Class B- Bonded Polyvinyl Chloride (PVC)-Coated Steel shall have an 11-gage (0.12 inch) metallic coated core wire.

C. *Vinyl Coating.* The color of the vinyl coating shall be dark green unless shown otherwise in the contract documents. The Engineer shall have the option of approving an alternate color if the specified color is unavailable. An adhesion test is not required for coatings which are extruded or extruded and bonded.

710-04 ALUMINUM COATED STEEL FENCE FABRIC

This specification covers the requirements for Aluminum Coated Chain Link Fence Fabric.

MATERIAL REQUIREMENTS. Aluminum coated steel fabric shall conform to the requirements of AASHTO M181, Chain Link Fence, Type II, except as modified herein.

Mesh Size and Coated Wire Diameter. The size of the mesh and the coated wire diameter shall be 2 inches and 9 gauge (0.148 inch) respectively unless otherwise specified in the contract documents.

710-05 COATED STEEL FENCE FABRIC, (95% ZINC 5% ALUMINUM - MISCHMETAL ALLOY)

This specification covers the requirements for coated steel fence fabric (95% zinc 5% aluminum - mischmetal alloy).

MATERIAL REQUIREMENTS. Coated steel fence fabric (95% zinc 5% aluminum - mischmetal alloy) shall conform to the dimensional and strength requirements of AASHTO M 181 Chain Link Fence Type I, except as modified herein.

A. Mesh Size. The size of the mesh shall be 2 inches unless otherwise specified in the contract documents.

B. Coated Wire Diameter. The size of the coated wire diameter shall be 9 gage (0.148 inch)unless otherwise specified in the contract documents.

C. Coating. The coating shall meet the requirements of ASTM F1345 Class 2 (1 oz/sf).

710-06 ROCK SLOPE NET AND WIRE MESH ASSEMBLIES

This specification covers the material requirements for the components for assembling a rock bolt generally used in reinforcing a rock slope or as part of a rock catchment system. The following materials are evaluated in this specification:

710.0601 – Rock Slope Net Assembly.
710.0602 – Rock Slope Wire Mesh Assembly.
710.0603 – Rock Slope Wire Mesh Drape Assembly.

MATERIAL REQUIREMENTS.

A. Rock Slope Net Assembly. Provide a fence consisting of a net fabricated from wire rope meeting the requirements of §710-27 *Rock Slope Wire Ropes, Seam Rope for Wire Rope Rock Catchment Fence.* The border rope of the net shall meet the requirements of §710-27 *Rock Slope Wire Ropes, Net Supporting Wire Rope for Wire Rope Rock Catchment Fence.* The mesh size of the net shall be 8 in. by 8 in. The net shall be diagonally woven.

B. Rock Slope Wire Mesh. Provide 11 gauge (1/8 in. diameter), single twisted, coated steel wire mesh, with Class 1 (Zn-5Al) coating conforming to ASTM F1345. The steel wire composing the mesh shall have a minimum tensile strength conforming to ASTM A817.

C. Rock Slope Wire Mesh Drape. Provide 11 gauge (1/8 in. diameter), 8 by 10 mesh type having a nominal mesh opening of 3 ¼ in. x 4 ½ in., galvanized steel wire mesh, conforming to ASTM A975, Style 1.

710-10 STEEL AND IRON POSTS, RAILS, BRACES, AND FITTINGS FOR CHAIN LINK FENCE

This specification covers the requirements for steel and iron posts, rails, braces and fittings used in erecting chain link fence. The contractor shall have the option of supplying any one of the post sections shown on the Standard Sheets.

MATERIALS REQUIREMENTS. The following specifications cover the material requirements for each of the sections, fittings, and tension wires shown in the Post and Rail schedule on the Standard Sheets for Chain Link Fence:

A. Class A, Schedule 40 Pipe. Posts, rails and braces shall be standard weight Schedule 40 Pipe, manufactured in accordance with ASTM F1083, except that the protective coating system shall be as specified herein.

B. Class B, Steel Tubing. Posts, rails and braces shall be manufactured by one of the following methods with the steel conforming to ASTM A1011 or ASTM A1008 and A1011/A1011M with a minimum yield strength of 50,000 psi:

- Furnace butt welded, continuous welded
- Cold rolled and electric resistance welded
- Seamless

The tubing shall conform to the following dimensions:

Nominal Size (inches)	Outside Diameter, inches	Minimum Wall Thickness, inches	Weight lb/ft
1 1/4	1.660	0.111	1.836
1 1/2	1.900	0.120	2.281
2	2.375	0.130	3.117
2 1/2	2.875	0.160	4.639

C. Class C, Rolled-Formed Shapes. Posts, rails and braces shall be roll formed shapes which meet the requirements of ASTM F1043.

D. H-Posts. H Posts shall be fabricated from hot-rolled steel sections which meet the requirements of ASTM F1043.

E. Fittings. Fittings shall be manufactured of weldable steel, malleable iron, cast steel, cast iron, or aluminumalloy.

1. Weldable Steel. Weldable steel shall be commercial quality or better, produced by one of the following processes: Open-Hearth, Electric Furnace, or Basic Oxygen.

2. Malleable Iron. Malleable Iron shall conform to the requirements of '715-09.

3. Cast Iron. Cast iron shall conform to the requirements of '715-05.

4. Cast Steel. Cast steel shall conform to the requirements of '715-02.

5. Aluminum Alloy. Aluminum alloy shall meet the material requirements of '710-11.

Fittings other than aluminum fittings in contact with galvanized surfaces shall be galvanized in accordance with '719-01, Type II. Fittings in contact with aluminum surfaces shall be made of aluminum alloy or be aluminum coated in accordance with '719-03.

F. Tension Wire. Tension wire shall meet the requirements of ASTM A641M, as modified herein. The wire shall be a no. 7 gage minimum 0.177 ± 0.004 inch in diameter, having a minimum tensile strength of 80,000 psi, with a minimum galvanized coating of 0.7 oz/sf or a minimum aluminum coating of 0.3 oz/sf.

Protective Coating Systems, Posts, rails and braces shall be coated with a protective coating system conforming to one of the following depending on structural member.

A. Class A Schedule 40 Pipe; Class B Steel Tubing

1. Galvanized Coatings. Galvanized, both inside and out, in accordance with ASTM F1083.

2. Combined Coatings

a. External surfaces. The external surfaces shall be coated with the following combined coating system:

(1) Hot Dip Galvanizing. The external surface shall be hot-dip galvanized with ASpecial High Grade@ or AHigh Grade@ slab zinc conforming to ASTM B6. The weight of the coating shall be a minimum 0.9 oz/sf.

(2) Chromate Conversion Coating. Chromate conversion coating shall be specifically designed for use as a pretreatment of galvanized surfaces. The coating shall be applied prior to the application of the thermoplastic acrylic coating at the manufacturer's recommended rate.

(3) Clear Coating. A thermoplastic acrylic or cross linked polyester coating shall be applied with a minimum dry film thickness of 0.3 mils.

b. Internal Surfaces. The internal surfaces of the pipe or tubing shall be coated with one of the following:

(1) Zinc rich coating. The zinc rich coating shall contain not less than 87% zinc dust by weight and shall be capable of providing galvanic protection. The minimum coating thickness shall be 0.3 mils.

(2) Cross linked polyester coating containing a corrosion inhibitor

(3) Hot-dip galvanized coating. The hot-dipped galvanized coating shall average not less than 0.35 oz/sf and no single specimen shall show less than 0.25 oz/sf.

B. Class C Roll Formed Shapes and H Posts. All surfaces shall be hot-dip galvanized in accordance with the requirements of '719-01, Type I.

C. Class A Schedule 40 Pipe; Class B Steel Tubing; Class C Roll Formed Shapes, HPosts.

1. Aluminum with Chromate Coatings. All surfaces shall be given a hot-dipped 99% pure aluminum, Type II coating. The aluminum coating shall average 0.66 oz/sf and no single specimen shall show less than 0.61 oz/sf when tested in accordance with ASTM A428. The coating shall meet the adherence and quality requirements of '719-03. The aluminum coated surfaces shall be given a colorless chromate chemical treatment. The external surfaces shall be given a colorless protective resin coating to protect the material from abrasion in shipment and storage.

2. Mischmetal Alloy Coating (95% Zinc 5% Aluminum). Coating shall meet the requirements of ASTM F1043 Protective Coatings on Steel Framework for Fences Type C, except the coating weight shall be 1.0 oz/sf.

710-11 ALUMINUM POSTS, RAILS, BRACES AND FITTINGS FOR CHAIN LINKFENCE

This specification covers the requirements for aluminum posts, rails, braces and fittings to be used in erecting chain link fencing.

MATERIAL REQUIREMENTS. Posts, Rails, Braces and Fittings shall conform to the following materials specifications, alloy, temper and dimensional requirements in Table below.

Material	Material Spec.	Alloy & Temper	Dimensions
Fabric Ties	715-04	5052-H-38, 1100-H18 or 3003-H14	0.144 in. nom.dia.or 1/2 in. wide x 0.06 in. thick
Top & Bottom Tension Wires	715-04	6061-T94	0.192 in. nom. dia.
Hog Rings	715-04	6061-T94	0.110 in. nom. dia.
Stretcher Bars	715-04	6063-T5 or 6063-T6	1/4 x 3/4 in.
Truss Rods	715-04	6061-T6 or 6063-T6	3/8 in. nom. dia.
Cast Tumblers	715-03	356.0-T6	-
Wrought Turnbuckles	715-04	6061-T6 or 6063-T6	-
Brace & Stretcher Bands	715-04	3003-H14 or 6063-T6	1/8 x 7/8 in.
Carriage Bolts	715-04	2024-T4	-
Brace Ends & Rail Ends	715-03	356.0-T6, 360.0, D712.0, or ZG 61A-T5	-
Expansion Sleeves	715-04	6063-T6 or 6063-T832	See Note 1
Nuts	715-04	2024-T4 or 6061-T6	-
Line Posts	715-04	6063-T6	Sched. 40 pipe 2 in. diam.
End, Corner & Intermediate Posts	715-04	6063-T6	Sched. 40 pipe 2 1/2 in. diam.
Post Tops	715-03	356.0-F, 360.0, D712.0, or ZG61A-T5	-
Top Rails	715-04	6063-T6	Sched. 40 pipe 1/4 in. diam.
Brace Rails	715-04	6063-T6	Sched. 40 pipe 1/4 in. diam.

NOTE: 1. Modified Schedule 40 pipe, 1 1/2 in. nom. diam., 1.69 in. Inside Diameter, 0.078 in. Minimum Wall Thickness, 6 in. long.

710-12 PLASTIC COATED POSTS, RAILS, BRACES AND FITTINGS FOR CHAIN LINK FENCE

This specification covers the requirements for plastic coated posts, rails, braces and fittings used for erection of chain link fencing.

MATERIAL REQUIREMENTS. Posts, rails, braces, fittings, and accessories shall comply with the requirements of '710-10, except for the galvanized coatings. Post, rails, braces, fittings and accessories shall be resin-clad with either an epoxy modified ply (vinyl chloride), or a thermoplastic polyester resin. The coating shall have a minimum thickness of 7 mils and shall be of the same color as the fabric.

FABRICATION REQUIREMENTS. The epoxy modified poly (vinyl chloride) coating shall be chemically bonded to heated pipe, fittings, etc., or the fitting and pipe, etc., shall be clad with a heavy molecule, saturated, linear thermoplastic polyester resin applied by electrostatic spray and fusing or equal method. Each length of pipe shall be sealed with two snug-fitting polyethylene plug-type seals to prevent condensation and eliminate internal corrosion.

710-13 WOOD AND TIMBER POSTS AND TIMBER BLOCKOUTS

This specification covers wood posts used as witness posts, timber posts, and blockouts used in guiderail construction.

MATERIALS REQUIREMENTS. Wood posts, timber posts, and timber blockouts shall comply with the requirements of '712-14, Stress Graded Timber and Lumber, except that not every timber blockout need be branded, provided that approximately 10% of the blockouts are branded, and that the unbranded blockouts are visually similar, as determined by the engineer, to the branded blockouts. Using the clean wood properties of ASTM D2555, the bending stress (Modulus of Rupture) shall not be less than 4000 psi. They shall be surfaced on four sides and the dimensions shall be actual or nominal as indicated on the plans. If the dimensions are indicated to be nominal, the actual dimensions provided shall be in accordance with current trade practice. Surface dried redwood, red cedar, cypress or black locust may be used untreated. Other lumber including douglas fir, pine, oak, birch, apple, and beech may also be used but shall be pressure treated in accordance with '708-31, Wood Preservative-Water Borne after all the holes have been drilled and all other woodworking operations have been performed.
Bituminous preservative treatments will not be permitted. Before using, the Contractor shall submit to the Engineer, for approval, information as to the species of timber to be used and method of preservative treatment to be employed.

710-14 GALVANIZED STEEL BARRIER POSTS

This specification covers galvanized steel posts used as guiderail and median barrier posts, I-beam posts for existing guide railing and median barrier, and required soil plates, Anchor Post Base, and slip impact bases.

MATERIAL REQUIREMENTS . Galvanized steel barrier post shall conform to the following: Galvanizing '719-01 Galvanized Coatings and Repair Methods, Type I Steel ASTM A36

Posts. Steel posts used as guiderail and median barrier posts or I-beam posts for existing guide railing and median barrier, shall be fabricated from steel conforming to the ASTM A36 shape specified on the standard sheet for the guide railing or median barrier being utilized.

Soil Plates, Slip Impact Bases, and Other Post Components. Soil plates, slip impact bases, and other post components shall be fabricated from steel conforming to the dimensions shown on the standard sheet for the guide railing or median barrier being utilized.

FABRICATION. Guiderail and median barrier posts or I-beam posts for existing guide railing and median barrier shall be fabricated with all required welding, punching, drilling, or cutting of the post or any component of the post completed prior to galvanizing. Welding shall be done in accordance with the requirements of the *New York State Steel Construction Manual*, except that radiographic inspection of shop welds will not be required.

710-17 CORRUGATED BEAM GUIDE RAILING END TERMINAL (ENERGY-ABSORBING)

This specification covers the material and performance requirements for energy-absorbing corrugated beam end terminals.

MATERIALS REQUIREMENTS. All metal components and hardware shall be new and galvanized to meet or exceed the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

710-18 HEAVY POST BLOCKED-OUT CORRUGATED BEAM GUIDE RAILING END TERMINAL (ENERGY-ABSORBING)

This specification covers the material and performance requirements for energy-absorbing end terminals for HPBO corrugated beam end terminals.

MATERIALS REQUIREMENTS. All metal components and hardware shall be new and galvanized to meet or exceed the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

710-19 HEAVY POST BLOCKED-OUT CORRUGATED BEAM MEDIAN BARRIER END TERMINAL (ENERGY-ABSORBING)

This specification covers the material and performance requirements for energy-absorbing end terminals for HPBO corrugated beam median barriers.

MATERIALS REQUIREMENTS. All metal components and hardware shall be new and be galvanized to meet or exceed the requirements of §719-01 *Galvanized Coatings and Repair Methods, Type I.*

710-20 CORRUGATED BEAM GUIDE RAILING AND MEDIAN BARRIER

This specification covers corrugated beam guide railing and median barrier including corrugated beams, posts, anchorage units and accessory hardware.

MATERIAL AND FABRICATION REQUIREMENTS

Posts. Posts shall meet the requirements of '710-14 Galvanized Steel Barrier Posts

Beams ,Terminal Sections and Hardware. Corrugated beams, terminal sections and all hardware shall be fabricated in accordance with the details shown on the standard sheets. Bolt holes in the beam at the post hole and elsewhere, as necessary, shall be enlarged or slotted to permit expansion and contraction, and to facilitate erection. The beams shall be of uniform section and straight, unless shop curved beams are required by the plans or specifications. The edges shall be rolled to eliminate sharp edges. When shop curving of corrugated beams is required the radius of curvature shall be stamped into the base metal of the beam. The stamping shall be on the back, at or near both ends of the beam, and in a location where it will be visible to a worker after erection. Beams and terminal sections shall be rolled from 12 gage (nominal thickness 0.105 inches -0.009 inch tolerance) or heavier sheet or coil stock. The sheet or coil stock shall be new billet open hearth, electric furnace, or basic oxygen steel sheet. The minimum yield point and elongation of the steel used in the beam sections shall be 50,000 psi and 12% in 2 inch gage length respectively. Terminal sections, used for finishing-off or ornamental purposes, may be of mild steel, 33,000 psi yield point.

Plates and Anchorage Units. Plates and Anchorage Units shall be as detailed on the standard sheet for corrugated beam type guide railing and median barrier. They shall conform to ASTM A36.

Splices. Splices shall be made with flat, round headed, grip able, galvanized bolts, nuts and washers conforming to the following unless specified otherwise in the contract documents: Bolts ASTM A307 Grade A, Nuts ASTM A563 Grade A or better, and Washers ASTM F844. They shall be galvanized in accordance with the requirements of '719-01 Galvanized Coatings and Repair Methods, Type II (ASTM A153) unless another coating is specified. Post connection bolts and the grippable splice bolts shall be as detailed on the Standard Sheets.

Fabrication Welding. Fabrication welding shall be done in accordance with the New York State Steel Construction Manual, except radiographic inspection of shop welds will not be required.

Galvanizing. The rail element shall be galvanized in accordance with '719-01, Galvanized Coatings and Repair Methods, Type I (ASTM A123) or Type IV (ASTM A653/653M) of the standard specifications, except that the minimum check limits for the weight of coating as determined by the triple spot and single spot tests for '719-01, Galvanized Coatings and Repair Methods, Type IV (ASTM A653/653M), shall be 4 oz/ft5 and 3 oz/ft5 respectively, (total amount both sides of sheet). Posts, plates, and anchorage units shall be galvanized in accordance with '719-01, Galvanized Coatings and Repair Methods, Type I (ASTM A123). Hardware shall be galvanized in accordance with '719-01, Galvanized Coatings and Repair Methods, Type II (ASTM A153). When beams are to be galvanized in accordance with '719-01, Galvanized Coatings and Repair Methods, Type I (ASTM A123), they shall be blanked to the proper shape, fabricated and ready for assembly before galvanizing. No punching, drilling, cutting or welding will be permitted after galvanizing. When galvanizing in accordance with '719-01, Galvanized Coatings and Repair Methods, Type IV (ASTM A653/653M), the beam may be fabricated, cut, punched or drilled from galvanized sheet or coil stock. The exposed edges resulting from this process do not have to be repaired or touched up in any way.

710-21 BOX BEAM GUIDE RAILING AND MEDIAN BARRIER

This specification covers box beam guide railing and median barrier including the guide rail, posts, end assembly units and accessory hardware.

MATERIAL REQUIREMENTS

Posts. Posts shall meet the requirements of '710-14 Galvanized Steel Barrier Posts.

Rails. Rails shall be cold-formed welded and seamless structural tubing. The rails shall conform to ASTM A500, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes, Grade B, except as modified below. Splice plates and plates welded to tubes for splice assemblies shall be Charpy V-Notch tested. Splice tubes need not be tested.

All rail shall be tested in accordance with ASTM E436 ADrop-Weight Tear Tests of Ferritic Steels@ except as modified below. The tests shall be done after all galvanizing and associated operations have been performed on the rail.
The testing shall be conducted at a temperature of -0.4OF, without removing the galvanizing, on 2 x 9 inch specimens supported to achieve a 7 inch span.

The percent shear area will be determined by testing nine (9) specimens, three (3) from each of three (3) sides not containing a weld. The shear areas of the three specimens from the side with the lowest average shear area shall be disregarded and the final average based on the remaining six specimens. If the average percent shear area falls below 50, the material represented by these tests shall be rejected. To facilitate acceptance and rejection of material the manufacturer of the structural shape shall, before galvanizing, identify the product with the steel heat number, or some number which is traceable to the heat number, and its own unique identification code. The identification method shall be such that it can be read after the structural shape is galvanized. The identification information shall be placed on the structural shape at intervals not to exceed 4 feet. When shop curving of box beams is required, the radius of curvature shall be stamped into the base metal of the beam. The stamping shall be the vertical faces, at or near both ends of the beam, and in a location where it will be visible to a worker after erection.

No mill transverse welds will be permitted on the rail sections. Longitudinal welds shall be made by the resistance, gas shielded arc, submerged arc or plasma arc welded process; shall be sound, free from defects, and shall not be repaired. The welded joint, in cold-formed welded rail, shall have a minimum tensile strength specified for the railing when tested according to the tensile strap test of ASTM Method E8. All fabrication shall be done in accordance with the requirements of the Steel Construction Manual.
Rails shall be galvanized in accordance with '719-01, Type I, Galvanized Coatings and Repair Methods. Slots and round holes may be subsequently drilled, punched, burned, or cut and re-galvanized according to the paragraph below on Re-galvanizing Iron and Steel Using a Flame Sprayed Coating System. This repair procedure shall also apply to curved rail sections and splice plates as required.

Re-galvanizing Iron and Steel Using a Flame Sprayed Coating System. Those areas to be re-galvanizing shall be blasted with silica sand or crushed garnet of such gradation that sand shall be mesh size # 20 to # 40 U.S. Standard Sieve with a minimum of 40% retained on a # 30 U.S. Standard Sieve. Pressure of not less than 75 psi shall be maintained at the blast generator.

A sample steel plate shall be blasted until the surface cannot be further cleaned or roughened. This plate shall be used for visual comparison and any areas that do not meet this standard as to roughness or cleanliness shall be re-blasted.
The wire used in spraying shall be 1/8 or 3/16 inch diameter, zinc 99.0% purity.

Air pressure at the Air Control Unit shall be 60 psi and there shall be no more than 35 feet of 3/8 inch I.D. hose between the Air Control Unit and the gun.

The metal coating shall be applied at a minimum thickness of 0.0045 inches. At least one coating shall be applied within 4 hours of blasting and the surface shall be completely coated within 8 hours of blasting.

The specified thickness of coating shall be applied in multiple layers and in no case shall less than two passes be made over every part of the surface.

Fasteners. Fasteners shall be galvanized and conform to the following unless specified otherwise in the contract documents. Bolts ASTM A307 Grade A, nuts ASTM A563 Grade A or better, and washers ASTM F844.

FABRICATION. Curved box beam guide rail or median barrier shall be shop bent or shop mitered in accordance with the following. At the fabricator's option, the shop mitering process may be used instead of a shop bending process. However, shop bending may not be used in place of shop mitering.

1. Shop Bent Box Beam Guide Railing. Box beam guide rail installed on a curved alignment with a radius above 20 and up to 720 feet shall be shop bent prior to galvanizing. In order to achieve a smooth arc, the bend points shall be placed no farther apart than two feet when the radius is from 20 to 50 feet, no farther apart than three feet when the radius is between 50 and 150 feet, and no farther apart than four feet when the radius is 150 feet or greater.

2. Shop Mitered Box Beam Guide Railing. Box beam guide railing installed on a curved alignment with a radius of 20 feet or less shall be miter cut and welded in the shop prior to galvanizing. For radii less than 12 feet, the average spacing of the cuts shall be approximately 18 inches. For radii from 12 feet to 20 feet, the average spacing of the cuts shall not exceed 24 inches. Cut locations shall be adjusted as needed to avoid bolt holes and post brackets. After the miter cuts are completed, backer bars shall be tack welded

to one side of the cut and the miter shall be closed to within a quarter of an inch (+ 0", -1/8") and butt welding performed in accordance with AWS D1.1. Section 3.

***3. Shop Bent Median Box Beam Barrier*.** Box beam median barrier installed on a curved alignment with a radius above 30 and up to 1525 feet shall be shop bent prior to galvanizing. For radii between 30 and 60 feet, the bending shall be performed prior to cutting the slots for the post support paddles. In order to achieve a smooth arc, the bend points shall be placed no farther apart than 18 inches.

***4. Shop Mitered Box Beam Median Barrier*.** Box beam median barrier installed on a curved alignment with a radius of 30 feet or less shall be miter cut and welded in the shop prior to galvanizing. For radii less than 12 feet, the average spacing of the cuts shall be approximately 18 inches. For radii of 12 feet or greater, the average spacing of the cuts shall not exceed 24 inches. Cut locations shall be adjusted as needed to avoid post support slots. After the miter cuts are completed, backer bars shall be tack welded to one side of the cut and the miter shall be closed to within a quarter of an inch (+ 0", -1/8") and butt welding performed in accordance with AWS D1.1. Section 3.

710-22 CABLE GUIDE RAILING

This specification covers cable guide railing including cable, posts, anchorage units, and accessory hardware.

MATERIAL REQUIREMENTS. Cable Guide Railing shall conform to the following:

Posts, Soil Plates	- 710-14 Galvanized Steel Barrier Posts,
Reflectors	- 730-01 Aluminum Sign Panels
Reflective Sheeting	- 730-05 Reflective Sheeting - Specifications regarding applied reflected sheet are herein amended to exclude Engineering Grade materials, limiting offerings to Hi-Intensity or Ultra-High Intensity grade material or above, or equal.
Cable	- AASHTO M30 or ASTM A741 Type I Construction, Class A Coating
Anchor Angle	- ASTM A36
Anchor Post Base	- ASTM A36
Bolts	- ASTM A307 Grade A
Nuts	- ASTM A563 Grade A
Washers	- ASTM F844

Cable End Assemblies. Designs for a steel turnbuckle cable-end assembly or spring cable-end assembly not shown on the standard sheet or detailed in the plans shall be submitted for approval. Compensating devices must have a spring rate of 450 ± 45 lb/in and a total available "throw" of 6 inches minimum.

Hook Bolts. Hook bolts shall develop an ultimate pull open strength of from 450 lbs. to 1000 lbs. applied in a direction normal to the longitudinal axis of the post.

Galvanizing. The bolts, including the J@ bolt used to mount the cable, nuts, washers, anchor rods, spring compensator components, steel turnbuckle cable end assembly, and all cast steel or malleable iron hardware, except the wedge shown in Detail X@ on the standard sheet, shall be galvanized in accordance with the requirements of '719-01 Galvanized Coatings and Repair Methods, Type II, unless another coating is specified. The wedge shown in Detail X@ shall be ungalvanized (black). The anchor angles, and Anchor Post Base shall be galvanized in accordance with the requirements of '719-01 Galvanized Coatings and Repair Methods, Type I.

Welding. Welding shall be performed in accordance with the requirements of the New York State Steel Construction Manual, except radiographic inspection of shop welds will not be required

710-23 STEEL BRIDGE RAILING

This specification covers the material requirements for Steel Bridge Railing and its component parts.

MATERIAL REQUIREMENTS. Steel Bridge Railing materials shall conform to the following requirements:

ITEM	ASTM Designations	
Rail Tubes	A500 Grade B	
Rail End Caps	A36	A709 Grade 36
Base Plates[1]	A572 Grade 50	A709 grade 50
Anchor Studs	A325	A449 Grade 1
Splice Bolts	A325	A449 Grade 1
Round Head Bolts	A325	A449 Grade 1
Nuts[2]	A563	
Washers[2]	F436	
High Carbon Heat Treated Spring Steel Lock Washers	ASME B18.2	
Anchor Plates	A36	A709 Grade 36
Plate Shims	A36	A709 Grade 36
Tube Rail Splices	A500 Grade B	
Solid Rail Splices	A572 Grade 50	A709 grade 50
Angle[1]	A572 Grade 50	A709 grade 50
Splice Plates	A572 Grade 50	A709 grade 50
Railing Post[1]	A572 Grade 50	A709 grade 50
Tubular Posts	A500 Grade B	

[1] All post material, including base plates, shall be furnished to minimum Charpy V-notch toughness requirements as required by §715-01, under Charpy V-Notch Impact test.

[2] Use the following nut and washers for the given bolt class:

BOLT or STUD Class	NUT – A563 (Class & Dimension Style of nut)	Washer A563 Type
4.6	5H1	1 or 3
8.8	10S HH	1 or 3

Beveled shims may be machined from the same type of metal as in the post base plates or may be cast from material conforming to the requirements of '715-02, Steel Castings, or '715-09, Malleable Iron Castings.

All rail, except bicycle and pedestrian rail, shall be tested in accordance with ASTM E436 - "Drop- Weight Tear Tests of Ferritic Steels", except as modified below.

The tests shall take place after all galvanizing and associated operations have been performed on the rail. The testing shall be conducted at a temperature of 0°F, without removing the galvanizing, on 2 x 9 inch specimens supported to achieve a 7 inch span.

The percent shear will be determined by testing nine (9) specimens, three (3) from each of three (3) sides not containing a weld. The shear areas of the three specimens from the side with the lowest average shear area shall be disregarded and the final average based on the remaining six specimens. If the average percent shear area falls below 50 the material represented by these tests shall be rejected.

Splice plates and plates welded to tubes for splice assemblies shall be Charpy V-notch tested. Splice tubes need not be Charpy V-notch tested.

To facilitate acceptance and rejection of material, the manufacturer of the structural shape shall, before galvanizing, identify the product with the steel heat number, or some number which is traceable to the heat number, and its own unique identification code. The identification method shall be such that it can be read after the structural shape is galvanized. The identification information shall be placed on the structural shape at intervals not to exceed 4 feet.

FABRICATION. Bridge Railing shall be fabricated to the dimensions shown in the contract plans and in compliance with the specifications.

A. Shop Drawings. Shop drawings, when required by the contract documents, shall be provided in accordance with the requirements of the S.C.M., except that:

1) the drawings shall be submitted to the Engineer for review and approval, and
2) the computed weights need not be shown.

B. Welding. Shop welding shall be performed only where specifically noted on the contract documents. Transverse welds shall not be permitted unless directly called for on the contract plans. All welding shall be done in accordance with the requirements of the SCM.

C. Cutting. All exposed flame cut surfaces shall have a surface roughness not to exceed 250, as defined by the ANSI standard specification B46.1. Grind all edges of Posts and Post Base Plates so that all sharp edges are removed.

D. Bending. Rails for curved structures shall be curved in the shop prior to galvanizing. To facilitate bending, rails may be heated to a temperature not exceeding 1200°F.

E. Galvanizing. Galvanizing shall conform to the requirements of '719-01, Galvanized Coatings and Repair Methods, Type I. All components of the railing, including anchor studs, nuts and washers, shall be galvanized. The rails, post assemblies, splices and all hardware shall be fabricated and ready for assembly prior to galvanizing.

All galvanized bolts and galvanized anchor studs shall have a Class 2A Thread. All galvanized nuts shall have a standard oversized tap to allow for the galvanizing on the bolts and nuts. Shop galvanizing repair of uncoated areas will be permitted on localized areas. Repair of localized areas is limited to a total of 2 square inches on any post or rail. A post or rail which contains galvanizing defects totaling more than 2 square inches shall be stripped and re-galvanized.
Shop repair shall be made in accordance with the methods given in '719-01.

The following areas will not require galvanizing repair: One 1/8 inch maximum dimension spot of tight flux remaining in the fusion line of any 7 inch length of weld after blast cleaning picking and galvanizing.

F. Brown Rail. When brown rail is specified, all components of the railing system shall be galvanized, after which, the visible portions of the system shall be painted in accordance with §657 Painting Galvanized and Aluminum Surfaces. Paint color shall be ‘Weathered Brown’ as defined by 708-05 Standard Paint Colors.

NOTE Regarding Acceptance of Product: The manufacturer shall furnish NYSDOT with three (3) certified copies of physical test and chemical analysis of the materials used in the manufacture of the railing. Check analysis may be made by NYSDOT from delivered material. Inspection will be performed in accordance with the provisions of the SCM, except that mill inspection will not be done. Materials that do not bear the Inspector’s mark of acceptance shall not be accepted at a project site.

710-24 BOX BEAM GUIDE RAIL END ASSEMBLY, TYPE III; AND BOX BEAM MEDIAN BARRIER END ASSEMBLY, TYPE C

These specifications cover the material and quality requirements for Box Beam Guide Rail End Assembly Type III and Box Beam Median Barrier End Assembly, Type C. These end assemblies are manufactured articles requiring federal approval as Test Level 3 end terminals for box beam guide rail and median barrier. They function by absorbing energy either through crushing of fiberglass elements or by splitting the beam element at the corners of the box beam. When specified, these end assemblies are used to terminate the ends of box beam guide rails and box beam median barriers. Box Beam Guide Rail End Assembly Type III and Box Beam Median Barrier End Assembly, Type C are fabricated in accordance with these specifications, the manufacturer's instructions, and the manufacturer=s drawings. They are available in two styles. These are Wyoming style and another style that uses a box beam splitting mandrel.

MATERIALS REQUIREMENTS.

A. GENERAL. Soil plates, struts, bearing plates shall meet the requirements of ASTM A36. All metal components shall be hot dip galvanized in accordance with '719-01, Galvanized Coatings and Repair Methods.

Reflective sheeting pre-mounted on a frangible material shall be provided by the manufacturer for the free end of the end assembly. If approaching traffic will be permitted on one side only, reflectorization shall consist of alternating reflectorized 4 inch yellow and non-reflectorized 4 ½ inch black stripes oriented at a 45 degree angle, with the lower edge of the stripes near the traveled way to be used by the approaching traffic. The reflective material shall meet the requirements of '730-05, Reflective Sheeting, Class B or higher. If approaching traffic will be permitted on both sides of the end assembly reflectorization shall be upward pointing chevrons of the same dimensions.

B. END ASSEMBLIES USING CRUSHABLE FIBERGLASS ELEMENTS (WYOMING STYLE): Materials used in the fabrication of the Box Beam Guide Rail End Assemblies Type III and Box Beam Median Barrier End Assembly, Type C (Wyoming style) shall conform with the following requirements:

Wood and Timber Post Posts and Timber Blockouts	'710-13
Foundation Tubes, Nose Assembly, Outer Tube, Telescoping Section and Intermediate Spacer Block	'710-21
Fasteners, except shear bolts on posts 6, 7, & 8	ASTM A307
Shear bolts on posts 6, 7, & 8	SAE Grade 0
Rubber Pad	Hard Rubber Division II Sect18.2
Steel Posts, Shelf Angles, and other metal parts	ASTM A36
Galvanized Coatings and Repair Methods	'719-01

The Cable Assembly shall consist of galvanized steel cable, 6 x 3/4 inch, with 3/4 inch threaded rod swaged to both ends.

The composite tube shall be MMFG Extren series 500 pulltruded fiberglass structural tubes and shall exhibit the following properties:

1. Composite tubing shall be manufactured using the pulltrusion process. Tubing shall be manufactured of glass fiber reinforced resin with a glass resin ratio of 50%. The resin shall be iso-phthallic polyester. Glass reinforcement shall include the following three varieties:
   A. Surface mat shall be used on all exterior surfaces.
   B. Continuous glass strand rovings shall be used internally.
   C. Continuous strand mats shall be used internally.
2. The composite material shall exhibit the following minimum mechanical properties:
   A. Ultimate Tensile Strength: Ultimate Tensile strength shall be longitudinally, 30,000 psi and transversely, 7000 psi measured from coupons. Bending strength of the full section shall be 20,000 psi.
   B. Ultimate Compressive Strength shall be as given above except Transversely, shall be 15,000 psi.
   C. Ultimate Shear Strength shall be 4500 psi.
   D. Modulus of Elasticity shall be 250,000 psi
   E. Barcol Hardness shall be 50.
3. The energy dissipation properties of the alternate fiberglass epoxy composite tube shall be evaluated using static compressive testing. Each test specimen shall be 2.0 feet long with a 4 inch long tulip shape cut into one end of the test specimen. The test specimen shall be crushed statically at a rate of 4 inches per minute and the total crush length shall be not less than 1.0 foot. A minimum of three static compressive tests shall be conducted. The results of each test shall meet the following static energy dissipation properties:

First Stage Energy Absorber	
Average Crush Force	18,000 ± 2000 lbs.
Maximum Compressive Force	26,000 lbs.
Allowable Compressive Force Variation	±2500 lbs.
Second Stage Energy Absorber	
Average Crush Force	41,000 ± 3000 lbs.
Maximum Compressive Force	55,000 lbs.
Allowable Compressive Force Variation	±5000 lbs.

C. END ASSEMBLIES USING BOX BEAM BURSTING MANDREL :

Materials used in the fabrication of the Box Beam Guide Rail End Assemblies Type III (BEAT) shall conform with the following requirements:

Mandrel Tube, Box Beam rail	'710-21
Impact Head and components, including face plate, top and bottom plates, lower and upper support boxes, Gussets 10 Ga.	ASTM A36
Steel post, guide plates and mandrel support block, gusset plate, guide support, bent and front guide plates, and all metal parts	ASTM A36
Mandrel Plate	ASTM A514, with a minimum Brinell hardness number of 250

Ordinary box beam guide rail and ordinary box beam median barrier included within the pay limits for the bursting style Type III End Assembly for guide rail and Type C End Assembly for median barrier shall conform to the same specifications as box beam guide rail to which the Type III or Type C bursting style end assembling is attached.

710-26 PLASTIC AND SYNTHETIC BLOCK-OUTS FOR HEAVY POST GUIDERAIL SYSTEMS

This specification describes plastic and synthetic material block-outs used to provide uniform offset distance from the corrugated beam rail to the heavy post.

The block-out shall have the same general dimensions as detailed in the Department Standard Sheets. The block-out shall not contain excessive voids that would compromise its physical strength. The material shall be designed for outdoor exposure and shall include chemical additives to resist UV degradation. If the product contains recycled materials, they shall be environmentally friendly and non-hazardous. Blocks shall contain no materials that will negatively affect their field performance, such as materials that absorb moisture.

710-27 ROCK SLOPE WIRE ROPES

This specification covers the material requirements for the components for wire ropes generally used in a rock catchment system. The following materials are evaluated in this specification:

710.2701 – Rock Slope Wire Ropes, Net Supporting Wire Rope for Wire Rope Rock Catchment Fence.
710.2702 – Rock Slope Wire Ropes, Seam Rope for Wire Rope Rock Catchment Fence.
710.2703 – Rock Slope Wire Ropes, Tieback Restraining Cable for Wire Rope Rock Catchment Fence.
710.2704 – Rock Slope Wire Ropes, Anchor Cable for Wire Rope Rock Catchment Fence.
710.2705 – Rock Slope Wire Ropes, Seam Rope for Wire Mesh Slope Protection

MATERIAL REQUIREMENTS. Provide material in accordance with TABLE 710-27A *Rock Slope Wire Ropes*.

TABLE 710-27A ROCK SLOPE WIRE ROPES

Rock Slope Wire Rope	Rope/Cable	Minimum Diameter	Minimum Breaking Strength
Wire Ropes for Wire Rope Rock Catchment Fence	Net Supporting Wire Rope Seam Rope Tieback Restraining Cables Anchor Cables (10 ft. min. length, equipped with heavy duty type thimbles)	5/8 in. (6x19 construction) 5/16 in. (7x7 construction) 5/8 in. (6x19 construction) ¾ in.	37 kips 9 kips 37 kips 53 kips
Seam Wire for Wire Mesh Slope Protection	Seam Rope	5/16 in. (7 x 19 Galvanized Aircraft Cable)	10 kips

All wire ropes for the wire nets, supporting ropes, seam ropes and anchors shall be composed of steel wires individually galvanized before being woven into the ropes.

710-30 RIGHT-OF-WAY FENCING

These specifications cover the material requirements required for the construction of right-of-way fences comprised of (a) galvanized steel or aluminum coated steel fence fabric, and (b) posts, braces and hardware designed to support and retain the fencing.

MATERIAL REQUIREMENTS:

Fence Fabric: Right-of-way fencing fabric shall conform to the requirements of ASTM A116 Zinc Coated (Galvanized) Steel Woven Wire Fence Fabric@. The fabric shall be woven in accordance with Design Number 1047-6-9 or 1047-6-11 as shown in Table 1 of both ASTM A116. The weight of the coating on the Zinc-Coated (Galvanized) Fence Fabric shall conform to the coating weight requirements of Class 3 shown in Table 2 of ASTM A116.

Fence Posts and Braces: Posts and brace sizes shall be as indicated on the Standard Sheets. Steel line posts shall conform to the requirements of ASTM A702. Steel end, corner or intermediate post and braces shall conform to the requirements of Section 6.5 through Section 6.5.4 of ASTM A702; or the requirements for Class A, Schedule 40 Pipe or Class B, Steel Tubing of '710-10.03 of the Standard Specifications. Posts and braces conforming to the requirements of ASTM A702 shall be galvanized in accordance with the requirements of '719-01 Type I. Type A Schedule 40 Pipe and Type B Steel Tubing shall use one of the protective coating system specified in 7A of '710-10.03.

Wood posts and braces shall be seasoned southern yellow pine, red (Norway) pine, spruce, Douglas fir, hemlock, larch, or redwood. All wood posts and braces shall be pressure treated with a water-borne wood preservative conforming to the requirements of '708-31. The wood posts shall be subject to inspection before and during treatment at the option of the NYSDOT. They shall be sound, free from loose knots or decay, and with no through checks on tops or butts. Posts shall be machine peeled to a smooth uniform appearance and free from all inner bark. The preservative pressure treatment shall be by the empty cell process in accordance with C5 of the American Wood-Preservers' Association Standards.

Fittings: Fittings shall be manufactured of weldable steel, malleable iron, cast steel, cast iron, or aluminum alloy. Fittings other than aluminum shall be galvanized in accordance with the requirements of '719-01 Type II.

Fasteners: Bolts, nuts, and washers shall conform to the following, unless specified otherwise in the contract documents:

BOLTS	ASTM A307
NUTS	ASTM A563 Grade A or better
WASHERS	ASTM F844

The fasteners shall be galvanized in accordance with the requirements of '719-01 Type II.

Gates: Gates shall be constructed of Class A Schedule 40 Pipe conforming to '710-10 welded at all corners or assembled with corner fittings. The size of the pipe used to fabricate the gate shall be as shown on the Standard Sheets. When corner fittings are used the gates shall have truss rods of minimum 3/8 inch diameter to prevent sag or twist. Gate leaves shall have vertical intermediate bracing so that no vertical members are more than 8 feet apart. Gate leaves over 10 feet shall have a truss rod of 3/8 inch minimum diameter even if the corners are welded. The fence fabric used on the gate shall conform to the fence fabric in the remainder of the fence.

A. Hinges. Hinges shall be weldable steel, cast steel, or malleable iron 180O offset industrial type. The hinges shall not twist or turn under the action of the gate. The gate shall be able to be opened by one person. The hinges shall be galvanized in accordance with the requirements of '719-01 Type I.

B. Latches. Latches, stops, and keepers shall be provided for all gates. Latches for single leaf gates may be a forked latch type. Double leaf gates shall have a plunger bar type latch arranged to engage a stop. Latches shall be capable of being locked and the Contractor shall provide a lock with triplicate keys for each gate. Keepers shall consist of a mechanical device for securing the free end of a gate when in the full open position.

C. Gate Posts. Gate posts shall conform to the dimensions shown on the Standard Sheets. Steel gate posts shall be fabricated from either Class A Schedule 40 Pipe or Class B Steel Tubing conforming to the requirements of '710-10. Wood gate posts shall be made from wood conforming to the requirements for wood posts and braces as specified in “Fence Posts and Braces”. *Buy America requirements apply.*

BARRICADES:

VERTICAL PANELS (Vertical Barricade):

Vertical panels are defined by FHWA as a Category II devise and shall conform to the requirements of the MUTCD and be NCHRP 350 or MASH approved.

They shall be constructed of plastic, aluminum, or other lightweight materials. Vertical panels shall be supported by a base capable of maintaining the panel in an upright position and in the proper position and orientation. Vertical panels shall have 4 to 6 inch wide diagonal stripes of alternating orange and white reflective sheeting, sloping downward at an angle of 45˚ toward the side on which traffic is to pass. Vertical panels which are 36 inch and larger shall have 6 inch wide diagonal stripes.

Standard vertical panels shall be a minimum of 24 inches in height and a minimum of 8 inches in width. The top of the panel shall be mounted a maximum of 36 inches high. Support posts for standard vertical panels shall not be located on the traffic face of the panel. `

Oversized vertical panels shall be a minimum of 36 inches in height and have a minimum reflective area of 2.0 square feet. Reflective sheeting shall conform to '730-05 Reflective Sheeting however this specification is amended herein to exclude Engineering Grade materials, limiting offerings to Hi-Intensity or Diamond, Super, Ultra-High Intensity grade material or above, or equal.

TYPE I CONSTRUCTION BARRICADES:

Type I construction barricades are defined by FHWA as a Category II Device and shall conform to the requirements of the MUTCD and shall be NCHRP 350 or MASH approved. Type I construction barricades shall be constructed of a pair of impact resistant plastic or polyethylene A-frames, with a single rail panel 8 to 12 inches wide and a minimum of 24 inches long. Rails on barricades used on expressways and other high-speed roadways shall have an area of at least 2.0 square feet. The top of the rail panel shall be mounted at a minimum height of 36 inches. Barricade frames shall be designed to maintain the proper orientation and location of the device during windy conditions however non-rigid ballast may be placed on the frame, close to the ground, to hold the barricade in position, but shall not obscure the view of the rail panels to approaching traffic. Barricade rail panels shall have 4 inch wide reflective, alternating orange and white diagonal stripes sloping at an angle of 45˚. Reflective sheeting shall conform to 730-05 Reflective Sheeting however this specification is amended herein to exclude Engineering Grade materials, limiting offerings Hi-Intensity or Diamond, Super, Ultra-High Intensity grade material or above, or equal.

TYPE II CONSTRUCTION BARRICADES:

Type II construction barricades are defined by the FHWA as a Category II device, shall conform to the requirements of the MUTCD and shall be NCHRP 350 or MASH approved. Type II construction barricades shall be constructed of pair of impact resistant plastic or polyethylene A-frames, with a two insert able rail panels 8 to 12 inches wide and a minimum of 24 inches long. Rails on barricades used on expressways and other high-speed roadways shall have an area of at least 2.0 square feet. The top of the rail panel shall be mounted at a minimum height of 36 inches. Barricade frames shall be designed to maintain the proper orientation and location of the device during windy conditions however non-rigid ballast may be placed on the frame, close to the ground, to hold the barricade in position, but shall not obscure the view of the rail panels to approaching traffic. Barricade rail panels shall have 4 inch wide reflective, alternating orange and white diagonal stripes sloping at an angle of 45˚. Reflective sheeting shall conform to '730-05 Reflective Sheeting however this specification is amended herein to exclude Engineering Grade materials, limiting offerings to Hi-Intensity or Diamond, Super, Ultra-High Intensity grade material or above, or equal.

TYPE III CONSTRUCTION BARRICADES:

Type III construction barricades are defined by the FHWA as a Category II Device, shall conform to the requirements of the MUTCD and shall be NCHRP 350 or MASH approved. Type III construction barricades shall be constructed of a pair of plastic or metal pre-drilled uprights mounted in a weighted base upon which three rail panels 8 to 12 inch wide and a minimum of 48 inches long are attached. The top of the upper panel shall be mounted at a minimum height of 60 inches. Barricade frames shall be designed to maintain the proper orientation and location of the device during windy conditions. Non-rigid ballast may be placed on the frame, close to the ground, to hold the barricade in position, and shall not obscure the view of the rail panels to approaching traffic. Barricade rail panels shall have 6 inch wide reflective alternating orange and white diagonal stripes sloping at an angle of 45°. Reflective sheeting shall conform to '730-05 Reflective Sheeting however this specification is amended herein to exclude Engineering Grade materials, limiting offerings to Hi-Intensity or Diamond(Ultra-High Intensity) grade material or above, or equal.

ADDITIONAL NOTE REGARDING the USE of BARRICADE WARNING LIGHTS:

Warning lights, when used, shall be securely mounted directly to the barricade frame, above the top rail, using a bolt, nut, and washer of sufficient strength to ensure that the light does not detach if impacted by a vehicle, and no part of the light or wiring shall cover the face of the rail. Batteries shall be placed at ground level, except that integral batteries weighing a maximum of 7 pounds may be mounted on the barricade frame. Warning lights shall not be attached to the barricade rail.

TRAILER ATTENUATOR (TA) SYSTEM:

This crash cushion system will meet the FHWA guidelines (MASH TL3), designed at the time of the bid opening to dissipate the collision energy of standard passenger vehicles traveling at speeds up to 62 mph; thereby providing impact protection during collisions into the rear of a truck while performing either as mobile work zone shadow vehicle or as a stationary work zone barrier vehicle.

The TA shall be designed to be installed and detached on any vehicle with a minimum weight of 9920 pounds and a heavy duty, permanently frame-mounted hitch assembly rated to 20 ton, in a simple and fast manner with the major components staying together when detached from the vehicle. If any additional mounting plates or equipment are required for installation or use, they are to be a part of your offering. The frame shall be capable of collapsing when impacted by an errant vehicle. It shall use a hydraulic dampener system or other methods of anti-rotational devices to minimize rotation during an offset impact, thus helping to minimize secondary accidents. The system should allow the trailer to act like a normal trailer when trailering and resist rotation when impacted by an errant vehicle.

The TA shall not protrude over, into or forward under the truck, and in the event of an impact shall not be capable of damaging the vehicle's vital elements. When deployed, the TA shall not impede the line-of-site of an Arrow board or Message board if mounted on the truck, installed per MUTCD (Manual on Uniform Traffic Control Devices) guidelines at a height of 2135mm (7'-0") to the bottom of board. It shall be capable of being refurbished using simple hand tools, undamaged sections of the original framework and components, and replacement parts. A comprehensive parts list should be a part of the offering.

. The TA shall consist of the following components:

1. Support Structure with Articulating Arms
2. Impact Frame
3. Hitch Assembly - consisting of the trailer hitch with cylinder dampener system or other anti- rotational system incorporated.
4. Intermediate Frame
5. Suspension, Axle, Wheels & Tires

The TA shall have a trailer lighting assembly per FMVSS No. 108 Lamps, Reflective Devices, and Associated Equipment. All components shall be appropriate for their intended purpose under any adoptions issued by the NHTSA, SAE and FMVSS. This is standard practice for electrical lighting. The TA shall include brake lights, tail-lights, turn signals and an ICC bar light. Wires shall be routed in a protective, jacketed cable. The cable shall be routed and secured to the frames at 18" maximum intervals. For repair or replacement, individual circuits shall be easily identified and accessible. Molded connectors shall be used where individual wires would otherwise be exposed to the elements. A standard, single, seven (7) pin, trailer connector shall make the connection for all lights to the back of the truck. Conspicuity tape and reflectors shall be installed following the same established standards as the lighting.

One hand crank jack with swivel caster with a total rated load capacity of at least 1200 lbs., shall be supplied with the TA to facilitate its installing, and for removing the TA from a truck for storage. The tongue weight of the trailer shall not be so heavy as to preclude the above from being safely performed routinely by no more than two people.

The surface of the Impact Frame facing oncoming traffic, shall display a black on yellow inverted V chevron pattern with 100mm (4 in.) wide color bands. The colors shall meet the value and tolerance limits established by MUTCD.

All welding shall be done by, or under the direction of, a certified welder. All exposed steel surfaces on the TA shall be painted black or be galvanized. Paint shall be applied after the proper preparation of all steel and aluminum components. The metal preparation shall include cleaning, degreasing and abrading the metal surface. Primer shall be used if steel is not powder coated or galvanized. All paint shall be lead free.

The TA shall be assembled with Commercial Quality bolts, nuts, and washers conforming to ANSI (American National Standard Institute) specifications unless otherwise specified. If a hydraulic system is used, the system shall consist of cylinders, hoses, tank and subcomponents. The hydraulics would allow the system to articulate like a normal trailer behind the support vehicle, but would lock to prevent the trailer from rotating during off-set or angled impacts. The system is to be designed to automatically lock the trailer brakes in the event of a hitch failure and the trailer breaks away from the tow vehicle.

Approximate Weight & Dimensions			
Width	Length	Weight	Ground Clearance
7' 6" to 8'6"	16' - 20'	1875 to 2650lbs.	9" to 15"

712-06 EXPENDABLE IMPACT ATTENUATOR

This specification covers the material and performance requirements for expendable impact attenuators.

MATERIALS REQUIREMENTS. Expendable Impact Attenuator components shall meet the following requirements:
Impact attenuators that use liquid or other materials as a filler or to provide ballast will be evaluated for potential environmental impacts and/or seasonal limitations. Impact attenuators will be approved for use in shielding an object of a maximum width as specified in the Approved List, and specific configurations may be approved for maximum speeds.

Covers shall be provided by the manufacturer for all units where ingress of debris from the top will result in deterioration of performance.

Metal parts shall be fabricated from M1020 Merchant Quality or ASTM A36M steel.

All galvanization shall be in accordance with §719-01 *Galvanized Coatings and Repair Methods, Type I.*

Welding shall be in accordance with the Steel Construction Manual, except radiographic inspection shall not be required.
The size and recommended attachment method for reflective marking shall be specified.

Impact attenuator systems shall be NCHRP 350 or MASH approved. Impact attenuators meeting the requirements of NCHRP 350 or MASH Test Level 2 are acceptable only as Test Level 2 devices. Test Level 3 devices are acceptable for Test Level 3 and Test Level 2.

Manufacturers or material suppliers desiring to have impact attenuators approved shall prepare and submit Materials Details Sheets consisting of copies of drawings, specifications, test reports, and Federal acceptance letters, to the Director of the NYSDOT Materials Bureau.

712-07 INERTIAL BARRIER MODULES

Sand-filled inertial barrier systems are used for site hazard protection. Modules composing the array shall be free-draining with respect to residual moisture in the fill sand. Their lids shall be such that they divert precipitation and stop moisture from seeping into the shell. Lids shall be fastened with a minimum of six equally spaced pop rivets or secured by other approved fasteners so as to provide a reasonably vandal resistant, closed barrel. Inertial Barrier Modules must be certified as passing NCHRP 350 or MASH Test Level 2 and or Test Level 3.

MATERIAL REQUIREMENTS. The modules shall be federal yellow or as shown on the plans. They shall be durable, waterproof, resistant to deterioration from ultra-violet rays, deformation from dynamic loadings due to vibration in the placement area and long-term stresses induced by thermal expansion and contraction and fill settlement.
The fill sand shall conform to the requirements of either '703-06, Cushion Sand, or '703-07, Concrete Sand. Sodium chloride, as dry rock salt, equal to 3-5 percent by weight of the sand, shall be thoroughly mixed into the sand. Sodium chloride shall meet the requirements of '712-03, Sodium Chloride.

712-08 REUSABLE IMPACT ATTENUATORS

Reusable Impact Attenuator components shall meet the following requirements:
Impact attenuators that use liquid or other materials as a filler or to provide ballast will be evaluated for potential environmental impacts and/or seasonal limitations. Impact attenuators will be approved for use in shielding an object of a maximum width as specified in the Approved List, and specific configurations may be approved for maximum speeds. Covers shall be provided by the manufacturer for all units where ingress of debris from the top will result in deterioration of performance.

Metal parts shall be fabricated from M1020 Merchant Quality or ASTM A36M steel. All Galvanization shall be in accordance with §719-01 *Galvanized Coatings and Repair Methods, Type I.*

Welding shall be in accordance with the Steel Construction Manual except radiographic inspection shall not be required.
Impact attenuator systems shall be NCHRP 350 or MASH approved. Impact attenuators meeting the requirements of Test Level 2 or Test Level 3. Test Level 2 approved devices are acceptable only as Test Level 2 devices. Test Level 3 approved devices are acceptable for Test Level 3 and Test Level 2.

Manufacturers or material suppliers desiring to have impact attenuators approved shall prepare and submit Materials Details Sheets consisting of copies of drawings, specifications, test reports, and Federal acceptance letters, to the Director of the Materials Bureau. The NYSDOT review process requires a minimum of 45 calendar days.

As a condition for approval as a reusable attenuator, Manufacturer shall certify and provide factual data showing that the maximum (materials only) present-day cost for the repair needs incurred, during any one of the NCHRP 350 or MASH crash tests that were considered necessary for the approval, will not exceed the maximum material cost per incident as stipulated by the Director of the Design Quality Assurance Bureau and posted on the Department's web site. The time required for the average repair shall not exceed 4 person-hours. In some circumstances, the Director may accept an In-Service Evaluation Report conforming to the guidelines of NCHRP350 Chapter 7 in lieu of the standard crash test costs. Such a report shall include contact information from the originating agency(ies). The State reserves the right to withdraw approval of an item as "reusable" if the in-service repair costs regularly exceed the posted maximum.

(729-10) TEMPORARY IMPACT ATTENUATORS - REDIRECTIVE:

Re-directive Temporary Impact Attenuators are defined by NCHRP 350 as a Category III device and shall be NCHRP 350 or MASH approved as a re-directive, non-gating device. Temporary impact attenuators that use liquid or other materials as a filler or to provide ballast will be evaluated for potential environmental impacts and/or seasonal limitations.

Temporary impact attenuators meeting the requirements of NCHRP 350 Test Level 2 are acceptable only as Test Level 2 devices. A Temporary impact attenuator accepted as a Test Level 3 device is also acceptable as Test Level 2 device. Temporary impact attenuators will be approved for use in shielding an object of a maximum width as specified by manufacturer, and specific configurations may be approved for maximum speeds per the test level of the NHCRP 350 or MASH approval. Approach ends of Temporary impact attenuators shall have impact attenuator markings in accordance with the MUTCD.

If a temporary foundation slab is required, concrete shall be Class A concrete conforming to Section 501 *Portland Cement Concrete - General*; reinforcing steel shall conform to §709-01 *Bar Reinforcement, Grade 420*. Seals and anchors shall conform to §701-05 – Concrete Grouting Material and §701-07 Anchoring Materials – Chemically Curing as found the NYSDOT Standard Specifications.

(729-11) TEMPORARY IMPACT ATTENUATORS - GATING:

Gating Temporary Impact Attenuators are defined by NCHRP 350 as a Category III device and shall be NCHRP 350 or MASH approved as a gating device. Temporary impact attenuators that use liquid or other materials as a filler or to provide ballast will be evaluated for potential environmental impacts and/or seasonal limitations. Temporary impact attenuators meeting the requirements of NCHRP 350 or MASH Test Level 2 are acceptable only as Test Level 2 devices. A Temporary impact attenuator accepted as a Test Level 3 device is also acceptable as a Test Level 2 device. Temporary impact attenuators will be approved for use in shielding an object of a maximum width as specified by manufacturer, and specific configurations may be approved for maximum speeds per the test level of the NHCRP 350 or MASH approval. Approach ends of Temporary impact attenuators shall have impact attenuator markings in accordance with the MUTCD.

If a temporary foundation slab is required, concrete shall be Class A concrete conforming to Section 501 *Portland Cement Concrete - General*; reinforcing steel shall conform to §709-01 *Bar Reinforcement, Grade 420*. Seals and anchors shall conform to §701-05 – Concrete Grouting Material and §701-07 Anchoring Materials – Chemically Curing as found in the NYSDOT Standard Specifications.

(729-12) TRUCK-MOUNTED & TRAILER MOUNTED IMPACT ATTENUATORS:

Truck-Mounted Impact Attenuators (TMAs) or Trailer Mounted Impact Attenuators (TMIAs)mounted on the rear of work vehicles are defined by NCHRP 350 as a Category III device and must be NCHRP 350 or MASH approved. TMAs meeting the requirements of NCHRP 350 / MASH Test Level 2 are acceptable only as Test Level 2 devices. Mounted Attenuators accepted as a Test Level 3 device is also acceptable as a Test Level 2 device. Approach ends of TMIAs shall have impact attenuator markings in accordance with the MUTCD.

(729-13) TEMPORARY SAND BARRELS:

Sand Barrels are defined by NCHRP 350 as a Category III device, and shall be NCHRP 350 or MASH approved.
Sand barrels shall be yellow, durable, waterproof, ultraviolet-stable plastic. The first barrel in the array shall have impact attenuator markings in accordance with the MUTCD. Sand barrels shall resist deformation from dynamic loadings due to vibration in the placement area and long-term stresses induced by thermal expansion/contraction and fill settlement. Sand barrels shall be free draining with respect to residual moisture in the fill sand. Lids shall divert precipitation and prevent moisture from entering the module. Lids shall be fastened or otherwise secured to provide a closed, reasonably vandal-resistant barrel. The fill sand shall conform to the requirements of either '703-06 *Cushion Sand* or '703-07 *Concrete Sand*. Sodium chloride, as dry rock salt, equal to 3-5 percent by weight of the sand, shall be thoroughly mixed into the sand. Sodium chloride shall meet the requirements of '712-03 *Sodium Chloride*.

(729-14) VEHICLE-ARRESTING SYSTEMS

Vehicle-arresting systems are defined by FHWA as a Category III device shall be NCHRP 350 or MASH approved. Systems are designed to bring moving vehicles to a safe, non-lethal stop. Systems can be installed above ground, in-ground or be fully transportable. Applications for this type of system include highway run-off control and escape ramps, median barriers, High Occupancy Vehicle (HOV) lane closures, work zone protection, rail crossing disaster prevention and entry-denial/control for secure area lockdown and anti-terrorist safeguards.

(729-18) WARNING LIGHTS

SCOPE. This specification covers the material and performance requirements for warning lights. Warning lights are not defined separately by FHWA, but rather are considered a system component.

MATERIAL REQUIREMENTS. Warning lights shall be mounted on signs or channelizing devices in a manner that, if hit by an errant vehicle, they will not be likely to penetrate the windshield. Warning lights shall be Type A (low-intensity flashing), Type B (high-intensity flashing), or Type C (steady-burning). Warning lights shall meet the requirements of the MUTCD Section 6F.83 and the ITE Purchase Specification for Flashing and Steady Burn Warning Lights. Warning lights shall have a minimum nominal diameter of 7 inches and shall emit yellow light. Flashing warning lights shall flash between 55 and 75 times per minute. Flashing warning lights required to operate 24 hours per day shall be Type B. Steady-burning warning lights shall operate from one-half hour after sunset to one-half hour before sunrise. Warning lights shall have a minimum mounting height of 30 inches to the bottom of the lens. Warning lights shall be powered by batteries, line power, or solar cells adequate to maintain the required luminance during all periods of required operation.

CRASH CUSHIONS (freestanding, Sand-filled Plastic Containers):

The crash cushion barrels, manufactured by Energy Absorption Systems (Energite III) and TrafFix Devices Inc. (Big Sandy Impact Attenuator Sand Barrels), or equal, shall consist of individual self-contained, freestanding plastic containers which are easy to install with limited site preparation; and which may be used for temporary and permanent low frequency installations. This crash cushion system meets the FHWA guidelines (NCHRP 350, Test Level 3 or MASH) as a non-directive crash cushion. The crash cushion modules shall be designed and manufactured of materials which will shatter upon impact, allowing the vehicle's momentum to be transferred to the sand mass while bringing the out-of-control vehicle to a controlled, safe stop, minimizing personal injury. The sand mass in each module of an array shall be positioned so that the center of gravity is at the proper elevation to control the attitude of the impacting vehicle to avoid a ramping effect.

The module system shall be designed to allow fixing dry sand mass capacities at the following weights: 200#, 400#, 700#, 1400# and 2100#, in accordance with the manufacture's recommendations and as determined by the agency's qualified engineer. Each container shall have clear graduated markings on the inside to allow for proper filling of sand mass in accordance with the prescribed array design. Each module shall measure approximately 35"-37" in diameter and 36"-38" high. The outer container (cylinder) shall be constructed of minimum 1/4" thick structural density polyethylene or polypropylene. The lids and core/cone inserts (where required) shall fit securely and shall be made of polyethylene, polystyrene or polypropylene. Units shall be furnished complete and shall be ready for assembly and installation by agency personnel; including clear instructions for assembly, installation and maintenance.

Necessary components and replacement parts should also be available for purchase through the catalog.

QUAD GUARD SYSTEM:

This crash cushion system, as manufactured by Energy Absorption Systems, or equal, meets the Federal guidelines (NCHRP 350, Test Level 3 or MASH); which requires a crash cushion designed for narrow hazardous areas to be re-directive and non-gating for light cars and high center-of-gravity pickup trucks at speeds up to 62 mph and at angles up to 20°.

Necessary components and replacement parts should also be available for purchase through the catalog.

TAU II IMPACT ATTENUATOR SYSTEM:

This crash cushion system, manufactured by Barrier Systems, Inc. of Rio Vista, CA, or equal, meeting the FHWA guidelines (NCHRP 350, Test Level 3 or MASH), is an impact attenuator of the thrie beam type with expendable barriers. These attenuators are configured with a varying number of bays and may transition to vertical walls, safety shape concrete barriers, thrie beam corrugated barrier and corrugated beam. Necessary components and replacement parts should also be available for purchase through the catalog.

BRAKEMASTER 350 SYSTEM:

This crash cushion system, as manufactured by Energy Absorption systems, or equal, meets the FHWA guidelines (NCHRP 350, Test Level 3 or MASH), as a re-directive, gating guardrail end treatment. This system provides shielding for dangerous guardrail ends at wide median and roadside sites with adequate clear zones. The system allows its guardrail panels to move rearward during head-on impacts, and also safely redirects vehicles in side impacts at speeds up to 62 mph and a angles up to 20°.

Necessary components and replacement parts should also be available for purchase through the catalog.

REACT 350 SYSTEM:
This crash cushion system, as manufactured by Energy Absorption Systems, or equal, meets the FHWA guidelines (NCHRP 350, Test Level 3 or MASH), as a re-directive, non-gating crash cushion. The system allows its plastic cylinders to regain up to 90% of their original shape and capacity when impacted at speeds in the range of 45-70 mph. The system is designed to attenuate head-on impacts and, together with the anchor system, safely redirect side angle impacts.
Necessary components and replacement parts should also be available for purchase through the catalog.

NU-GUARD -27:
This Strong Post Guide Rail System as designed by Nucor Steel Marion, meets FHWA Guidelines, passing NCHRP 350, Test Level 3 and MASH testing criteria and is accepted as a guiderail system for both roadside and median applications. Using rib-back U-Channel steel posts, offset blocks and standard w-beams enables fast installation. Nu-Guard- 27 is FHWA accepted for use on roads with design speeds up to 65mph, and can be used in both weak and strong post applications.
Necessary components and replacement parts should also be available for purchase through the catalog.

NU-GUARD-31:
This Strong Post Guide Rail System as designed by Nucor Steel Marion, meets FHWA Guidelines, passing NCHRP 350, Test Level 3, Test Level 4 and MASH Test Level 3 criteria and is accepted as a guiderail system for both roadside and median applications. Using rib-back U-Channel steel posts, and standard w-beams enables fast installation. Nu-Guard-31, as designed, calls for the beam section to rise during impact resulting in a smoother, more predictable redirection.
Necessary components and replacement parts should also be available for purchase through the catalog.

GREGORY MINI SPACER SYSTEM
The *Gregory* GMS as designed by the Gregory Highway Safety Products Division of Gregory Industries meets FHWA Guidelines, full crash tested and accepted to NCHRP 350, Test Level 3 criteria. The system eliminates the need for offset blocks through the use of proprietary hardware designed to give consistent release to w-beam rail, without depending upon slot deformation or complex kinematics by allowing the post to move out of the way upon impact. The “escaping” rail maintains its “W” profile and strength to better contain and redirect impacting vehicles.
Necessary components and replacement parts should also be available for purchase from the core list and trough the catalog.

X-TENSION/ X-MAS MEDIAN ATTENUATOR SYSTEM:
This crash cushion system, manufactured by Barrier Systems, Inc. of Rio Vista, CA, or equal, meeting the FHWA guidelines (NCHRP 350, Test Level 3 or MASH), is an fully Re-Directive, Non-Gating median attenuator system which also offers Tangent and Flared systems for guiderail end terminals designed as a tension-based system as opposed to being compression based. Using an impact head with a cable friction plate inside, a slider assembly and slider bracket, a cable anchor bracket, a foundation anchor assembly, two cable assemblies, a ground strut, standard steel or wood posts and three standard 12 gauge highway W-beam rails.
Necessary components and replacement parts should also be available for purchase through the catalog.

SAFETY (SNOW) FENCING
Snow fencing is a polyethylene rolled plastic sheet material designed to slow wind and create drifts for snow storage so that they will not interfere with roadways, driveways or runways. Strong HDPE plastic resists wind damage and remains flexible in freezing temperatures. It is to be attached across span to conventional steel, plastic or wooden fence posts. It shall be designed so that the sheet is “perforated” via a designed repetitive series of oval openings creating a flexible “mesh” the openings should be approximately 3-1/2” x 1” each. The HDPE plastic shall be of medium gauge, both UV Inhibited and UV Stabilized, with a tensile strength of at least 370 pounds per foot. The plastic shall be weather resistant and capable of performing in temperatures ranging from -60°F to +180°F. The core item calls for the product to be Orange in color, however additional offerings in catalogs may be of different color and heavy gauge as well. Catalogs may also contain other fencing products compliant with the technical specifications listed herein.

WARNING FLAGS
Warning flags are weather resistant, UV Inhibited, UV Stabilized, square cut, highly flexible plastic sheeting consisting of either retroreflective vinyl or nylon and Red or fluorescent orange/red in color. The core list items shall be 12” and 18” square and securely mounted on either wooden or plastic staffs (dowels) 18 to 24 inches in length and not to exceed a diameter of 3/8”. Catalog offerings may include flags of like material in 24” and 36” square sizes with staffs approximately 36” in length.

BARRICADE TAPE
Barricade tape is used to warn, cordon off and restrict clear access to potentially dangerous areas or to areas where open available entry must be deterred. It is a durable, weather-resistant 3”wide, 2 mil thick, bright yellow polyethylene film, imprinted on one side with easy to read, bold, black, 2” high letters in a standardized safety legend, or with evenly spaced 2” wide diagonal striping. The tape is non-adhesive backed, and stays flexible from below freezing to 100°F, and comes in 1000’rolls. Catalog should list the standard legends available, and may offer a red base color and dual sided printing. Catalogs may also offer easy tearing and tying, non-imprinted/non-adhesive polyethylene or PVC Flagging Tape for use in marking area boundaries. Flagging Tape may be 1” to 2” in width, 150’ to 500’ in roll length, and come in blue, red, yellow, fluorescent green, fluorescent orange or fluorescent pink.

(730-05) REFLECTIVE SHEETING

These specifications cover reflective sheeting for Material Use as a component part of the manufacturing of and use on Crash Mitigation Equipment.

GENERAL. The reflective sheeting supplied shall be colored, flexible, weather resistant, and shall have a smooth outer surface. If the reflective sheeting contains spherical lens elements, the lens elements shall be embedded within a transparent plastic, so as to produce a smooth, flat outer surface. All sheeting shall be of good appearance, free from ragged edges, cracks, scales, blisters, or other defects. The back of the reflective sheeting shall be protected by a removable liner and shall include a pre-coated pressure-sensitive or a heat-activated adhesive, either of which may be applied without the necessity of additional adhesive tack coats on the reflective sheeting or application surface. Reflective sheeting shall be one of the following ASTM D4956 types:

730-05.02 - ASTM Type III (Class B). A high-intensity reflective sheeting often referred to as high intensity. It is recommended for highway signs, construction signs, delineators, and other work zone devices.

730-05.03 - ASTM Type V (Class C). A super-high-intensity reflective sheeting recommended for delineators, construction barricades, and vertical panels. This material is not recommended for highway or construction zone sign faces.

730-05.04 - Fluorescent Orange (Class D). A fluorescent orange-colored sheeting with reflective properties similar to Class B high intensity. This sheeting is only recommended for use on orange-colored construction signs, and for the orange portions of construction barricades, vertical panels, and other work zone devices with rigid substrates, when a high level of conspicuity or visibility is needed.

730-05.05 - ASTM Type IX (Class E). A very-high-intensity retroreflective sheeting having highest retroreflective characteristics at short road distances. Recommended for permanent signs, delineators, construction zone devices, and vertical panels, when a high level of conspicuity or visibility is needed.

TABLE 730-05-1 FLUORESCENT SHEETING REQUIREMENTS

Fluorescent Color	Luminance Factor (Y %) Min		Maximum Spectral Radiance Factor(%)	Color Specification Limits [1]							
				1		2		3		4	
	Y_t	Y_f		x	y	x	y	x	y	x	y
Orange	25	15	110.0	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355
Yellow	45	20	---	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442
Yellow Green	60	20	---	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540

NOTE: 1. Four pairs of chromaticity coordinates determine acceptable color in terms of the CIE, 1931 Standard Colorimetric System measured with Standard Illuminant D_{65}.

MATERIAL REQUIREMENTS. Reflective sheeting shall meet the requirements of ASTM D4956 and the following:

1. Fluorescent Colors Shall conform to the requirements of Table 730-05-1.
2. Fluorescent Orange Class D - 730-05.04 Class D fluorescent orange reflective sheeting:

A. Coefficient of Retroreflection (RA). The coefficient of retroreflection shall meet or exceed the Reflectivity requirements indicated in Table 730-05-2

TABLE 730-05-2 FLUORESCENT ORANGE COEFFICIENT OF RETROREFLECTION, RA		
Observation Angle (°)	Entrance Angle (°)	Minimum RA (cd/fc/ft2)
0.2	-4	100.0
0.2	+ 30	34.0
0.5	-4	64.0
0.5	+ 30	22.0

B. Daytime Color. The color shall conform to the requirements for luminance factor, maximum spectral radiance factor (peak reflectance), and color specification limits indicated in Table 730-05-1. Color measurements shall be determined in accordance with ASTM E991, using instrumentation which has circumferential viewing (illumination). Calculations shall be performed in accordance with ASTM E308 for the CIE 1931 2° standard observer.

C. Artificial Weathering. After 1500 hours of artificial weathering performed in accordance with ASTM G 26, Method A, using a Type B weatherometer, the following requirements shall be met:

- The minimum coefficient of retroreflection shall be 55.0 cd/fc/ft2 at 0.2° observation angle; -4° entrance angle.
- The luminance factor (Y Percent) shall be from 20.0 to 45.0.
- The maximum spectral radiance factor (peak reflectance) shall not be less than 60.0 percent.
- The color specification limits shall conform to the requirements shown above in Class D, *B. Daytime Color*.

3. **Type IX (Class E) - 730-05.05.** All colors shall conform to the requirements of ASTM D4956, except fluorescent colors. Fluorescent colors shall conform to the requirements of Table 730-05-1 and Table 730-05-3 of this specification

TABLE 730-05-1 FLUORESCENT SHEETING REQUIREMENTS						
Fluorescent Color	Luminance Factor (Y %) Min	Maximum Spectral Radiance Factor(%)	Observation Angle (°)			
	Entrance Angle (°)		0.1	0.2	0.5	1.0
Orange	-4°		200	115	72	24
	+30°		110	34	22	14
Yellow	-4°		400	240	165	45
	+30°		250	150	75	24
Yellow Green	-4°		540	325	235	65
	+30°		380	200	105	35

FABRICATION. The reflective sheeting shall be so fabricated as to allow easy cutting to specified sizes and shapes.

The sheeting surface shall be solvent resistant and shall permit solvent cleaning. All solvents used for cleaning operations shall be as recommended by the sheeting manufacturer and shall comply with all Federal, State, and Local air quality regulations. To ensure uniform appearance and brilliance under both nighttime and daytime conditions, the reflective sheeting shall be cut, matched and positioned on the prepared sign panel or other substrate in strict accordance with the recommendations of the sheeting manufacturer. Backgrounds, characters, delineators, etc., shall be coated and/or edge sealed in accordance with the recommendations of the sheeting manufacturer. When performed, coating operations shall be done in a workmanlike manner so as to create an even, clear, uniform coat which shall be free of streaks, drops or other defects which might affect reflectivity.

Reflective sheeting shall be furnished in both rolls and sheets. Rolls shall be packed individually and contain not more than four splices per 150 feet linear measurement. Cut sheets shall be packaged flat and in such a manner as to minimize any damage or defacement that may occur to the sheeting during shipment or storage. The sheeting surface shall be capable of being readily processed and be compatible with recommended transparent and opaque process inks. The finished sheeting surface shall show no loss of the color with normal handling, cutting and application.

TESTING. Outdoor test specimen panels shall include both unprocessed reflective sheeting and reflective sheeting processed with the manufacturer's recommended transparent and opaque inks. Type III (Class B), and Type IX (Class E), except Type IX fluorescent orange, reflective sheeting shall be exposed outdoors on a test deck for a minimum 3-year continuous time period. Class D and Type IX (Class E) fluorescent orange sheeting shall be exposed outdoors on a test deck for a minimum 1 year continuous time period. Outdoor exposure testing will not be required for Type V (Class C) reflective sheeting.

Outdoor testing shall consist of exposing reflective sheeting test specimen panels, facing south, and inclined at an angle of 45° from a horizontal position. The test deck facility shall be located in a climate similar to that in which the material is intended to be used, or at a site approved by the Materials Bureau. Testing shall be performed by an independent testing agency or in conjunction with the National Transportation Product Evaluation Program (NTPEP).

Following the specified outdoor exposure time period, all weathered test panels of reflective sheeting shall meet the following performance requirements. The sheeting on the test panels shall show no appreciable adhesion loss, cracking, blistering, crazing, dimensional change, or color change. The minimum percent retained coefficient of retroreflection (RA) shall be as specified below when compared to a control unexposed specimen counterpart. The control specimen reflectivity values (RA) shall be measured at the start of outdoor exposure testing. Measurements shall be taken at 0.2 degree observation angle; - 4 degree entrance angle.

TABLE 730-05-4 MINIMUM PERCENT RETAINED COEFFICIENT OF RETROREFLECTION (RA)	
Type I (Class A) Materials Designation 730-05.01	50%
Type III (Class B) Materials Designation 730-05.02	80%
Class D (Materials Designation 730-05.04)	50%
Type IX (Class E) Materials Designation 730-05.05	60%

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