



U.S. Department  
of Transportation  
**Federal Highway  
Administration**

August 15, 2007

1200 New Jersey Avenue, SE.  
Washington, DC 20590

In Reply Refer To: HSSD/CC-57B

Mr. Barry D. Stephens  
Sr. Vice President Engineering  
Energy Absorption Systems, Inc.  
3617 Cincinnati Avenue  
Rocklin, CA 95765

Dear Mr. Stephens:

In your letter of May 04, 2007, you requested formal FHWA acceptance of a new version of your redirective, non-gating crash cushion called the QuadGuard<sup>®</sup> Elite system, reduced to a length of 8 bays. To support your request, you provided copies of a E-TECH Testing Services Inc. report dated December 2006, entitled "NCHRP Report 350 TL-3 Crash Test Results for the 8 Bay QuadGuard<sup>®</sup> Elite", test videos and drawings of the system.

### **Requirements**

Crash cushions should meet the guidelines contained in the NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". The FHWA Memorandum, "**ACTION**: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of support structures.

### **Product description**

The Energy Absorption Systems, Inc. QuadGuard<sup>®</sup> Elite System is a crash cushion intended to shield highway hazards subjected to the possibility of high impact frequency. The system is available in a variety of lengths (number of bays) and widths (backup configurations). The original 11 bay test level 3 (TL-3) QuadGuard<sup>®</sup> Elite was accepted on December 30, 1998, (FHWA acceptance letter CC-57). The new 8 bay QuadGuard<sup>®</sup> Elite is essentially the same system with the elimination of the last three bays of the 11 bay version.

The original test data demonstrated that the 11 bay QuadGuard<sup>®</sup> Elite system has an excess capacity. Further, 8 years of field experience confirmed that the cylinders performed as intended after multiple impacts. Therefore, you decided to develop an 8 bay alternative which would maintain essentially the same performance characteristics while being less costly and suitable for a greater number of sites.

Design details for the 8 bay QuadGuard® Elite system are shown in Enclosure 1. Major assemblies include the Cylinder, Diaphragm, Fender Panel, Monorail, Nose, and Backup. It has a nominal length of 8.10 m (26.6 ft) and can be configured with backup widths of 610 mm, 762 mm, 914 mm, 1753 mm, and 2286 mm (24", 30", 36", 69" and 90"). The QuadGuard® Elite System consists of reusable high density polyethylene plastic (HDPE) energy absorbing cylinders surrounded by a frame of steel Quad-Beam® guardrail that can telescope rearward during head-on impacts. There are no cylinders in the first two bays. The QuadGuard® Elite System has a center monorail that resists lateral movement during side angle impacts and a backup structure that resists movement during head-on impacts. The nose assembly consists of a flexible nose wrap and an energy absorbing HDPE cylinder. Transitions from the system to the hazard located behind the system are available and may be required depending on site conditions.

Two thicknesses of HDPE cylinders are used in the 8 bay Elite System. Bays 3 through 5 contain 51 mm (2") thick cylinders measuring 813 mm (32") in diameter and 508 mm (20") wide. Bays 6 through 8 contain 102 mm (4") thick cylinders also measuring 813 mm (32") in diameter and 508 mm (20") wide. The 102 mm (4") thick cylinders are actually a composite of two 51 mm (2") thick cylinders nested together. The 711 mm (28") diameter innermost cylinder is also used in the nose of the system. All cylinders are secured within the system by means of 13 mm (0.51") diameter galvanized wire rope tethers which pass through adjacent cylinders and wrap around the support leg of the diaphragm between them. In this way two tethers hold each cylinder in place between diaphragms. The portion of the tether that passes through the cylinders is jacketed by a steel tube to prevent the wire rope from tearing into the HDPE cylinder. The ends of each tether are tied together with standard wire rope clamps.

### **Test article installation**

The test article was rigidly secured to a 27.6 MPa unreinforced concrete foundation using MP-3™ anchors. The test article was anchored with standard MP-3 anchor bolts which are 19 mm (0.75") diameter by 178 mm (7") long ASTM A-193 Grade B7 polyester grouted studs embedded to a depth of 140 mm (5.5").

### **Testing**

The NCHRP Report 350 requires that in order for redirective, non-gating crash cushions to meet the NCHRP 350 TL-3 criteria they must successfully pass tests 3-30, 3-31, 3-32, 3-33, 3-36, 3-37, 3-38 while test 3-39 is intended to test crash cushions in hits by opposing traffic in median and roadside installations. Since the 11 bay QuadGuard® Elite in different width configurations was previously accepted as a TL-3 device, and because the 8 bay QuadGuard® Elite system is essentially the same as the first 8 bays of the 11 bay QuadGuard® Elite, and the small car 820C vehicle did not collapse beyond bay 8 in the testing of the 11 bay system, we agree with your assumption that running test 3-31 with 2000P vehicle would be sufficient to evaluate the performance of the 8 bay QuadGuard® Elite system.

According to the information you provided the test article performed successfully in test 3-31. Occupant risk factors were within the limits specified in NCHRP 350. The test article damage was categorized as "superficial" since all major components were reusable without straightening.

There was no damage to the concrete anchoring system and no significant debris expelled during the impact. The system restored to its initial position. Summary of tests results are presented in Enclosure 2.

We therefore agree that 8 bay QuadGuard<sup>®</sup> Elite system as described above meets the appropriate evaluation criteria for NCHRP 350 TL-3 devices and may be used at all appropriate locations on the National Highway System (NHS) when selected by the contracting authority, subject to the provisions of Title 23, Code of Federal Regulations, Section 635.411, as they pertain to proprietary products. Also, please note that this acceptance is based on the reported crash performance of the device and is not meant to address its installation, maintenance or repair characteristics.

### **Standard provisions**

Please note the following standard provisions that apply to the FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the devices and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the device will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the device being marketed is significantly different from the version that was crash tested, it reserves the right to modify or revoke its acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that they will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance, designated as number CC-57B shall not be reproduced except in full. This letter, and the test documentation upon which this letter is based, is public information. All such letters and documentation may be reviewed at our office upon request.
- The 8 bay QuadGuard<sup>®</sup> Elite system is a patented product and considered proprietary. If proprietary devices are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, they: (a) must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented device for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate device, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

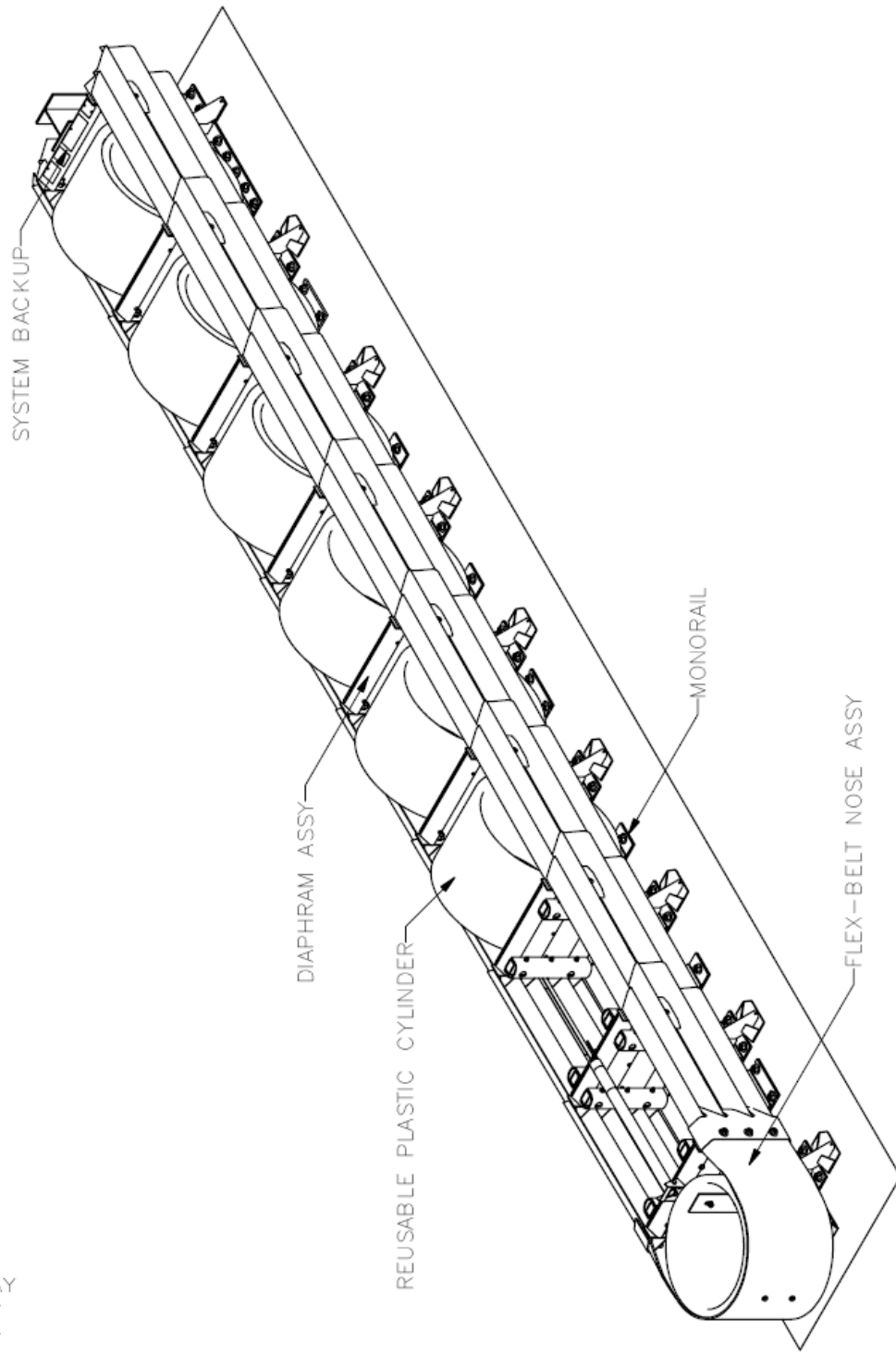
A handwritten signature in blue ink that reads "George E. Rice, Jr." The signature is written in a cursive style with a prominent "G" and "R".

George E. Rice, Jr.  
Acting Director, Office of Safety Design  
Office of Safety

Enclosures

NCHRP 350 TEST LEVELS	DESIGN SPEED (km/h)	BAYS #	LENGTH (m)	BACKUP WIDTH in[mm]
TL3	100	8	8.10	24[610]-90[2280]
TL2	70	7	7.26	24[610]-90[2280]

1998 11 BAY  
1999 7 BAY  
2007 8 BAY



## QuadGuard® Elite System



**ENERGY ABSORPTION SYSTEMS, INC.**  
**ENGINEERING AND RESEARCH DEPARTMENT**

QS2408E

SHEET NO.

DATE:

1 OF 2

2/26/2007



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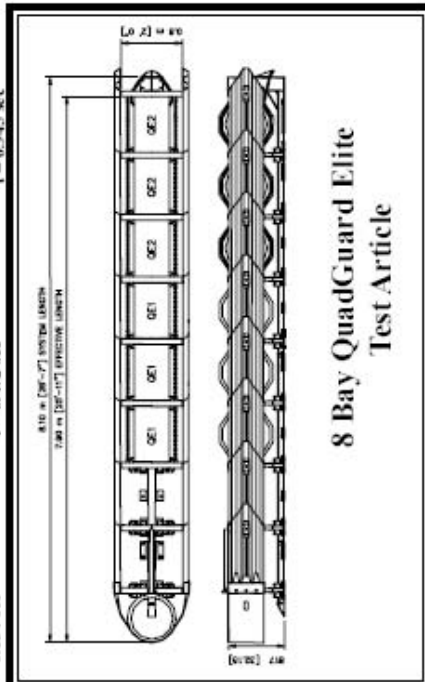
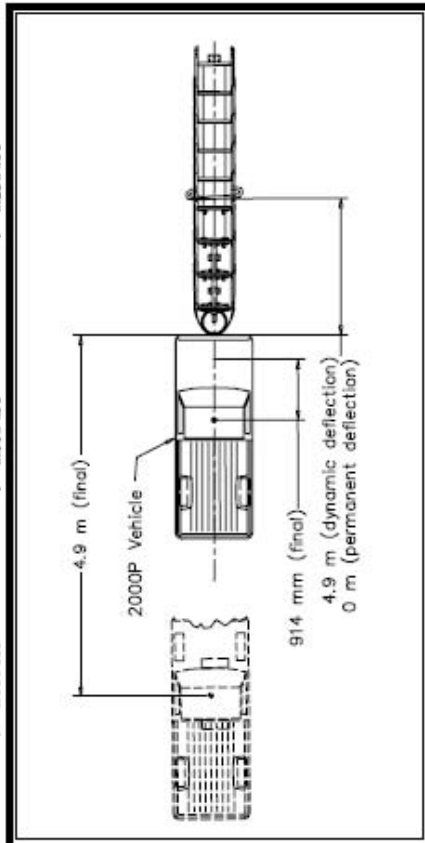
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### 8 Bay QuadGuard Elite Test Article

#### General Information

Test Agency ..... E-TECH Testing Services, Inc.  
 Test Designation ..... NCHRP 350 Test 3-31  
 Test No. .... 01-5500-013  
 Date ..... 10/27/06

Test Article  
 Type ..... Energy Absorption Systems, Inc.  
 Installation Length ..... 8 Bay QuadGuard Elite  
 Material and key elements ..... 7.9 m (effective length)  
 Foundation and Anchoring ..... AASHTO M180 galvanized steel panels, HDPE Cylinders, and A36 other clean and dry with (48) 19 mm x 178 mm ASTM A193 Grade B-7 threaded studs and MP-3 Anchoring System

Test Vehicle  
 Type ..... Production Model  
 Designation ..... 2000P  
 Model ..... 1990 Chevrolet  
 Mass (kg)  
 Curb ..... 1931  
 Test Inertial ..... 2035  
 Dummy ..... NA  
 Gross ..... 2035

Impact Conditions  
 Speed (km/h) ..... 99.7  
 Angle (deg) ..... 0  
 Impact Severity (kJ) ..... 779.9

Exit conditions (rebound)  
 Speed (km/h) ..... 27.2  
 Angle (deg - veh. cg.) ..... 0

Occupant Risk Values  
 Impact Velocity (m/s)  
 x-direction ..... 9.3  
 y-direction ..... 0.0  
 Ridedown Acceleration (g/s)  
 x-direction ..... -13.3  
 y-direction ..... 1.9

European Committee for Normalization (CEN) Values  
 THIV (km/h) ..... 33.6  
 PHD (g/s) ..... 13.3  
 ASI ..... 1.0

Test Article Deflections (m)  
 Dynamic ..... 4.9  
 Permanent ..... 0.0

Vehicle Damage (Primary Impact)  
 Exterior  
 VDS ..... FD-3  
 CDC ..... 12FDEW3

Interior  
 VCDI ..... AS0000000  
 Maximum Deformation (mm) ..... Negligible

Post-Impact Vehicular Behavior (deg - rate gyro)  
 Maximum Roll Angle ..... -1.3  
 Maximum Pitch Angle ..... 13.8  
 Maximum Yaw Angle ..... 8.8

## **Title 23, Code of Federal Regulations**

### **§ 635.411 Material or product selection.**

(a) Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project, unless:

(1) Such patented or proprietary item is purchased or obtained through competitive bidding with equally suitable unpatented items; or

(2) The State transportation department certifies either that such patented or proprietary item is essential for synchronization with existing highway facilities, or that no equally suitable alternate exists; or

(3) Such patented or proprietary item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.

(b) When there is available for purchase more than one nonpatented, nonproprietary material, semifinished or finished article or product that will fulfill the requirements for an item of work of a project and these available materials or products are judged to be of satisfactory quality and equally acceptable on the basis of engineering analysis and the anticipated prices for the related item(s) of work are estimated to be approximately the same, the PS&E for the project shall either contain or include by reference the specifications for each such material or product that is considered acceptable for incorporation in the work. If the State transportation department wishes to substitute some other acceptable material or product for the material or product designated by the successful bidder or bid as the lowest alternate, and such substitution results in an increase in costs, there will not be Federal-aid participation in any increase in costs.

(c) A State transportation department may require a specific material or product when there are other acceptable materials and products, when such specific choice is approved by the Division Administrator as being in the public interest. When the Division Administrator's approval is not obtained, the item will be nonparticipating unless bidding procedures are used that establish the unit price of each acceptable alternative. In this case Federal-aid participation will be based on the lowest price so established.

(d) Appendix A sets forth the FHWA requirements regarding (1) the specification of alternative types of culvert pipes, and (2) the number and types of such alternatives which must be set forth in the specifications for various types of drainage installations.

(e) Reference in specifications and on plans to single trade name materials will not be approved on Federal-aid contracts.

(f) In the case of a design-build project, the following requirements apply: Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the Request for Proposals document unless the conditions of paragraph (a) of this section are applicable.

[41 FR 36204, Aug. 27, 1976, as amended at 67 FR 75926, Dec. 10, 2002]