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New York State Department of Transportation
ENGINEERING INSTRUCTION

EI 98-036

Title: **MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL**

Distribution:
- ☐ Manufacturers (18)
- ☒ Main Office (30)
- ☒ Local Govt. (31)
- ☒ Regions/Agencies (32)
- ☐ Surveyors (33)
- ☒ Consultants (34)
- ☒ Contractors (39)
- ☐ _____( )

Approved:

R. Dennison, Deputy Chief Engineer, Design Division

10/21/98
Date

ADMINISTRATIVE INFORMATION: *This instruction becomes effective with the letting of 02/18/99.* The design information for the units, specifications, and usage are all contained herein. This Engineering Instruction does not cancel or modify any existing Engineering Instruction. The contents of this instruction will eventually be incorporated into the Highway Design Manual.

PURPOSE: The purpose of this Engineering Instruction is to issue special specifications for a Redirective Gating End Terminal (Brakemaster 350) for median barriers in permanent applications. This safety device has passed the NCHRP 350 tests. According to FHWA all safety devices in Contracts advertised after September 1998 have to meet NCHRP 350 requirements.

TRANSMITTED MATERIALS: Transmitted items include pay items as follows:

15606.31 (M) Median Barrier Redirective Gating End Terminal.
15606.3150 (M) Median Barrier Redirective Gating End Terminal (Rustic).

Note: (M) indicates both English and Metric specifications are transmitted.

BACKGROUND: This Median Barrier Redirective Gating End Terminal (Brakemaster 350) was developed in conformance with NCHRP Report 350 by Energy Absorption Systems, Inc., Chicago, IL 60601. It meets the test level 3 criteria, which means it has passed various crash tests including a 100 km/h (62 mph), 15° and 20° impacts with a 2000 kg pickup truck. Because of the extensive repairs needed after a hit, it should primarily be used in low-frequency impact sites. Brakemaster 350 should be used to shield the ends of HPBO corrugated median barrier. Other safety articles that also may be used as of now include the QuadGuard and React 350. These other articles have been discussed in separate Engineering Instructions. Based on the results of the NCHRP 350 tests, FHWA has approved the use of Brakemaster 350 on the National Highway System (NHS) by States if they wish.

COST: The material cost of each unit of Brakemaster 350 is $4000. Add $1500 to $2000 for installation and markup. The cost of any earthwork and grading is not included in this figure and will be paid for separately.

DIMENSIONS: The length of the brakemaster unit from the nose to the back is 9.95 m (32' - 8"). An additional 1.9 m (6' - 3") is required in the front of the nose for the foundation tube anchor assembly that goes in the ground (this is especially important when placing Brakemaster at an intersection). The width of the unit is 635 mm (25") and the height is 686 mm (27").

USAGE POLICY: Items 15606.31 (M) Median Barrier Redirective Gating End Terminal and 15606.3150 (M) Median Barrier Redirective Gating End Terminal (Rustic) may be used to protect the ends of HPBO corrugated median barriers. Because of their high maintenance cost, they should primarily be used at low frequency impact sites.

Brakemaster 350 may be used for speeds upto 110 km/h (70 mph). There is only one model with 5 bays. It may be placed on a foundation of firm soil, compacted subbase, asphalt or concrete. The area under the unit needs to be flat and cross slopes steeper than 8% are to be avoided. If encountered, they should be corrected by means of leveling or grading.

Generally, the presence of expansion joints does not present a problem, but you may contact the manufacturer Energy Absorption Systems, Chicago, IL at (312) 467-6750 or the vendor with any questions.

Curbs and islands higher than 100 mm (4") should be removed. Mountable curbs and islands 100 mm (4") or lower may be retained if they are needed to collect and control pavement runoff, but otherwise even they should be removed from the back of the unit to a point 15 m (50') in advance of the nose of the unit. New curbings , of any height, are not to be installed within the above described limits during or prior to the period when these devices are to be in use.

Layout Information The centerline of the Brakemaster 350 must be in line with the centerline of the median barrier behind the unit to within ±1°. Also, the other end of the median barrier cannot be free standing. It should be anchored either to the ground, another rigid structure or another end terminal.

Brakemaster 350 is a gating end terminal upstream of the third bay counting from the free end (there are 5 bays in all). Thus the last two bays with a total length of 3.6 m (12'=6'x2) would redirect vehicles when struck.

Obstacle Free Area Brakemaster 350 is a gating end terminal. The FHWA recommends that gating end terminals have a *minimum* clear zone of 22.5 m long (75') X 6 m wide (20') *along the median barrier*. This area should be clear of trees, poles, drop-offs, oncoming vehicular traffic and other hazards that a vehicle might encounter when it gates behind the terminal after an angular impact at or near the nose and attempts to recover. If 6 m (20') width is not available, then at least a 1.2 m (4') obstacle free width measured from the outside face of the Brakemaster has to be provided on either side since Brakemaster 350 flares a maximum of 1.2 m (4') on either side when struck by a vehicle on the nose. *Thus, Brakemaster 350 should be used for medians wider than 3.2 m (10.5'=4'+2.5'+4')*. In case of narrow medians, other end terminals should be used such as QuadGuard or React 350 or any other approved system.

IMPLEMENTATION: The main office Design Quality Assurance Bureau will insert the attached specifications into projects that call for their use.

VENDOR INFORMATION: Brakemaster 350 is vended in New York State by Transpo Industries, Inc., New Rochelle, NY - (914) 636-1000.

CONTACT PERSONS: Pratip Lahiri at (518) 457-4090 of the Design Quality Assurance Bureau.

ITEM 15606.31 MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL
ITEM 15606.3150 MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL (RUSTIC)

DESCRIPTION. The Contractor shall furnish and install Median Barrier Redirective Gating End Terminals and Median Barrier Redirective Gating End Terminals (Rustic) at locations shown on the plans or where directed by the Engineer, in accordance with the requirements indicated herein, the directions of the manufacturer, or the instructions of the Engineer.

MATERIALS. The Median Barrier Redirective Gating End Terminal shall be the Brakemaster 350 manufactured by Energy Absorption Systems, Inc., Chicago, IL.

Note. *The Brakemaster 350 system was successfully crash tested in accordance with NCHRP 350. Brakemaster 350s installed under this Contract must be equivalent to the successfully tested articles.*

The Median Barrier Redirective Gating End Terminal shall consist of a rigid front anchor assembly, a breakaway assembly, a brake/tension support, a cable/brake assembly, panel/strap assemblies, diaphragms, and transition straps. It shall be installed in a bidirectional configuration.

The End Terminal components shall meet the following requirements:

Front Anchor. The system shall be anchored at the front by a foundation tube anchor assembly. The top of the rigid front anchor shall have two steel tubes conforming to ASTM A36 for attaching the threaded end of the cable/brake assembly and for attaching the two threaded rods of the breakaway assembly. The threaded rods shall also attach the brake/tension support assembly to the anchor assembly.

Breakaway Assembly. The breakaway assembly shall consist of a galvanized sheet metal nose which bolts to a lever arm made of ASTM A36 material, and wraps around the arm to attach to the panels on the brake/tension support assembly. The lever arm shall have two steel tube ends connected by two threaded rods, conforming to ASTM A193 grade B7, to the rigid front anchor assembly.

Brake Tension Support. The brake/tension support (BTS) shall consist of a rigid channel structure made of ASTM A36 material at the front of the system and shall attach to the rigid front anchor with threaded rods.

Cable Brake Assembly. The cable/brake assembly shall consist of two brakes positioned on a galvanized wire rope cable that conforms to Federal Specification RR-W410A, Type III and supported within the brake/tension support.

One end of the cable shall attach to the rigid front anchor. The cable shall then pass through holes in the diaphragms, through holes in the downstream guiderail posts and shall be secured with a large plate washer and nut.

The brakes shall consist of spring plates and brake sleeves. The spring plates and brake sleeves shall provide a friction resistance which decelerates a vehicle impacting the system on the

nose. The spring plates shall be made of high strength steel conforming to AISI 4140 alloy steel - AR 400.

Panel/Strap Assembly. The panel/strap assembly shall consist of twelve gauge ASTM A36 steel W-beam section panels provided with holes on each end for assembly. The tension straps shall be used to connect panels to diaphragm assemblies.

Diaphragms. The diaphragms shall consist of ASTM A36 tubular steel posts with feet, side plates and a cable grommet. Side plates shall be welded to the ends of the top cap of the posts.

Transition Strap. A transition strap shall consist of a flat bar strap made of ASTM A36 material which attaches to the diaphragm, panel/strap and downstream guiderail.

Galvanizing. After fabrication, all metal work except the brake assemblies and tension straps shall be galvanized in accordance with §719-01. All welding shall be done prior to galvanizing and shall comply with the requirements specified in the New York State Steel Construction Manual, except that radiographic inspection will not be required.

All bolts, nuts and washers used within the Brakemaster 350 Systems shall be galvanized per §719-01.

Brake assembly shall be coated with an epoxy coating. The tension straps shall be pre-galvanized sheet steel to prevent corrosion.

Reflectorization The sheet metal nose shall have, in the front facing traffic, alternating 4" wide reflectorized stripes and black opaque non-reflectorized stripes diagonally at 45 degrees angle or in chevron formation as indicated on the plans or as directed by the Engineer. The reflectorized stripes shall conform to §730-05, Reflective Sheeting, class B or an approved equal. The pattern shall be at least 12" on a side. If no color is given for the reflectorized stripes, the color shall be yellow.

Rustic The Median Barrier Redirective End Terminal (Rustic) shall comply with the above requirements except metal parts exposed to view shall meet the requirements of §710-25 Guide Rail and Median Barrier Systems (Rustic).

BASIS OF ACCEPTANCE. Median Barrier Redirective Gating End Terminal will be accepted at the project site on the basis of the Terminal's conformance to the manufacturer's drawings and the manufacturer's certification that the product delivered is in conformance with these specifications. The supplier shall provide two copies of the manufacturer's drawings and installation instructions through the Contractor to the Engineer at least ten (10) business days prior to the installation of the product.

CONSTRUCTION DETAILS. The Contractor shall install the End Terminal only after receiving authorization from the Engineer.

The End Terminal shall bear upon a prepared surface as shown in the plans, or where directed by the Engineer. Necessary site preparation shall have been performed in accordance

with the requirements under their respective items.

The Contractor shall be required to complete the Median Barrier End Terminal installation within 5 working days after installation of the HPBO median barrier or removal of the anchor or turned down end, so as to limit the exposer of vehicular traffic to impact with the exposed end of the barrier.

Traffic control devices which may include cones, signs, barricades, etc shall be provided as directed by the Engineer. Those devices shall not be removed until the End Terminal system is fully operational.

In the event the End Terminal or End Terminal (Rustic) is damaged, the units shall be promptly repaired. Unless another period is indicated in the Contract documents, promptly shall mean fourteen (14) calendar days from damage.

METHOD OF MEASUREMENT. Median Barrier Redirective Gating End Terminal or Median Barrier Redirective Gating End Terminal (Rustic) will be measured as the number of End Terminals satisfactorily furnished and installed in accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions. The payment limits extend from the free end of the End Terminal to the center of the first HPBO guide rail post which is located approximately 32'-8" from the free end.

BASIS OF PAYMENT. The unit price bid per Median Barrier Redirective Gating End Terminal or Median Barrier Redirective Gating End Terminal (Rustic) shall include the cost of all labor, materials, and equipment necessary to satisfactorily furnish and install the units between the above described payment limits. The cost of earthwork, grading, top soiling, and seeding shall be measured and paid for separately. The cost to repair the End Terminal or End Terminal (Rustic) damaged by public travel will be borne by the Contractor or by the State in accordance with the provisions of §107-09 Damage.

Payment will be made under:

Item No.	Item	Pay Unit
15606.31	Median Barrier Redirective Gating End Terminal	Each
15606.3150	Median Barrier Redirective Gating End Terminal (Rustic)	Each

ITEM 15606.31 M **MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL**

ITEM 15606.3150 M **MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL (RUSTIC)**

DESCRIPTION. The Contractor shall furnish and install Median Barrier Redirective Gating End Terminals and Median Barrier Redirective Gating End Terminals (Rustic) at locations shown on the plans or where directed by the Engineer, in accordance with the requirements indicated herein, the directions of the manufacturer, or the instructions of the Engineer.

MATERIALS. The Median Barrier Redirective Gating End Terminal shall be the Brakemaster 350 manufactured by Energy Absorption Systems, Inc., Chicago, IL.

Note. *The Brakemaster 350 system was successfully crash tested in accordance with NCHRP 350. Brakemaster 350s installed under this Contract must be equivalent to the successfully tested articles.*

The Median Barrier Redirective Gating End Terminal shall consist of a rigid front anchor assembly, a breakaway assembly, a brake/tension support, a cable/brake assembly, panel/strap assemblies, diaphragms, and transition straps. It shall be installed in a bidirectional configuration.

The End Terminal components shall meet the following requirements:

Front Anchor. The system shall be anchored at the front by a foundation tube anchor assembly. The top of the rigid front anchor shall have two steel tubes conforming to ASTM A36M for attaching the threaded end of the cable/brake assembly and for attaching the two threaded rods of the breakaway assembly. The threaded rods shall also attach the brake/tension support assembly to the anchor assembly.

Breakaway Assembly. The breakaway assembly shall consist of a galvanized sheet metal nose which bolts to a lever arm made of ASTM A36M material, and wraps around the arm to attach to the panels on the brake/tension support assembly. The lever arm shall have two steel tube ends connected by two threaded rods, conforming to ASTM A193M grade B7, to the rigid front anchor assembly.

Brake Tension Support. The brake/tension support (BTS) shall consist of a rigid channel structure made of ASTM A36M material at the front of the system and shall attach to the rigid front anchor with threaded rods.

Cable Brake Assembly. The cable/brake assembly shall consist of two brakes positioned on a galvanized wire rope cable that conforms to Federal Specification RR-W410A, Type III and supported within the brake/tension support.

One end of the cable shall attach to the rigid front anchor. The cable shall then pass through holes in the diaphragms, through holes in the downstream guiderail posts and shall be secured with a large plate washer and nut.

The brakes shall consist of spring plates and brake sleeves. The spring plates and brake

sleeves shall provide a friction resistance which decelerates a vehicle impacting the system on the nose. The spring plates shall be made of high strength steel conforming to AISI 4140 alloy steel - AR 400.

Panel/Strap Assembly. The panel/strap assembly shall consist of twelve gauge ASTM A36M steel W-beam section panels provided with holes on each end for assembly. The tension straps shall be used to connect panels to diaphragm assemblies.

Diaphragms. The diaphragms shall consist of ASTM A36M tubular steel posts with feet, side plates and a cable grommet. Side plates shall be welded to the ends of the top cap of the posts.

Transition Strap. A transition strap shall consist of a flat bar strap made of ASTM A36M material which attaches to the diaphragm, panel/strap and downstream guiderail.

Galvanizing. After fabrication, all metal work except the brake assemblies and tension straps shall be galvanized in accordance with §719-01. All welding shall be done prior to galvanizing and shall comply with the requirements specified in the New York State Steel Construction Manual, except that radiographic inspection will not be required.

All bolts, nuts and washers used within the Brakemaster 350 Systems shall be galvanized per §719-01.

Brake assembly shall be coated with an epoxy coating. The tension straps shall be pre-galvanized sheet steel to prevent corrosion.

Reflectorization The sheet metal nose shall have, in the front facing traffic, alternating 100 mm wide reflectorized stripes and black opaque non-reflectorized stripes diagonally at 45 degrees angle or in chevron formation as indicated on the plans or as directed by the Engineer. The reflectorized stripes shall conform to §730-05, Reflective Sheeting, class B or an approved equal. The pattern shall be at least 300 mm on a side. If no color is given for the reflectorized stripes, the color shall be yellow.

Rustic The Median Barrier Redirective End Terminal (Rustic) shall comply with the above requirements except metal parts exposed to view shall meet the requirements of §710-25 Guide Rail and Median Barrier Systems (Rustic).

BASIS OF ACCEPTANCE. Median Barrier Redirective Gating End Terminal will be accepted at the project site on the basis of the Terminal's conformance to the manufacturer's drawings and the manufacturer's certification that the product delivered is in conformance with these specifications. The supplier shall provide two copies of the manufacturer's drawings and installation instructions through the Contractor to the Engineer at least ten (10) business days prior to the installation of the product.

CONSTRUCTION DETAILS. The Contractor shall install the End Terminal only after receiving authorization from the Engineer.

ITEM 15606.31 M **MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL**

ITEM 15606.3150 M **MEDIAN BARRIER REDIRECTIVE GATING END TERMINAL (RUSTIC)**

The End Terminal shall bear upon a prepared surface as shown in the plans, or where directed by the Engineer. Necessary site preparation shall have been performed in accordance with the requirements under their respective items.

The Contractor shall be required to complete the Median Barrier End Terminal installation within 5 working days after installation of the HPBO median barrier or removal of the anchor or turned down end, so as to limit the exposer of vehicular traffic to impact with the exposed end of the barrier.

Traffic control devices which may include cones, signs, barricades, etc shall be provided as directed by the Engineer. Those devices shall not be removed until the End Terminal system is fully operational.

In the event the End Terminal or End Terminal (Rustic) is damaged, the units shall be promptly repaired. Unless another period is indicated in the Contract documents, promptly repaired shall mean fourteen (14) calendar days from damage.

METHOD OF MEASUREMENT. Median Barrier Redirective Gating End Terminal or Median Barrier Redirective Gating End Terminal (Rustic) will be measured as the number of End Terminals satisfactorily furnished and installed in accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions. The payment limits extend from the free end of the End Terminal to the center of the first HPBO guide rail post which is located approximately 9.95 m from the free end.

BASIS OF PAYMENT. The unit price bid per Median Barrier Redirective Gating End Terminal or Median Barrier Redirective Gating End Terminal (Rustic) shall include the cost of all labor, materials, and equipment necessary to satisfactorily furnish and install the units between the above described payment limits. The cost of earthwork, grading, top soiling, and seeding shall be measured and paid for separately. The cost to repair the End Terminal or End Terminal (Rustic) damaged by public travel will be borne by the Contractor or by the State in accordance with the provisions of §107-09 Damage.

Payment will be made under:

Item No.	Item	Pay Unit
15606.31 M	Median Barrier Redirective Gating End Terminal	Each
15606.3150 M	Median Barrier Redirective Gating End Terminal (Rustic)	Each