SUPERSEDED BY EI 07-006 EFFECTIVE 9/06/07	MODIFIED BY EB 99-030 EFFECTIVE 3/29/99	New York State Department of Transportation ENGINEERING INSTRUCTION	EI 98-039

Title: **QUADGUARD - CONSTRUCTION ZONE - TERMINAL IMPACT ATTENUATOR and CONSTRUCTION ZONE REACT 350 CRASH 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 — Date: 12/7/98

ADMINISTRATIVE INFORMATION. This instruction becomes *effective with the letting of 02/18/99.* The devices described and the transmitted specifications may be used sooner. No instructions or bulletins are superseded. The specifications for GREAT-CZ are made obsolete.

SUPERSEDED SPECIFICATIONS. US customary unit specifications superseded: 11619.4003, 11619.4006, 15619.40, 15619.4003, 15619.4006. Metric specifications superseded: 15619.4003 M, 15619.4006 M, 15619.4008 M.

PURPOSE. To issue specifications and design information for temporary applications of the QuadGuard, a redirective impact attenuator manufactured by Energy Absorption, Inc; and for the REACT 350, a Reusable Energy Absorbing Crash Terminal, manufactured by Roadway Safety Services, Inc.. Permanent applications of these devices were discussed in Engineering Instructions 98-028 and 98-014, respectively.

TRANSMITTED MATERIAL. Special Specifications for the QuadGuard and REACT 350, as indicated below:

15619.41XXYY	QuadGuard - Construction Zone - Terminal Impact Attenuator, XX Inches Wide, YY Bays	Each
15619.41XXYY M	QuadGuard - Construction Zone - Terminal Impact Attenuator, XX Width Class, YY Bays	Each

where: In the english unit system, XX is the width of these units, in inches, measured at the back of the unit, and YY is the number of bays in the completed unit. The pay item numbers created for the english unit specifications are retained in the metric system for units of the same physical dimensions. The resulting numbering system coincides with the product numbering system adopted by the manufacturer.

15619.420X (M)	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350)	Each

where X takes on values from 1 through 4 depending on the model of REACT 350 used.

No drawings are transmitted. Because of the variety of installation conditions which may be encountered at the site, the manufacturer and vendor of the QuadGuard-CZ prefer to continue to prepare shop drawings showing all of the details needed at the particular sites. This service is part of the price of the unit. Considerable design, maintenance, and installation information, however, may be found in manuals which are under development and will be made available. Details for the temporary installations of the REACT 350 are included on Materials Details, which were transmitted separately under an EB by the Materials Bureau. Materials Details accompany shipments of product to the project site. Considerable information on how to select the sizes of units to use in given applications is included in the two Engineering Instructions, 98-028 and 98-014.

BACKGROUND. Quadguard - CZ - The Guard Rail Energy Absorbing Terminal - Construction Zone (GREAT-CZ), predecessor of the QuadGuard-CZ, has been used for some time in Department projects to shield narrow objects at locations where guide rails are not practical. In some cases, they have also been used for median barrier end terminals.

The GREAT-CZ is mentioned in the Highway Design Manual in §10.2.6 and §10.2.6.4. It is an energy absorbing device fabricated from thrie beam guide rail beams and hex foam cartridges that crush on impact, thereby absorbing the energy of the impacting vehicle.

With six or more bays, the QuadGuard is rated as a NCHRP 350 "Test Level 3" device. This means the units can be used on all facilities if the right number of "bays"is specified. EI 98-028 indicates how many bays should be used for the various impact speeds.

Because of the recent interpretation of the federal rule that only NCHRP 350 qualified devices may be installed on the National Highway System in projects advertised after 9-30-98, or under force account procedures after that date, regardless of letting, the GREAT-CZs will not be acceptable at some point in the future. QuadGuard CZs, on the other hand, will be acceptable for installation beyond that date in accordance with the federal rule.

QuadGuard-CZs with widths of 610 mm (24"), 760 mm (30"), or 915 mm (36") have the same "footprint" as the GREAT-CZs of those widths, and may be substituted for GREAT-CZs of these widths on contracts by order-on-contract at no additional costs and without rebate.

QuadGuard-CZs may be used to protect one way approaching traffic and, with the appropriate transition piece, may also be used in two-way traffic situations. Five of these transition pieces are available. These are for: 1) Concrete Jersey Barrier, 2) Corrugated W-rail, 3) Thrie Beam, 4) Vertical Surfaces, and 5) Single Slope Barrier.

REACT 350 - REACT 350s are reusable, self-restoring devices, i.e they can be restored to their functional state with virtually no repairs and in a short time. They were developed in conformance with NCHRP Report 350 by Roadway Safety Service, Inc., 80 Remington Blvd., Ronkonkoma, NY 11779. Objects that can be shielded by the REACT 350 include, but are not limited to, ends of concrete barrier, ends of narrow walls, ends of narrow parapets and heavy post blocked-out median barrier. The maximum width of an object that can be shielded by a REACT 350 unit is 610 mm (24"). Depending on the number of barrels selected, REACT 350s may be used at speeds up to 110 km/h (70 mph). Information on the number of barrels required for the various impact speeds can be obtained from Table 1 of EI 98-014.

The reusability property[1] is based upon the self-restoring nature of the high molecular weight polyethylene (ASTM D3350, cell class 345434C) cylinders and the wall thicknesses specified in the Materials Details for the anticipated impact speeds. Selected layout dimensions are included in Table 1 of EI 98-014. The approved Materials Details include complete dimensioning and layout details.

Details on anchorage of the units is also provided in the Materials Details. Under the specifications for installation on existing foundation, anchorage in asphalt concrete is possible provided the asphalt concrete is a minimum 50 mm thick installed over a minimum of 200 mm of compacted subbase. Up to twelve Asphalt Channel Stakes, which are 915 mm (36") in length of 76 mm X 127 mm (3" X 5") channel iron and up to 56 Asphalt Drive Spikes, which are 19 mm (¾") diameter deformed rods 355 mm (14") in length, are required for anchorage purposes. Upon severe impact, these must be reset in place and the resulting voids in the pavement repaired.

Anchorage to asphalt concrete was not permitted in permanent applications because of concerns that the Department would not be able to repair a damaged asphalt foundation quickly enough following impact. Since, however, a Contractor will be at the site during construction, and an EIC will be watching over the work, asphalt anchorage can be a reasonable alternative in the maintenance and protection of traffic setting for moderate to moderately severe service conditions. If collisions at the site are expected to be more than moderate in number or severity, a concrete foundation may be warranted, even in the Maintenance and Protection of Traffic setting.

These units may be installed on existing concrete foundations free of cracking or deterioration that may impair anchorage or the integrity of the foundation. Working cracks or working joints should not be bridged by these units.

If a new foundation slab is required under the item, concrete shall be 200 mm (8") thick Class A concrete conforming to §501-2. Reinforcing steel shall conform to §709-04 Epoxy Coated Bar Reinforcement, Grade 420 or §709-01 Bar Reinforcement, Grade 420, and shall be located and sized as detailed in the approved Materials Details.

LAYOUT INFORMATION. EI 98-014 and EI 98-028 should be consulted for detailed layout information.

USAGE. QuadGuard-CZ may be included in contracts or considered as substitutes for the GREAT-CZs by order-on-

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[1]Although much depends on the speed of impact, these crash terminals have successfully taken hits and been easily restored six times so far. The manufacturer claims that a terminal could take hits up to nine times before there is a need for complete replacement.

contract, without rebate or additional cost to the State, if requested by the Contractor. After the effective date of this instruction, QuadGuard-CZs shall be included in the PS & Es, instead of the GREAT-CZs, when these type devices are desired. The number of bays shall be selected from the table given in EI 98-028, based on impact speed. The width of the unit, measured at the back of the unit near the protected object, shall be not less than the width of the protected object.

QuadGuards are especially warranted when the end of a narrow object is to be shielded and the width available at the site is very limited.

REACT 350s may also be used to shield narrow objects, less or equal to 610 mm (24") in width, and as end terminals for concrete barriers. REACT 350s are 915 mm (36") wide, which is slightly more than the width of the narrowest QuadGuard. In some applications, this additional width may be critical in the choice. REACT 350s are thought to require less maintenance than the QuadGuard as there are no parts that will require replacement after most impacts. Both are regarded as redirective crash cushions. At present, there is no in-service crash performance data or experience with these devices.

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 curbs, 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.

For the QuadGuard-CZ, cross slopes steeper than 8% and changes in the rate of cross slope (twist) greater than 2% from front to back of slab are to be avoided. If encountered, they should be corrected by means of leveling or grading.

For the REACT 350, cross slopes and longitudinal slopes steeper than 10% under the unit are to be avoided. If encountered, they should be corrected by means of leveling or grading.

IMPLEMENTATION. The attached pay items are main office inserts.

Certain information should be shown on the plans. This information would include a plan view showing the unit, its concrete pad or notes that the existing foundation at the site is to be used for foundation, the locations of any drainage structures, utility information, expansion joints, working cracks, edges of pavements, curbing or islands, and identifying any special transitions required between these units and the shielded object.

If QuadGuards are to be attached to concrete barrier, the concrete barrier should be embedded and reinforced over the first 2.50 m (8.25') from the QuadGuard. Bar reinforcement, consisting of # 13 (#4 English) epoxy coated bars at 200 mm c/c (8" c/c) each-way, is required. Twelve (12) Type A Typical Stirrups from the Standard Sheets, spaced 200 mm (8") on centers, will provide the vertical reinforcement in both faces. Six (6) straight bars 2.50 m (8.25') long replace the four (4) 600 mm (24") long dowels shown on the standard sheets. These would be spaced at 200 mm (8") to provide the horizontal reinforcement.

VENDOR INFORMATION. The QuadGuard-CZ is vended in New York State by Transpo Industries - (914) 636-1000 and REACT 350 by Roadway Supply of New England - (603) 433-7446.

CONTACT PERSON. Larry Brown of DQAB at (518) 457-4093 or Pratip Lahiri at (518) 457-4090.

ITEM 15619.41XXYY QUADGUARD - CONSTRUCTION ZONE - TERMINAL IMPACT ATTENUATOR

DESCRIPTION. The contractor shall furnish, install, repair, maintain, move and remove QuadGuard-CZ Terminal Impact Attenuators at the locations shown on the plans or directed by the Engineer in accordance with these specifications, the approved Shop Drawings, and the directions of the Engineer.

MATERIALS. QuadGuard-CZ Terminal Impact Attenuators shall be manufactured by Energy Absorption Systems, Inc. of Chicago, Illinois or they shall be a terminal determined by the Regional Director to be equal thereto and be approved by the Deputy Chief Engineer, Design Division.

Each QuadGuard-CZ Terminal Impact Attenuator shall contain all external and internal parts necessary to give satisfactory service at the indicated site. QuadGuard-CZ Terminal Impact Attenuator component parts shall meet the following requirements:

A. **Cartridges.** The cartridge boxes shall be Type I and Type II cartridge boxes and shall be of the number and arrangement required by the Manufacturer for the intended application. Cartridge boxes shall be manufactured from a weather-resistant plastic material. Type I cartridges shall contain paper honeycomb material. Type II cartridges shall contain steel honeycomb material which shall be coated to minimize the effects of corrosion.

B. **Cartridge Brackets.** Each bay shall be equipped with cartridge brackets.

C. **Diaphragms.** Diaphragms shall be made from 10 gage ASTM A36 steel quadruple corrugated beam. The length of each diaphragm shall be as required for each application. Two support legs shall be welded to a channel which, in turn, shall be welded to the quadruple corrugated beam. Ski shaped plates shall be welded to the bottom of the support legs. The diaphragms shall be designed to lock onto, and be guided by, an anchored and mounted center monorail support structure.

After fabrication, the diaphragms shall be hot-dip galvanized in accordance with ASTM A123.

D. **Fender Panels**. Fender panels shall be fabricated from 10 gage ASTM A36 steel quadruple corrugated beam guide rail sections. Each fender panel shall be drilled and slotted so that when assembled in the field, the front end shall be bolted to a diaphragm by means of the three horizontally placed 5/8 inch bolts, one of which shall be a "mushroom bolt." The back end of each quadruple corrugated beam fender panel shall overlap and be connected to the fender panel of the next bay by means of mushroom bolts, which fit through the long horizontal slot in the forward fender panel and the short vertical slot in the overlapped fender panel. (The bolt shall have a nut and square washer on the inside.) This permits movement, front to back, of one set of fender panels relative to the panels in the following bay.

E. **Monorail Assembly.** The monorail assembly shall be fabricated to the dimensions shown on the plans.

F. **Tension Strut Back-up**. If a concrete back-up structure is <u>not</u> to be provided, then a tension strut back-up assembly shall be provided. The details of this assembly shall be as indicated in the plans.

G. **Nose Cover**. The nose cover shall be made from a high density polyethylene plastic material of the color indicated in the plans or directed by the Engineer. If no color is given, color shall be yellow.

H. **Metal Work**. All metal work, except transition panels, shall be fabricated from either M1020 Merchant Quality or ASTM A36 steel. After fabrication, all metal work shall be hot dip galvanized in accordance with ASTM A123. Welding shall be in accordance with the New York State Steel Construction Manual.

I. **Fasteners**. All bolts used within the QuadGuard Terminal Impact Attenuator shall be American Standard Regular Bolts, unless indicated otherwise in the Plans. Anchor bolts shall be ASTM

A193 grade B7, grouted into the concrete slab with polyester grout.

J. **Concrete.** Concrete for back-up walls and pad shall meet the requirements of Sections 501 and 555 of the Standard Specifications for Class A concrete.

K. **Reinforcing Steel.** Reinforcing steel shall conform to §709-04 Epoxy Coated Bar Reinforcement, Grade 60.

L. **Transition Panels.** Transition panels shall be fabricated from steel conforming to ASTM A36, hot dip galvanized in accordance with ASTM A123. Five standard transition panels shall be available. These shall be: QuadGuard-CZ to Jersey Barrier; QuadGuard-CZ to W-rail Corrugated Beam; QuadGuard-CZ to Thrie Beam; and QuadGuard-CZ End Shoe(for vertical surfaces); and QuadGuard-CZ to Single Slope Concrete Barrier.

M. **Reflectorization.** Reflectorization, consisting of Class B (High Intensity) sheeting conforming to §730-05 directly applied to aluminum sheeting, shall be affixed to the nose piece of the QuadGuard-CZ in a manner satisfactory to the engineer. Aluminum sheeting shall be 6061T6, 0.032" thick. The pattern and color of the reflectorization shall be as indicated on the plans.

If no pattern is provided, the pattern shall be approximately square, 18 inches on a side. Whenever traffic is allowed to pass on both sides of the unit, the pattern shall be chevrons formed with alternating four inch (4") reflectorized stripes and black opaque non-reflectorized stripes. When traffic will be permitted on only one side, the pattern shall be diagonal four inch (4") stripes, downward pointing to the side traffic is to be permitted, formed as indicated above.

If no color is given, color shall be yellow.

Acceptance. QuadGuard-CZ Terminal Impact Attenuator will be accepted on the basis of conformance of the QuadGuard-CZ Terminal Impact Attenuator with the approved Shop Drawings and the manufacturer's certificate of compliance with these specifications.

CONSTRUCTION DETAILS. Prior to ordering any materials required under this item, the Contractor shall submit two copies of the shop drawings to the Engineer for approval. Shop drawings shall show supports, connections, miscellaneous parts, concrete back-up walls or steel back-up plates, and anchorages not detailed in the plans but necessary to develop the full potential of the QuadGuard-CZ Terminal Impact Attenuator. In addition to the above, the Contractor shall deliver to the Engineer two (2) copies of Design Manuals, Installation Manuals, and Maintenance Manuals prepared for the product. The Contractor shall install the QuadGuard-CZ Terminal Impact Attenuator only after approval of the above shop drawings and authorization from the Engineer to do so.

QuadGuard-CZ shall be built either on existing concrete pad minimum 6" deep or existing 6" minimum asphalt (type 6 or 7) over 6" minimum compacted subbase (minimum 95% of maximum theoretical density). If neither situation exists, then a concrete pad (minimum 8" deep) shall be built as per manufacturer's instructions.

The Contractor shall construct the concrete pad, if required, and back-up structure at the locations shown, or directed, to the dimensions indicated in the approved shop drawings. Steel Tension Strut Backup Assemblies shall be used, except, when protecting concrete piers, concrete parapets, concrete walls, or other rigid objects, either the Steel Tension Strut Backup Assembly or the Concrete Backup Assembly, at the option of the Contractor, shall be used. The appropriate standard transition or, if none of the standard transitions is appropriate, a special transition piece shall be furnished and installed.

QuadGuard-CZ Terminal Impact Attenuators shall bear upon prepared surfaces as shown in the plans. Necessary site preparation shall be performed in accordance with, and included under, their respective items.

To minimize exposure of vehicular traffic to the possibility of impact on the back-up structure, the Contractor shall complete the attenuator installation within seven (7) calendar days after completion

of the back-up structure.

Traffic protection devices, such as cones, drums, lights, signs, barricades, or other articles directed by the Engineer, shall be provided and maintained under their respective items. Those devices shall not be removed until the QuadGuard-CZ Terminal Impact Attenuator is fully operational, and, in lighted areas or areas to be lighted, these articles shall also be maintained until the lighting system is operational.

The Contractor shall be required to maintain the Quadguard-CZ Terminal Impact Attenuator and shall be responsible for a continuous 24 hour operation. If for any reason an attenuator is out of operation the Contractor shall provide delineation, as described above, acceptable to the Engineer until repairs are made or a new attenuator installed.

QuadGuard-CZ shall be moved to another location or removed from the project site as shown in the plans or as directed by the Engineer. When the QuadGuard-CZ is removed from a location and the concrete/asphalt foundation is left in place, the anchors shall be removed from the foundation and the damaged areas repaired with concrete/asphalt as directed by the Engineer. If a portable concrete pad was placed at the location or a new concrete pad was built, then the foundation shall be removed along with the QuadGuard-CZ and the area restored to match the surrounding area as directed by the Engineer.

METHOD OF MEASUREMENT. The work will be measured as the number of QuadGuard Terminal Impact Attenuators of the specified width and number of bays satisfactorily furnished, installed and removed in accordance with these specifications, the plans, approved shop drawings, and the directions of the Engineer. *Note: The plastic nose assembly and its Type I cartridge are not counted in determining the number of bays when installing a new attenuator.*

BASIS OF PAYMENT. The requirements of section 619-5 Basis of Payment shall apply as if the phrase "impact attenuators, crash terminals," is inserted after the word "Barriers," in the "General" section of §619-5.

The unit price bid shall include the cost of all labor, materials, and equipment necessary to satisfactorily erect, maintain, repair and remove an attenuator. The unit price bid shall include the metal or concrete back-up system, the concrete pad if indicated, and necessary materials to fasten the QuadGuard - CZ Terminal Impact Attenuator to the protected feature. Site preparation and maintenance and protection of traffic will be paid for separately under their respective items.

Repair of attenuators damaged by public traffic shall be paid for by dividing the unit bid price by the number of bays plus one, of the damaged attenuator and multiplying the resulting figure by the number of bays damaged. Nose units, if damaged, shall be considered to be a bay. No payment will be made to the Contractor for repair or replacement of any attenuator damaged by the Contractor's operations.

Whenever the Engineer directs that the attenuator be moved to a new location, payment will be made in the same manner as if it were a new attenuator. Minor movements within a single site, such as movements to realign, adjust, maintain, etc., will not be considered as a movement to a new location and will not entitle the Contractor to additional payment.

After an attenuator is placed and is operational, payment will be made for ninety (90) percent of the unit bid price, the remaining ten (10) percent will be paid upon removal.

ITEM 15619.41XXYY QUADGUARD - CONSTRUCTION ZONE - TERMINAL IMPACT ATTENUATOR

Payment will be made under:

Item No.	Item	Pay Unit
15619.41XXYY	QuadGuard - Construction Zone - Terminal Impact Attenuator, XX Inches Wide, YY Bays	Each

where: XX is the width of the QuadGuard-CZ Terminal Impact Attenuator, in inches, measured at the diaphragms; and YY is the number of bays. XX may take on values of 24, 30, 36, 69, and 90. YY may take on values of 03, 04, 05, 06, 09.

ITEM 15619.41XXYY M QUADGUARD - CONSTRUCTION ZONE - TERMINAL IMPACT ATTENUATOR

DESCRIPTION. The contractor shall furnish, install, repair, maintain, move and remove QuadGuard-CZ Terminal Impact Attenuators at the locations shown on the plans or directed by the Engineer in accordance with these specifications, the approved Shop Drawings, and the directions of the Engineer.

MATERIALS. QuadGuard-CZ Terminal Impact Attenuators shall be manufactured by Energy Absorption Systems, Inc. of Chicago, Illinois or they shall be a terminal determined by the Regional Director to be equal thereto and be approved by the Deputy Chief Engineer, Design Division.

Each QuadGuard-CZ Terminal Impact Attenuator shall contain all external and internal parts necessary to give satisfactory service at the indicated site. QuadGuard-CZ Terminal Impact Attenuator component parts shall meet the following requirements:

A. **Cartridges**. The cartridge boxes shall be Type I and Type II cartridge boxes and shall be of the number and arrangement required by the Manufacturer for the intended application. Cartridge boxes shall be manufactured from a weather-resistant plastic material. Type I cartridges shall contain paper honeycomb material. Type II cartridges shall contain steel honeycomb material which shall be coated to minimize the effects of corrosion.

B. **Cartridge Brackets.** Each bay shall be equipped with cartridge brackets.

C. **Diaphragms.** Diaphragms shall be made from 10 gage ASTM A36M steel quadruple corrugated beam. The length of each diaphragm shall be as required for each application. Two support legs shall be welded to a channel which, in turn, shall be welded to the quadruple corrugated beam. Ski shaped plates shall be welded to the bottom of the support legs. The diaphragms shall be designed to lock onto, and be guided by, an anchored and mounted center monorail support structure.

After fabrication, the diaphragms shall be hot-dip galvanized in accordance with ASTM A123.

D. **Fender Panels**. Fender panels shall be fabricated from 10 gage ASTM A36M steel quadruple corrugated beam guide rail sections. Each fender panel shall be drilled and slotted so that when assembled in the field, the front end shall be bolted to a diaphragm by means of the three horizontally placed 16 mm bolts, one of which shall be a "mushroom bolt." The back end of each quadruple corrugated beam fender panel shall overlap and be connected to the fender panel of the next bay by means of mushroom bolts, which fit through the long horizontal slot in the forward fender panel and the short vertical slot in the overlapped fender panel. (The bolt shall have a nut and square washer on the inside.) This permits movement, front to back, of one set of fender panels relative to the panels in the following bay.

E. **Monorail Assembly.** The monorail assembly shall be fabricated to the dimensions shown on the plans.

F. **Tension Strut Back-up**. If a concrete back-up structure is <u>not</u> to be provided, then a tension strut back-up assembly shall be provided. The details of this assembly shall be as indicated in the plans.

G. **Nose Cover**. The nose cover shall be made from a high density polyethylene plastic material of the color indicated in the plans or directed by the Engineer. If no color is given, color shall be yellow.

H. **Metal Work**. All metal work, except transition panels, shall be fabricated from either M1020 Merchant Quality or ASTM A36M steel. After fabrication, all metal work shall be hot dip galvanized in accordance with ASTM A123. Welding shall be in accordance with the New York State Steel Construction Manual.

I. **Fasteners**. All bolts used within the QuadGuard Terminal Impact Attenuator shall be American Standard Regular Bolts, unless indicated otherwise in the Plans. Anchor bolts shall be ASTM

A193 grade B7, grouted into the concrete slab with polyester grout.

J. **Concrete**. Concrete for back-up walls and pad shall meet the requirements of Sections 501 and 555 of the Standard Specifications for Class A concrete.

K. **Reinforcing Steel.** Reinforcing steel shall conform to §709-04 Epoxy Coated Bar Reinforcement, Grade 420.

L. **Transition Panels.** Transition panels shall be fabricated from steel conforming to ASTM A36 M, hot dip galvanized in accordance with ASTM A123. Five standard transition panels shall be available. These shall be: QuadGuard-CZ to Jersey Barrier; QuadGuard-CZ to W-rail Corrugated Beam; QuadGuard-CZ to Thrie Beam; and QuadGuard-CZ End Shoe (for vertical surfaces); and QuadGuard-CZ to Single Slope Concrete Barrier.

M. **Reflectorization**. Reflectorization, consisting of Class B (High Intensity) sheeting conforming to §730-05 directly applied to aluminum sheeting, shall be affixed to the nose piece of the QuadGuard-CZ in a manner satisfactory to the engineer. Aluminum sheeting shall be 6061T6, 0.81 mm thick. The pattern and color of the reflectorization shall be as indicated on the plans.

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

If no color is given, color shall be yellow.

Acceptance. QuadGuard-CZ Attenuator will be accepted on the basis of conformance of the QuadGuard-CZ Terminal Impact Attenuator with the approved Shop Drawings and the manufacturer's certificate of compliance with these specifications.

CONSTRUCTION DETAILS. Prior to ordering any materials required under this item, the Contractor shall submit two copies of the shop drawings to the Engineer for approval. Shop drawings shall show supports, connections, miscellaneous parts, concrete back-up walls or steel back-up plates, and anchorages not detailed in the plans but necessary to develop the full potential of the QuadGuard-CZ Terminal Impact Attenuator. In addition to the above, the Contractor shall deliver to the Engineer two (2) copies of Design Manuals, Installation Manuals, and Maintenance Manuals prepared for the product. The Contractor shall install the QuadGuard-CZ Terminal Impact Attenuator only after approval of the above shop drawings and authorization from the Engineer to do so.

QuadGuard-CZ shall be built either on existing concrete pad minimum 150 mm deep or existing 150 mm minimum asphalt (type 6 or 7) over 150 mm minimum compacted subbase (minimum 95% of maximum theoretical density). If neither situation exists, then a concrete pad (minimum 200 mm deep) shall be built as per manufacturer's instructions.

The Contractor shall construct the concrete pad, if required, and back-up structure at the locations shown, or directed, to the dimensions indicated in the approved shop drawings. Steel Tension Strut Backup Assemblies shall be used, except, when protecting concrete piers, concrete parapets, concrete walls, or other rigid objects, either the Steel Tension Strut Backup Assembly or the Concrete Backup Assembly, at the option of the Contractor, shall be used. The appropriate standard transition or, if none of the standard transitions is appropriate, a special transition piece shall be furnished and installed.

QuadGuard-CZ Terminal Impact Attenuators shall bear upon prepared surfaces as shown in the plans. Necessary site preparation shall be performed in accordance with, and included under, their respective items.

To minimize exposure of vehicular traffic to the possibility of impact on the back-up structure, the Contractor shall complete the attenuator installation within seven (7) calendar days after completion of the

back-up structure.

Traffic protection devices, such as cones, drums, lights, signs, barricades, or other articles directed by the Engineer, shall be provided and maintained under their respective items. Those devices shall not be removed until the QuadGuard-CZ Terminal Impact Attenuator is fully operational, and, in lighted areas or areas to be lighted, these articles shall also be maintained until the lighting system is operational.

The Contractor shall be required to maintain the QuadGuard-CZ Terminal Impact Attenuator and shall be responsible for a continuous 24 hour operation. If for any reason an attenuator is out of operation the Contractor shall provide delineation, as described above, acceptable to the Engineer until repairs are made or a new attenuator installed.

QuadGuard-CZ shall be moved to another location or removed from the project site as shown in the plans or as directed by the Engineer. When the QuadGuard-CZ is removed from a location and the concrete/asphalt foundation is left in place, the anchors shall be removed from the foundation and the damaged areas repaired with concrete/asphalt as directed by the Engineer. If a portable concrete pad was placed at the location or a new concrete pad was built, then the foundation shall be removed along with the QuadGuard-CZ and the area restored to match the surrounding area as directed by the Engineer.

METHOD OF MEASUREMENT. The work will be measured as the number of QuadGuard Terminal Impact Attenuators of the specified width and number of bays satisfactorily furnished, installed and removed in accordance with these specifications, the plans, approved shop drawings, and the directions of the Engineer. *Note: The plastic nose assembly and its Type I cartridge are not counted in determining the number of bays when installing a new attenuator.*

BASIS OF PAYMENT. The requirements of section 619-5 Basis of Payment shall apply as if the words "impact attenuators" and "crash terminals" are included in the list of items in lines 5 through 8 and lines 16 through 20.

The unit price bid shall include the cost of all labor, materials, and equipment necessary to satisfactorily erect, maintain, repair and remove an attenuator. The unit price bid shall include the metal or concrete back-up system, the concrete pad if indicated, and necessary materials to fasten the QuadGuard - CZ Terminal Impact Attenuator to the protected feature. Site preparation and maintenance and protection of traffic will be paid for separately under their respective items.

Repair of attenuators damaged by public traffic shall be paid for by dividing the unit bid price by the number of bays plus one, of the damaged attenuator and multiplying the resulting figure by the number of bays damaged. Nose units, if damaged, shall be considered to be a bay. No payment will be made to the Contractor for repair or replacement of any attenuator damaged by the Contractor's operations.

Whenever the Engineer directs that the attenuator be moved to a new location, payment will be made in the same manner as if it were a new attenuator. Minor movements within a single site, such as movements to realign, adjust, maintain, etc., will not be considered as a movement to a new location and will not entitle the Contractor to additional payment.

After an attenuator is placed and is operational, payment will be made for ninety (90) percent of the unit bid price, the remaining ten (10) percent will be paid upon removal.

ITEM 15619.41XXYY M QUADGUARD - CONSTRUCTION ZONE - TERMINAL IMPACT ATTENUATOR

Payment will be made under:

Item No.	Item	Pay Unit
15619.41XXYY M	QuadGuard - Construction Zone - Terminal Impact Attenuator, XX Width Class, YY Bays	Each

where: XX is the width class of the QuadGuard-CZ Terminal Impact Attenuator. Width class corresponds to the actual width, in inches, measured at the diaphragms. YY is the number of bays. XX may take on values of 24, 30, 36, 69, and 90. YY may take on values of 03, 04, 05, 06, 09.

ITEM 15619.420X CONSTRUCTION ZONE REACT 350 CRASH TERMINAL

DESCRIPTION. This work consists of furnishing, installing, repairing, maintaining, moving and removing Reusable Energy Absorbing Crash Terminals (REACT 350) of the type (model number) indicated in the item description 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 Reusable Energy Absorbing Crash Terminals shall be fabricated by:

Roadway Safety Services, Inc.
Ronkonkoma, NY - 11779
Tel. (847) 487-9810.

Note. *REACT 350s are patented articles, crash tested in accordance with NCHRP 350. REACT 350s installed under this Contract must be equivalent to the successfully tested articles and must conform to the approved Materials Details. If the articles to be furnished and installed are in any way different from the approved Materials Details, the Contractor and/or Manufacturer must submit new Materials Details to the Materials Bureau for approval prior to installation.*

The following materials shall be used in its fabrication:

Cylinders. Cylinders shall be black, high molecular weight polyethylene conforming to ASTM D3350 cell class 345434C. Dimensions and wall thicknesses of all cylinders shall be as given on the approved Materials Details.

Cables. Cables shall be approved 6 X 25 FW plow steel conforming to API STD-9A, galvanized, prestretched and nominally 58,800 pounds minimum breaking strength of the size and lengths indicated on the approved Materials Details. Cables shall be fitted both ends with galvanized fittings of the type indicated on the approved Materials Details.

Other Steel Parts. Anchor plates and structural angles shall be ASTM A36 steel, galvanized after fabrication. Structural Tube used to construct the back up structure, used in the rear section of the rail unit of the six (6) and nine (9) cylinder units and in the railing for the four (4) cylinder units shall be ASTM A 500, Grade B. The pipe sections used in the construction of the backup structure shall be ASTM A53, galvanized after fabrication, having sizes and wall thicknesses as indicated on the approved Materials Details. Chain shall be high strength steel linked chain of the indicated sizes, galvanized and fitted each end with screw pin anchor shackles. Fasteners, anchor bolts and anchor pins and other parts not specified herein shall be as given on the approved Materials Details or in the fabricators instructions.

Welding and Galvanizing. All welding shall be done prior to galvanizing those parts. Welding shall comply with the requirements specified in the New York State Steel Construction Manual, except that radiographic inspection will not be required. Galvanizing shall be in accordance with §719-01, unless indicated otherwise.

Foundation Slabs. If a new foundation slab is required under the item, concrete shall be Class A concrete conforming to §501-2; reinforcing steel shall conform to §709-04 Epoxy Coated Bar Reinforcement, Grade 60.

Acceptance. Reusable Energy Absorbing Crash Terminals (REACT 350) will be accepted at the project site on the basis of the manufacturer's name appearing on the Approved List, conformance of the delivered article with the approved Materials Details, and the manufacturer's certification that the product delivered is in conformance with these specifications. The supplier shall provide two copies of the approved Materials Details through the Contractor to the Engineer as part of the evidence of acceptability for the materials at least ten (10) business days prior to the use of the product.

ITEM 15619.420X CONSTRUCTION ZONE REACT 350 CRASH TERMINAL

CONSTRUCTION DETAILS.

REACT 350 shall be built either on existing concrete pad minimum 8" deep or existing 2" minimum asphalt (type 6 or 7) over 8" minimum compacted subbase (minimum 95% of maximum theoretical density). If neither situation exists, then a concrete pad (minimum 8" deep) shall be built as per manufacturer's instructions and approved materials details.

The foundation slab, if required, shall be reinforced concrete not less than 8 inches thick batched, formed, placed, finished, and cured in accordance with §501-3. The size and type of reinforcement shall be as shown in the foundation details in the approved Materials Details. If accelerators are needed, the Contractor must submit the concrete mix design to the Materials Bureau for prior approval.

Anchors, not cast integrally into the new slab, shall be approved concrete expansion anchors conforming to §701-05 or approved chemical anchors conforming to §701-07 and shall be set into holes drilled with rotary impact drills, approved by the Engineer, of the sizes recommended by the manufacturer of the anchor. Care shall be taken that anchor studs projecting from the surface of the slab or concrete pavement and exposed to traffic are well marked by barricade, drum, or protected by other means as required by the Engineer.

The anchor plates and backup structure shall be bolted in place in accordance with the anchor manufacturer's instructions, but no sooner than seven days after placement of fresh concrete, without accelerators; and no sooner than three days after placement of concrete which has been batched with an approved accelerator.

The base of the concrete barrier at the crash terminal end shall be cut at an angle as indicated in the approved Materials Details.

The appropriate number of cylinders of the indicated wall thicknesses shall be properly arranged on the track, fastened to each other and to the chain assemblies as indicated by the Materials Details. The upper and lower side cables shall be secured to anchorages and to the cylinders and all unnecessary slack shall be removed from the cables. Chains shall be connected to the chain rails as indicated by the Materials Details. The cover shall be installed after all cylinders, cables, chains, etc are in place or at the time directed by the Engineer.

The first barrel shall have, in the front facing traffic, alternating 4 inches wide reflectorized stripes and black opaque non-reflectorized stripes diagonally at 45 degrees angle or in a 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 24 inches on a side. If no color is given for the reflectorized stripes, the color shall be yellow.

Traffic protection devices, such as cones, drums, lights, signs, barricades, or other articles directed by the Engineer, shall be provided and maintained under their respective items. Those devices shall not be removed until the REACT 350 Terminal Impact Attenuator is fully operational, and, in lighted areas or areas to be lighted, these articles shall also be maintained until the lighting system is operational.

The Contractor shall be required to maintain the REACT 350 Terminal Impact Attenuator and shall be responsible for a continuous 24 hour operation. If, for any reason, an attenuator is out of operation the Contractor shall provide delineation, as described above, acceptable to the Engineer until repairs are made or a new attenuator installed.

REACT 350 shall be moved to another location or removed from the project site as shown in the plans or as directed by the Engineer. When the REACT 350 is removed from a location and the concrete/asphalt foundation is left in place, the anchors shall be removed from the foundation and the damaged areas repaired with concrete/asphalt as directed by the Engineer. If a portable concrete pad was placed at the location or a

new concrete pad was built, then the foundation shall be removed along with the REACT 350 and the area restored to match the surrounding area as directed by the Engineer.

METHOD OF MEASUREMENT. Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) will be measured as the number of terminals satisfactorily furnished, installed and removed in accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions.

BASIS OF PAYMENT. The requirements of section 619-5 Basis of Payment shall apply as if the phrase "impact attenuators, crash terminals," is inserted after the word "Barriers," in the "General" section of §619-5.

The unit price bid shall include the cost of all labor, materials, and equipment necessary to satisfactorily erect, maintain, repair and remove an attenuator. The unit price bid shall include, but not be limited to the back-up system, the concrete pad, if indicated, and any excavation or filling. Maintenance and protection of traffic will be paid for separately.

No payment will be made to the Contractor to repair, restore or replace an attenuator after a hit by public traffic. No payment will be made to the Contractor for repair or replacement of any attenuator damaged by the Contractor's operations.

Whenever the Engineer directs that the attenuator be moved to a new location, payment will be made in the same manner as if it were a new attenuator. Minor movements within a single site, such as movements to realign, adjust, maintain, etc., will not be considered as a movement to a new location and will not entitle the Contractor to additional payment.

After an attenuator is placed and is operational, payment will be made for ninety (90) percent of the unit bid price, the remaining ten (10) percent will be paid upon removal.

Payment will be made under:

Item No.	Item	Pay Unit
15619.4201	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.4	Each
15619.4202	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.6	Each
15619.4203	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.9	Each
15619.4204	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.9HS	Each

ITEM 15619.420X M CONSTRUCTION ZONE REACT 350 CRASH TERMINAL

DESCRIPTION. This work consists of furnishing, installing, repairing, maintaining, moving and removing Reusable Energy Absorbing Crash Terminals (REACT 350) of the type (model number) indicated in the item description 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 Reusable Energy Absorbing Crash Terminals shall be fabricated by:

Roadway Safety Services, Inc.
Ronkonkoma, NY - 11779
Tel. (847) 487-9810.

Note. *REACT 350s are patented articles, crash tested in accordance with NCHRP 350. REACT 350s installed under this Contract must be equivalent to the successfully tested articles and must conform to the approved Materials Details. If the articles to be furnished and installed are in any way different from the approved Materials Details, the Contractor and/or Manufacturer must submit new Materials Details to the Materials Bureau for approval prior to installation.*

The following materials shall be used in its fabrication:

Cylinders. Cylinders shall be black, high molecular weight polyethylene conforming to ASTM D3350 cell class 345434C. Dimensions and wall thicknesses of all cylinders shall be as given on the approved Materials Details.

Cables. Cables shall be approved 6 X 25 FW plow steel conforming to API STD-9A, galvanized, prestretched and nominally 260 kN minimum breaking strength of the size and lengths indicated on the approved Materials Details. Cables shall be fitted both ends with galvanized fittings of the type indicated on the approved Materials Details.

Other Steel Parts. Anchor plates and structural angles shall be ASTM A36M steel, galvanized after fabrication. Structural Tube used to construct the back up structure, used in the rear section of the rail unit of the six (6) and nine (9) cylinder units and in the railing for the four (4) cylinder units shall be ASTM A 500, Grade B. The pipe sections used in the construction of the backup structure shall be ASTM A53, galvanized after fabrication, having sizes and wall thicknesses as indicated on the approved Materials Details. Chain shall be high strength steel linked chain of the indicated sizes, galvanized and fitted each end with screw pin anchor shackles. Fasteners, anchor bolts and anchor pins and other parts not specified herein shall be as given on the approved Materials Details or in the fabricators instructions.

Welding and Galvanizing. All welding shall be done prior to galvanizing those parts. Welding shall comply with the requirements specified in the New York State Steel Construction Manual, except that radiographic inspection will not be required. Galvanizing shall be in accordance with §719-01, unless indicated otherwise.

Foundation Slabs. If a new foundation slab is required under the item, concrete shall be Class A concrete conforming to §501-2; reinforcing steel shall conform to §709-04 Epoxy Coated Bar Reinforcement, Grade 420.

Acceptance. Reusable Energy Absorbing Crash Terminals (REACT 350) will be accepted at the project site on the basis of the manufacturer's name appearing on the Approved List, conformance of the delivered article with the approved Materials Details, and the manufacturer's certification that the product delivered is in conformance with these specifications. The supplier shall provide two copies of the approved Materials Details through the Contractor to the Engineer as part of the evidence of acceptability for the materials at least ten (10) business days prior to the use of the product.

CONSTRUCTION DETAILS

REACT 350 shall be built either on existing concrete pad minimum 200 mm deep or existing 50 mm minimum asphalt (type 6 or 7) over 200 mm minimum compacted subbase (minimum 95% of maximum theoretical density). If neither situation exists, then a concrete pad (minimum 200 mm deep) shall be built as per manufacturer's instructions and approved materials details.

The foundation slab, if required, shall be reinforced concrete not less than 200 mm thick batched, formed, placed, finished, and cured in accordance with §501-3. The size and type of reinforcement shall be as shown in the foundation details in the approved Materials Details. If accelerators are needed, the Contractor must submit the concrete mix design to the Materials Bureau for prior approval.

Anchors, not cast integrally into the new slab, shall be approved concrete expansion anchors conforming to §701-05 or approved chemical anchors conforming to §701-07 and shall be set into holes drilled with rotary impact drills, approved by the Engineer, of the sizes recommended by the manufacturer of the anchor. Care shall be taken that anchor studs projecting from the surface of the slab or concrete pavement and exposed to traffic are well marked by barricade, drum, or protected by other means as required by the Engineer.

The anchor plates and backup structure shall be bolted in place in accordance with the anchor manufacturer's instructions, but no sooner than seven days after placement of fresh concrete, without accelerators; and no sooner than three days after placement of concrete which has been batched with an approved accelerator.

The base of the concrete barrier at the crash terminal end shall be cut at an angle as indicated in the approved Materials Details.

The appropriate number of cylinders of the indicated wall thicknesses shall be properly arranged on the track, fastened to each other and to the chain assemblies as indicated by the Materials Details. The upper and lower side cables shall be secured to anchorages and to the cylinders and all unnecessary slack shall be removed from the cables. Chains shall be connected to the chain rails as indicated by the Materials Details. The cover shall be installed after all cylinders, cables, chains, etc are in place or at the time directed by the Engineer.

The first barrel 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 a 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 600 mm on a side. If no color is given for the reflectorized stripes, the color shall be yellow.

Traffic protection devices, such as cones, drums, lights, signs, barricades, or other articles directed by the Engineer, shall be provided and maintained under their respective items. Those devices shall not be removed until the REACT 350 Terminal Impact Attenuator is fully operational, and, in lighted areas or areas to be lighted, these articles shall also be maintained until the lighting system is operational.

The Contractor shall be required to maintain the REACT 350 Terminal Impact Attenuator and shall be responsible for a continuous 24 hour operation. If, for any reason, an attenuator is out of operation the Contractor shall provide delineation, as described above, acceptable to the Engineer until repairs are made or a new attenuator installed.

REACT 350 shall be moved to another location or removed from the project site as shown in the plans or as directed by the Engineer. When the REACT 350 is removed from a location and the concrete/asphalt foundation is left in place, the anchors shall be removed from the foundation and the damaged areas repaired with concrete/asphalt as directed by the Engineer. If a portable concrete pad was placed at the location or a new concrete pad was built, then the foundation shall be removed along with the REACT 350 and the area

restored to match the surrounding area as directed by the Engineer.

METHOD OF MEASUREMENT. Construction Zone Reusable Energy Absorbing Crash Terminal will be measured as the number of terminals satisfactorily furnished, installed and removed in accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions.

BASIS OF PAYMENT. The requirements of section 619-5 Basis of Payment shall apply as if the words "impact attenuators" and "crash terminals" are included in the list of items in lines 5 through 8 and lines 16 through 20.

The unit price bid shall include the cost of all labor, materials, and equipment necessary to satisfactorily erect, maintain, repair and remove an attenuator. The unit price bid shall include, but not be limited to the back-up system, the concrete pad, if indicated, and any excavation or filling. Maintenance and protection of traffic will be paid for separately.

No payment will be made to the Contractor to repair, restore or replace an attenuator after a hit by public traffic. No payment will be made to the Contractor for repair or replacement of any attenuator damaged by the Contractor's operations.

Whenever the Engineer directs that the attenuator be moved to a new location, payment will be made in the same manner as if it were a new attenuator. Minor movements within a single site, such as movements to realign, adjust, maintain, etc., will not be considered as a movement to a new location and will not entitle the Contractor to additional payment.

After an attenuator is placed and is operational, payment will be made for ninety (90) percent of the unit bid price, the remaining ten (10) percent will be paid upon removal.

Payment will be made under:

Item No.	Item	Pay Unit
15619.4201 M	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.4	Each
15619.4202 M	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.6	Each
15619.4203 M	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.9	Each
15619.4204 M	Construction Zone Reusable Energy Absorbing Crash Terminal (REACT 350) Model 350.9HS	Each