MODIFIED BY EB 99-030 EFFECTIVE 3/29/99 & EI 99-032 EFFECTIVE 5/4/00 SUPERSEDED BY EI 01-026 EFFECTIVE 7/11/02		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 98-014

Title: **REUSABLE ENERGY ABSORBING CRASH TERMINAL (REACT 350) INSTALLATION ON EITHER NEW OR EXISTING FOUNDATION**

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

6/1/98
Date

ADMINISTRATIVE INFORMATION: *These specifications may be used immediately upon receipt.* The design information for the units, specifications, and availability of Material Details is all contained herein. This Engineering Instruction does not cancel or modify any existing Engineering Instruction.

PURPOSE: The purpose of this Engineering Instruction is to issue special specifications for these safety devices (REACT 350) in permanent applications. Although these devices may be used for both permanent and temporary (maintenance and protection of traffic) purposes, this Engineering Instruction addresses only the permanent usage. The temporary usage will be addressed in a subsequent Engineering Instruction

TRANSMITTED MATERIALS: Transmitted items include pay items as follows:

15654.200X (M) Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab
15654.210X (M) Reusable Energy Absorbing Crash Terminal (REACT 350) On Existing Concrete Foundation, where the value of X corresponds to the PAY ITEMS given in the Table 1 below, and (M) indicates that both the metric and U.S. customary unit version are referred to.

Approved Material Details will be transmitted separately by the Materials Bureau under an Engineering Bulletin prepared by that Bureau.

BACKGROUND: These reusable self-restoring devices 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 median barriers. Other safety articles that also may be used for some or all of these purposes include the GREAT, the QuadGuard, the CAT, the BRAKEMASTER; and for one way applications where room exists, sand barrel arrays. These other articles will be, or have been, separately discussed in the Highway Design Manual or in separate Engineering Instructions.

The NCHRP 350 tests that this device has passed include: test 3-30 - 820C vehicle at 113 km/hr and 0 degrees; test 3-31 - 2000P pickup truck impacted the nose at 113 km/hr and 0 degrees; test 3-38 - 2000P pickup truck impacted the device at 100 km/hr and 20 degrees; and test 3-39 - 820C car impacted the device at the interface of the backup structure and the last cylinder at 100 km/hr and 20 degrees. Based upon the results of these tests FHWA has classified the REACT 350 "experimental" which means states may use it on the NHS if they wish.

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

[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.

impact speeds. Selected layout dimensions are included in Table 1 below. The approved Materials Details will include complete dimensioning and layout details.

Table 1: Dimensional and Cost Data for REACT 350

SPEED km/h (mph)	NO. BARRELS	PAY ITEMS (new slab / exist foundation)	OVERALL LENGTH UNIT	COST OF UNIT	COST OF SLAB (includes excavation)
70 (45)	4	15654.2001 (M) 15654.2101 (M)	4.64 m (15'-2¾")	$14,500	$1000
90 (55)	6	15654.2002 (M) 15654.2102 (M)	6.47 m (21'-2¾")	$17,200	$1250
100 (60)	9	15654.2003 (M) 15654.2103 (M)	9.21 m (30'-2¾")	$20,800	$1750
110 (70)	9	15654.2004 (M) 15654.2104 (M)	9.21 m (30'-2¾")	$22,500	$1750

Slab dimensions, if slab is required, are 0'-8" (0.2 m) longer than the overall length of the units and 4'-2" (1.27 m) wide. Cost of slab is based on $0.90 per pound for reinforcing steel plus $284 per cubic yard for footing concrete and $250 for excavation. Costs of unit are based on quote from the manufacturer. The quoted prices include rear support assembly, base rails, stabilizer bars, cables/hardware, anchors, cylinders, cover/reflectors, documentation, and shipping to the jobsite. An allowance of $2,000 per unit has been added for the Contractor installation and markup.

If a new foundation slab is required under the item, concrete shall be 8 inches (200 mm) thick Class A concrete conforming to §501-2. Reinforcing steel shall conform to §709-04 Epoxy Coated Bar Reinforcement, Grade 60 (Grade 420) and shall be located and sized as detailed in the approved Materials Details.

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. Existing Hot Mix Asphalt concrete foundations or HMA overlay over concrete foundation may be used for temporary applications but are not recommended by the Manufacturer or the Department for permanent applications.

POLICY: Items 15654.200X (M) Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab and 15654.210X (M) Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation may be used to protect narrow objects. They are especially desirable whenever frequent frontal impacts are expected.

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

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

15654.200X REACT 350 CRASH TERMINAL INCLUDING NEW FOUNDATION SLAB

15654.210X REACT 350 CRASH TERMINAL ON EXISTING CONCRETE FOUNDATION

DESCRIPTION. This work consists of furnishing and installing 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. (516) 588-6200.

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.

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.

15654.200X REACT 350 CRASH TERMINAL INCLUDING NEW FOUNDATION SLAB

15654.210X REACT 350 CRASH TERMINAL ON EXISTING CONCRETE FOUNDATION

CONSTRUCTION DETAILS

Excavation. Excavation necessary shall be in accordance with Section 203 of the Standard Specifications. If the foundation slab is to be installed in a pavement that is to remain in place in the completed project, the limits of excavation in such pavement shall be saw cut full depth prior to removal of the pavement and performance of the excavation work. Unless indicated otherwise, the limits of pavement excavation shall be 24 inches outside the perimeter of the concrete slab.

Foundation Slab. The foundation slab, if required by the pay item, 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 into new reinforced concrete slab or existing concrete foundation. Anchors, not cast integrally into the new slab, shall be anchored with 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.

Front Anchorage and Rear Backup Structure. 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.

Restoration of Pavement. The excavated section of pavement between the new concrete slab and the limit of excavation shall be restored to the full height of the surrounding sound pavement in accordance with §401-3.07 - Conditioning of Existing Surface or as directed by the Engineer.

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

Cylinders, anchor cables, and cover. 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.

Reflectorized markings. The first barrel shall have, in the front facing traffic, 4 inches wide yellow and black reflectorized stripes at 45 degrees angle. The yellow stripes shall conform to §730-05, Reflective Sheeting, class C or an approved equal.

METHOD OF MEASUREMENT. Reusable Energy Absorbing Crash Terminal on Existing Concrete Foundation will be measured as the number of terminals satisfactorily furnished and installed on existing foundations in accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions.

Reusable Energy Absorbing Crash Terminal Including New Foundation Slab will be measured as the number of terminals including reinforced concrete foundations satisfactorily furnished and installed in

15654.200X REACT 350 CRASH TERMINAL INCLUDING NEW FOUNDATION SLAB

15654.210X REACT 350 CRASH TERMINAL ON EXISTING CONCRETE FOUNDATION

accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions.

The material placed under "Restoration of Pavement" shall be measured in accordance with §403-4 - Method of Measurement.

BASIS OF PAYMENT. The unit price bid per Reusable Energy Absorbing Crash Terminal Including New Foundation Slab (including, but not limited to, cost of excavation and saw cutting) or Reusable Energy Absorbing Crash Terminal on Existing Concrete Foundation shall include the cost of all labor, materials, and equipment necessary to satisfactorily complete the work. The work for "Restoration of Pavement" shall be paid for in accordance with §403-5 - Basis of Payment, under an existing item "403.21 - Asphalt Concrete - Truing and Leveling course".

Payment will be made under:

15654.2001	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.4	Each
15654.2002	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.6	Each
15654.2003	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.9	Each
15654.2004	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.9HS	Each
15654.2101	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.4	Each
15654.2102	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.6	Each
15654.2103	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.9	Each
15654.2104	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.9HS	Each

15654.200X M **REACT 350 CRASH TERMINAL INCLUDING NEW FOUNDATION SLAB**

15654.210X M **REACT 350 CRASH TERMINAL ON EXISTING CONCRETE FOUNDATION**

DESCRIPTION. This work consists of furnishing and installing 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. (516) 588-6200.

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.

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.

15654.200X M **REACT 350 CRASH TERMINAL INCLUDING NEW FOUNDATION SLAB**

15654.210X M **REACT 350 CRASH TERMINAL ON EXISTING CONCRETE FOUNDATION**

CONSTRUCTION DETAILS

Excavation. Excavation necessary shall be in accordance with Section 203 of the Standard Specifications. If the foundation slab is to be installed in a pavement that is to remain in place in the completed project, the limits of excavation in such pavement shall be saw cut full depth prior to removal of the pavement and performance of the excavation work. Unless indicated otherwise, the limits of pavement excavation shall be 600 mm outside the perimeter of the concrete slab.

Foundation Slab. The foundation slab, if required by the pay item, 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 into new reinforced concrete slab or existing concrete foundation. Anchors, not cast integrally into the new slab, shall be anchored with 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.

Front Anchorage and Rear Backup Structure. 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.

Restoration of Pavement. The excavated section of pavement between the new concrete slab and the limit of excavation shall be restored to the full height of the surrounding sound pavement in accordance with §401-3.07 - Conditioning of Existing Surface or as directed by the Engineer.

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

Cylinders, anchor cables, and cover. 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.

Reflectorized markings. The first barrel shall have, in the front facing traffic, 100 mm wide yellow and black reflectorized stripes at 45 degrees angle. The yellow stripes shall conform to §730-05, Reflective Sheeting, class C or an approved equal.

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

Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab will be measured as the number of terminals including reinforced concrete foundations satisfactorily furnished and

15654.200X M **REACT 350 CRASH TERMINAL INCLUDING NEW FOUNDATION SLAB**

15654.210X M **REACT 350 CRASH TERMINAL ON EXISTING CONCRETE FOUNDATION**

installed in accordance with the plans and specifications, directions of the Engineer, and the manufacturer's instructions.

The material placed under "Restoration of Pavement" shall be measured in accordance with §403-4 - Method of Measurement.

BASIS OF PAYMENT. The unit price bid per Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab (including, but not limited to, cost of excavation and saw cutting) or Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation shall include the cost of all labor, materials, and equipment necessary to satisfactorily complete the work. The work for "Restoration of Pavement" shall be paid for in accordance with §403-5 - Basis of Payment, under an existing item "403.21 M - Asphalt Concrete - Truing and Leveling course".

Payment will be made under:

15654.2001 M	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.4	Each
15654.2002 M	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.6	Each
15654.2003 M	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.9	Each
15654.2004 M	Reusable Energy Absorbing Crash Terminal (REACT 350) Including New Foundation Slab, Model 350.9HS	Each
15654.2101 M	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.4	Each
15654.2102 M	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.6	Each
15654.2103 M	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.9	Each
15654.2104 M	Reusable Energy Absorbing Crash Terminal (REACT 350) on Existing Concrete Foundation, Model 350.9HS	Each