

June 17, 1999

Refer to: HMHS-

CC57A

J.M. Essex, P.E.  
Senior Vice President, Sales  
Energy Absorption Systems, Inc.  
One East Wacker Drive  
Chicago, IL 60601

Dear Mr. Essex:

In your May 26 letter to me, you requested the Federal Highway Administration's review and acceptance at test level 2 (TL-2) of a 7-bay QuadGuard Elite crash cushion that is similar in design to the 11-bay QuadGuard Elite which was previously-accepted at test level 3 (TL-3). To support your request, you sent me copies of a May 1999 test report entitled "QuadGuard Elite System Qualification to NCHRP 350 Test Level 2 Engineering Summary", which included a report prepared by E-Tech Testing Services, Inc. entitled "NCHRP Report 350 Crash Test Results for the 7 bay (Test Level 2) QuadGuard Elite System" and was also dated May 1999. A videotape copy of the crash tests you conducted was provided to my staff by Mr. Douglas Bernard.

The TL-2 QuadGuard Elite is a 7-bay unit having a nominal length of 7264 mm as shown in Enclosure 1. It can be configured with backup widths of 610 mm, 762 mm, 914 mm, 1753 mm, or 2286 mm. There are no cylinders in the first two bays. Because the TL-2 QuadGuard Elite has the same framework as the TL-3 QuadGuard Elite, we agreed that tests 2-31 on the narrowest unit and test 2-32 on the widest unit appeared most critical and would allow us to evaluate the new design. Our review of these tests shows that all appropriate NCHRP Report 350 evaluation criteria were met. Test summaries are attached as Enclosure 2.

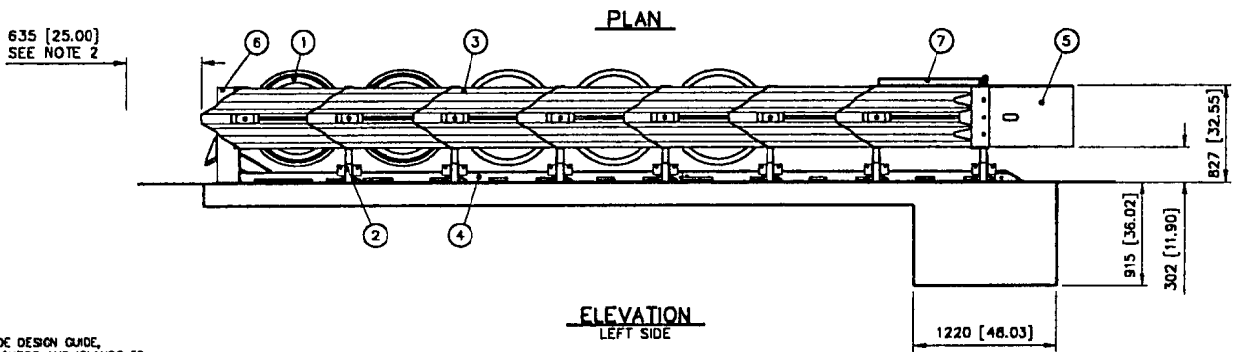
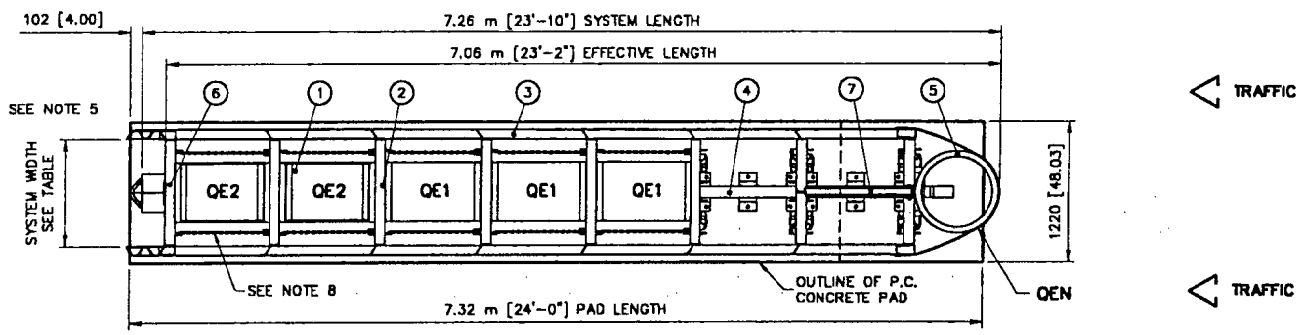
Based on our review of the information you provided, we agree that the 7-bay QuadGuard Elite meets the acceptance criteria for an NCHRP Report 350 crash cushion at test level 2 (TL-2). It may be used on the National Highway System (NHS) when such use is requested by a transportation agency. Because it is a proprietary device, its use on Federal-aid projects, except exempt, non-NHS projects, is subject to the conditions listed in Title 23, Code of Federal Regulations, Section 635.411, copies of which have previously been sent to you. Please do not hesitate to call Mr. Richard Powers of my staff at (202) 366-1320 if you have any questions.

Sincerely yours,

(original signed by Rudolph M. Umbs)

*for* Dwight A. Horne  
Director, Office of Highway Infrastructure

2 Enclosures



- NOTES:**
- IN COMPLIANCE WITH THE AASHTO 1998 ROADSIDE DESIGN GUIDE, MANUFACTURER RECOMMENDS REMOVAL OF ALL CURBS AND ISLANDS TO ENSURE PROPER IMPACT PERFORMANCE.
  - PROVISION SHALL BE MADE FOR REAR FENDER PANELS TO SLIDE REARWARD UPON IMPACT 635 [25.00] MIN.
  - 150 [6.00] MIN. REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE PAD OR 200 [8.00] MIN. NON-REINFORCED 28 MPa [4000 PSI] P.C. CONCRETE ROADWAY.
  - SEE THE "QUADGUARD ELITE SYSTEM DESIGN MANUAL" FOR A DESCRIPTION OF ITS IMPACT PERFORMANCE CHARACTERISTICS AND DESIGN LIMITATIONS BEFORE PLACING A SYSTEM AT A GIVEN SITE. INFORMATION AND COPIES OF ABOVE MANUAL ARE AVAILABLE BY CALLING CUSTOMER SERVICE DEPARTMENT AT 1-888-32-ENERG.

- WHERE NECESSARY, THE CUSTOMER SHALL SUPPLY A TRANSITION FROM THE QUADGUARD SYSTEM TO THE OBJECT BEING SHIELDED.
- UNITS OF MEASUREMENT ARE MILLIMETERS (INCHES) UNLESS OTHERWISE NOTED.
- BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.
- CHAINS INCLUDED ONLY ON 36" SYSTEMS.

MODEL	SYSTEM WIDTH
QS2407E*	610 [24.00]
QS3007E*	762 [30.00]
QS3607E*	914 [36.00]

\* Y= YELLOW NOSE  
G= GRAY NOSE

UNIDIRECTIONAL  
MODEL NO. QS\_\_07E (SEE CHART)

KEY	① QUADGUARD ELITE CYLINDER	④ MONORAIL	⑦ HIT INDICATOR		
	② DIAPHRAGM	⑤ NOSE ASSEMBLY			
	③ FENDER PANEL	⑥ BACKUP			
Revisions	Date	Rev.	By	Ckd.	App.

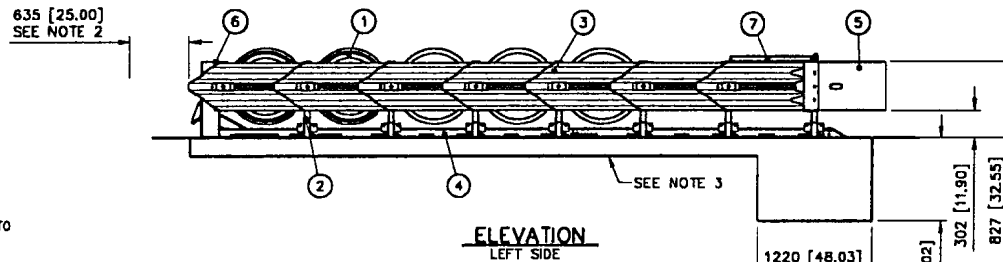
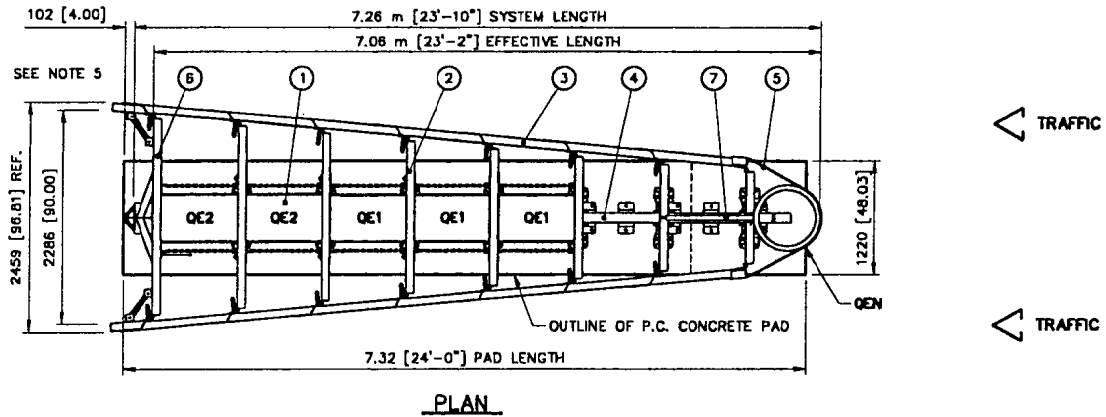
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NOSE COLOR	BAY ASSY. 3540483-0000
NUMBER OF UNITS	CHAIN ASSY. 3540491-0000
DIAPHRAGM ASSY. 3540487-0000	HIT INDICATOR ASSY. 3540483-0000
	NOSE ASSY. 3540499-0000

DESIGNED BY	S. Van Ogle	DATE	11/12/98
DESIGNED BY	R. Bloeski	DATE	11/12/98
DRAWN BY	KRM	DATE	2/3/99
CHECKED BY	RBB	DATE	2/3/99
CAD FILE:	QL2TSCVR-U.dwg		

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

**QUADGUARD® ELITE™ SYSTEM**  
W/ TENSION STRUT BACKUP

SHEET	1=40	TITLE	QL2TSCVR-U	PROJECT	1 of 1	REV	
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- BACKUP ASSEMBLY NOT INCLUDED IN MODEL NUMBER.

\* Y=YELLOW NOSE  
G=GRAY NOSE

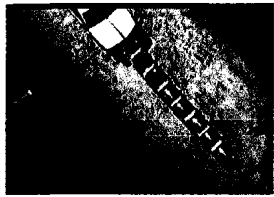
UNIDIRECTIONAL  
MODEL NO. QS9007E\*

Y C K	① QUADGUARD ELITE CYLINDER	④ MONORAIL	⑦ HIT INDICATOR			
	② DIAPHRAGM	⑤ NOSE ASSEMBLY				
	③ FENDER PANEL	⑥ BACKUP				
Revisions		Date	Rev.	By	Ckd.	App.

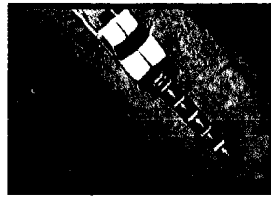
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SALES ORDER #	BACKUP ASSY. 3540396-0000
EH PROJECT #	RAIL ASSY. 3540482-0000
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NOSE COLOR	BAY ASSY. 3540494-0000
NUMBER OF UNITS	CHAIN ASSY. 3540491-0000
DIAPHRAGM ASSY.	HIT INDICATOR ASSY. 3540463-0000
	NOSE ASSY. 3540496-0000

DESIGNED BY	D. Staus	DATE	2/2/99
DESIGNED BY	R. Blockl	DATE	2/2/99
DRAWN BY	KRM	DATE	2/3/99
CHECKED BY	RBB	DATE	2/3/99
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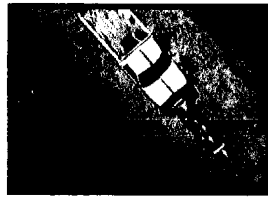
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	<b>QUADGUARD® ELITE™ SYSTEM</b> 90° SYSTEM W/83° TENSION STRUT BACKUP	
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FILE	QL2TSCVR-U90	REV
		1 of 1



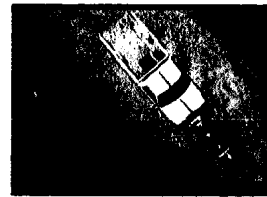
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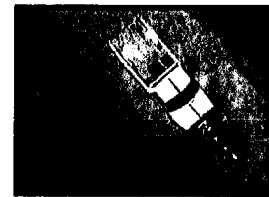
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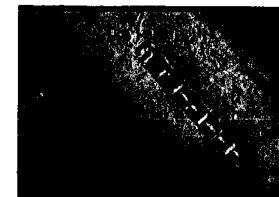
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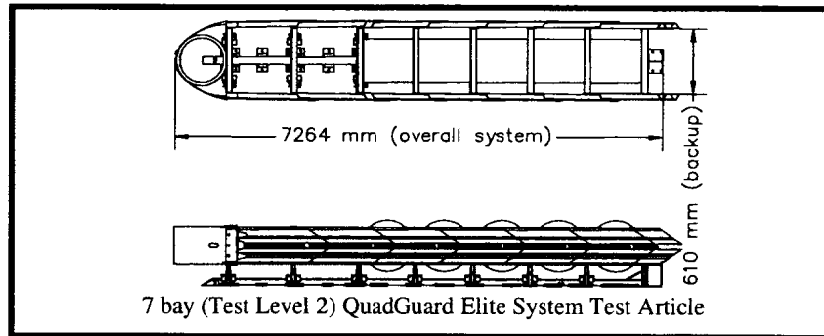
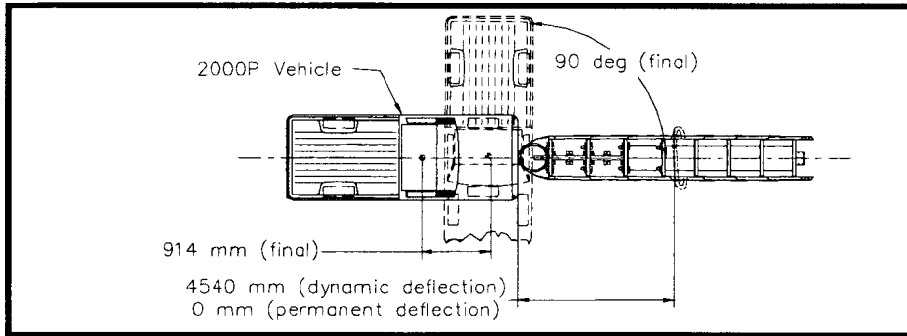
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E-TECH Testing Services, Inc.

**General Information**

Test Agency ..... E-TECH Testing Services, Inc.  
 Test Designation ..... NCHRP 350 Test 2-31  
 Test No. .... 01-7611-003  
 Date ..... 10/13/98

**Test Article**

Type ..... Energy Absorption Systems, Inc.  
 ..... 7 bay (Test Level 2) QuadGuard  
 ..... Elite System

**Size and/or dimension and material**

of key elements ..... 7264 mm System Length  
 ..... 610 mm Backup Width

**Test Vehicle**

Type ..... Production Model  
 ..... 3/4T Pickup  
 Designation ..... 2000P  
 Model ..... 1987 GMC C2500

**Mass (kg)**

Curb ..... 2005  
 Test inertial ..... 1993  
 Dummy(s) ..... N/A  
 Gross Static ..... 1993

**Impact Conditions**

Speed (km/h) ..... 69.6  
 Angle (deg) ..... 0  
 Impact Severity (kJ) ..... 372.6

**Exit conditions (rebound)**

Speed (km/h) ..... 27.7

**Occupant Risk Values**

Impact Velocity (m/s)  
 x-direction ..... 6.5  
 y-direction ..... 0.3

**Ridedown Acceleration (g's)**

x-direction ..... -9.3  
 y-direction ..... 1.7

**European Committee for Normalization (CEN) Values**

THIV (m/s) ..... 6.5  
 PHD (g's) ..... 8.9  
 ASI ..... 0.7

**Test Article Deflections (mm)**

Dynamic ..... 4540  
 Permanent ..... 0 (restored)

**Vehicle Damage**

Exterior  
 VDS ..... FC-2  
 CDC ..... 12FCEW2  
 Interior  
 OCDI ..... AS000000

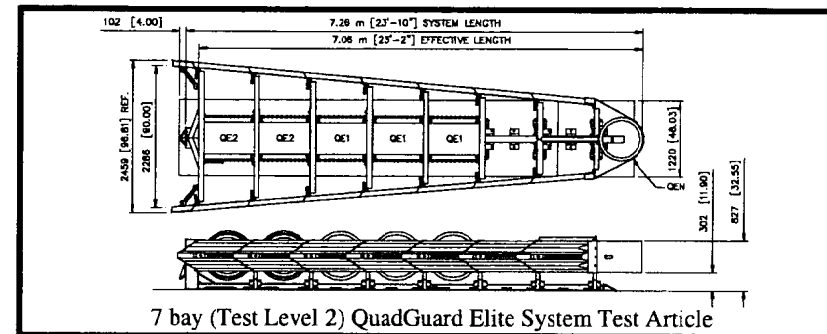
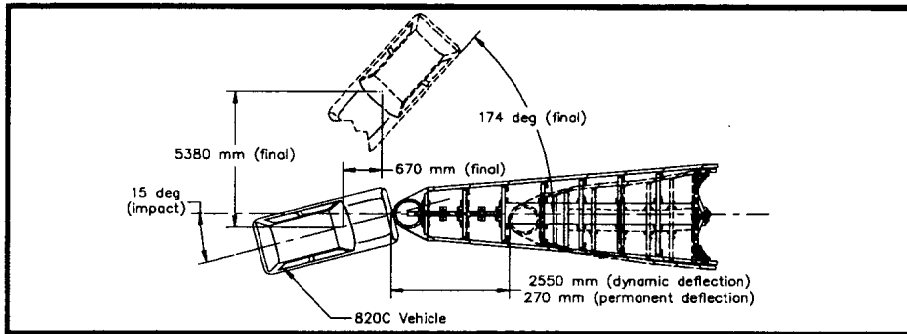
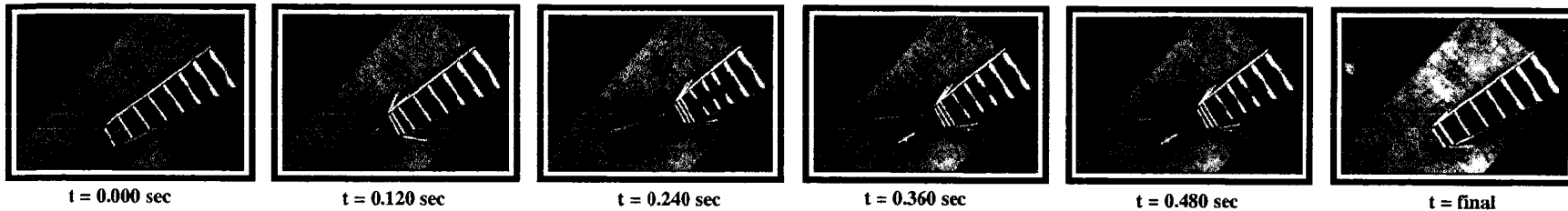
**Post-Impact Vehicular Behavior (deg - gyro @ c.g.)**

Maximum Roll Angle ..... -8.5  
 Maximum Pitch Angle ..... 4.3  
 Maximum Yaw Angle ..... -270.3

Test Level 2 QuadGuard® Elite™ Crash Test Results - 9 of 42

Figure 1. Summary of Results - 7 bay QuadGuard Elite System Test 01-7611-003

ENCLOSURE 2 (1 OF 2)



E-TECH Testing Services, Inc.

**General Information**

Test Agency ..... E-TECH Testing Services, Inc.  
 Test Designation ..... NCHRP 350 Test 2-32  
 Test No. .... 01-7611-004  
 Date ..... 2/12/99

**Test Article**

Type ..... Energy Absorption Systems, Inc.  
 ..... 7 bay (Test Level 2) QuadGuard  
 ..... Elite System

**Size and/or dimension and material**  
 of key elements ..... 7264 mm System Length  
 ..... 2286 mm Backup Width

**Test Vehicle**

Type ..... Production Model  
 Designation ..... 820C  
 Model ..... 1988 Ford Festiva

**Mass (kg)**

Curb ..... 807  
 Test inertial ..... 825  
 Dummy ..... 75  
 Gross Static ..... 900

**Impact Conditions**

Speed (km/h) ..... 70.6  
 Angle (deg) ..... 15  
 Impact Severity (kJ) ..... 158.8

**Exit conditions (rebound)**

Speed (km/h) ..... N/A

**Occupant Risk Values**

Impact Velocity (m/s)  
 x-direction ..... 7.4  
 y-direction ..... 1.3

**Ridedown Acceleration (g's)**

x-direction ..... -14.6  
 y-direction ..... -6.8

**European Committee for Normalization (CEN) Values**

THIV (m/s) ..... 7.9  
 PHD (g's) ..... 11.2  
 ASI ..... 0.9

**Test Article Deflections (mm)**

Dynamic ..... 2550  
 Permanent ..... 270

**Vehicle Damage**

**Exterior**  
 VDS ..... FC-4  
 CDC ..... 12FCEW3  
**Interior**  
 ODCI ..... AS000000

**Post-Impact Vehicular Behavior (deg - gyro @ c.g.)**

Maximum Roll Angle ..... 19.9  
 Maximum Pitch Angle ..... -9.3  
 Maximum Yaw Angle ..... 159.2

**Figure 6. Summary of Results - 7 bay QuadGuard Elite System Test 01-7611-004**