



March 20, 2009

In Reply Refer To: HSSD/CC-35I

Mr. Barry D. Stephens, P.E.  
Sr. Vice President Engineering  
Energy Absorption Systems, Inc.  
3617 Cincinnati Avenue  
Rocklin, CA 95678

Dear Mr. Stephens:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of a roadside safety device for use on the National Highway System (NHS).

Name of device:	5-bay QuadGuard II 5-bay QuadGuard II Wide 2-bay QuadGuard II
Type of device:	Impact Attenuators
Test Level:	NCHRP Report 350 Test Levels 2 and 3
Testing conducted by:	E-Tech Testing Services, Inc.
Date of request:	December 8, 2008

You requested that we find this device acceptable for use on the NHS under the provisions of National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

### **Requirements**

Roadside safety devices should meet the guidelines contained in the NCHRP Report 350." The FHWA Memorandum "Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

### **Description**

The QuadGuard<sup>®</sup> II is a redirective, non-gating crash cushion with a reduced length of 5 bays that is otherwise identical to the previously accepted Test Level 3 (TL-3) 6-bay unit (see FHWA Acceptance Letter CC-35, dated June 21, 1996). The difference is that one bay is removed from the rear of the system and a new sheet metal front nose is used. Likewise, the QuadGuard<sup>®</sup> II with a reduced length of 2 bays is identical to the previously accepted TL-2 3-bay unit (ref. CC-35C, dated June 17, 1999) with the exception of one of the rear bays being removed plus a new sheet metal front nose.

Features of the 5-bay QuadGuard<sup>®</sup> II systems (narrow and wide) as well as the 2-bay QuadGuard<sup>®</sup> II narrow system are depicted in the enclosed drawings for reference. The QuadGuard<sup>®</sup> II 5-bay narrow system has an overall length of 5830 mm (19' 1") and can be configured with backup widths of 610 mm (24 inches), 762 mm (30 inches), 914 mm (36 inches), 1753 mm (69 inches), and 2286 mm (90 inches). The 2-bay QuadGuard<sup>®</sup> II system has an overall length of 3080 mm (10' 1") and can be configured with a backup width of 610 mm (24 inches). The system consists of energy absorbing cartridges surrounded by a framework of steel Quad-Beam<sup>®</sup> guardrail that can telescope rearward during head-on impacts. The system has a center monorail that will resist lateral movement during side angle impacts and a back up structure that will resist movement during head-on impacts. Simply removing a rear Bay from an existing 6-Bay or 3-Bay system will not be adequate to meet TL-3 and TL-2 impact speeds, respectively. As noted in your report, the QuadGuard II system requires an upgraded nose assembly.

### **Crash Testing**

The original 6-bay test data of NCHRP 350 Test 3-31 and 3-32 demonstrated that the 2000P vehicle impacting at 0 degree and a nominal speed of 100km/h (63 mph) resulted in a ridedown g's of -14.52 and Occupant Impact Velocity ( $\Delta V$ ) of 10.55 m/s. An engineering review of this previous data indicated excess capacity in the device and prompted a crash test to be done after removing bay 6. The NCHRP 350 Tests 3-31 and 3-32 were conducted and the results are as follows:

#### Narrow System 610mm (24 inches) width:

Test 3-31: Impact speed: 101.1 km/h, ridedown of -17.3 g's, and  $\Delta V$  9.6 m/s.

Test 3-32: Impact speed: 98.3 km/h, ridedown of -17.4 g's, and  $\Delta V$  12.4 m/s.

#### Wide System 2286mm (90 inches) width:

Test 3-31: Impact speed: 99.7 km/h, ridedown of -17.0 g's, and  $\Delta V$  10.0 m/s.

Test 3-32: Impact speed: 97.7 km/h, ridedown of -17.4 g's, and  $\Delta V$  11.7 m/s.

Similarly the 3-bay narrow system test data demonstrated that the 2000P vehicle impacting at 0 degree and a nominal speed of 70km/h (43.5 mph) resulted in a ridedown g's of -19.57 and Occupant Impact Velocity ( $\Delta V$ ) of 8.89. Again an engineering review indicated excess capacity in the device and prompted the following crash tests with results as follows:

Test 2-31: Impact speed: 68.3 km/h, ridedown of -19.4 g's, and  $\Delta V$  10.7 m/s.

Test 2-32: Impact speed: 67.7 km/h, ridedown of -17.8 g's, and  $\Delta V$  10.8 m/s.

Due to the elimination of one bay at the rear of each system we concur that the tests performed provide adequate capacity of head-on impacts for all widths of TL-3 5-bay QuadGuard<sup>®</sup> II systems. In addition we also concur that the tests performed on the TL-2 2-bay QuadGuard<sup>®</sup> II system provide adequate capacity for head-on impacts for the 610mm (24 inches) width system. We agree that the front of the system was adequately tested for the 820C vehicle crash

characteristics. Based upon the multiple redirective test impacts into the QuadGuard<sup>®</sup> and the basic structure of the reduced 5-bay and 2-bay QuadGuard<sup>®</sup> II being unchanged, redirective tests are not required.

### **Findings**

The QuadGuard<sup>®</sup> II 5-bay and 2-bay systems meet the evaluation criteria for NCHRP Report 350 redirective, non-gating crash cushion at TL-3 and TL-2 impact conditions respectively and are acceptable for use on the NHS when such use is acceptable to the contracting authority. It's further acknowledged that the QuadGuard<sup>®</sup> II can be installed with existing QuadGuard<sup>®</sup> Transition hardware (Reference CC-35B, dated October 17, 1996.)

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, we reserve the right to modify or revoke our 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 it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-35I and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- The QuadGuard and QuadGuard II families of crash cushions are patented products and considered proprietary. If proprietary devices are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they 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, appearing to read "David A. Nicol". The signature is fluid and cursive, with the first name "David" being the most prominent.

David A. Nicol, P.E.  
Director, Office of Safety Design  
Office of Safety

Enclosures

**Table1: Table of TL- 3 Tests (5-Bay System).**

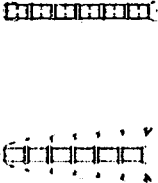
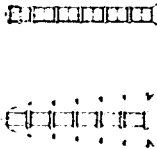
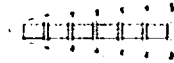
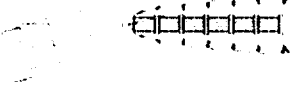
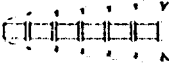
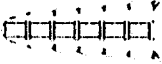
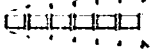
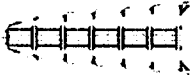
Illustration	Test #	Completed	Notes
	3-31	YES	Passed all ORV's. 5-Bay 24" Wide System was tested and passed all Occupant Risk Values. 5-Bay 90" Wide system was tested and passed all Occupant Risk Values.
	3-32	YES	Passed all ORV's. 5-Bay 24" Wide System was tested. 5-Bay 90" Wide System was tested.
	3-30	NO	Test 3-32 was completed as "Worst Case" for 820c.
	3-33	NO	Test 3-31 tested system capacity for 2000P and is considered worst case.
	3-36	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware therefore performance would remain unchanged.
	3-37	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware – performance remains unchanged.

Illustration	Test #	Completed	Notes
	3-38	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware – performance remains unchanged.
	3-39	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware / performance remains unchanged.

**Table2: Table of TL-2 Tests (2-Bay System)**

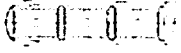


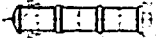



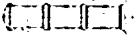
Illustration	Test#	Completed	Notes
	2-30	NO	Test 2-32 was completed as is considered “worst case” scenario for 820c.
	2-31	YES	Passed all ORV’s on 2-Bay System.
	2-32	YES	Passed all ORV’s on 2-Bay System.
	2-33	NO	Test 2-31 tested system capacity for 2000P and is considered worst case.

Illustration	Test#	Completed	Notes
	2-36	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware – performance remains unchanged.
	2-37	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware – performance remains unchanged.
	2-38	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware – performance remains unchanged.
	2-39	NO	Qualified under the Original QuadGuard Test Matrix. No changes in Structural Hardware – performance remains unchanged.



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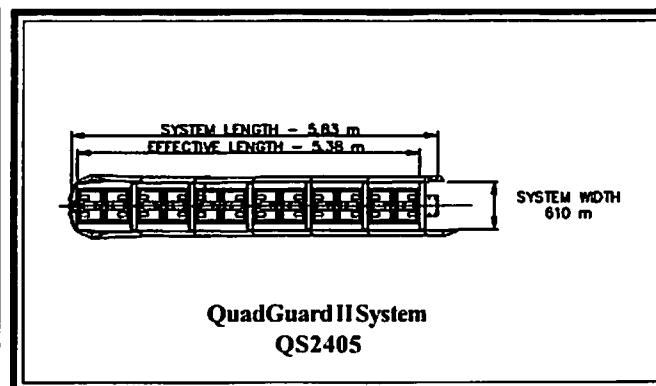
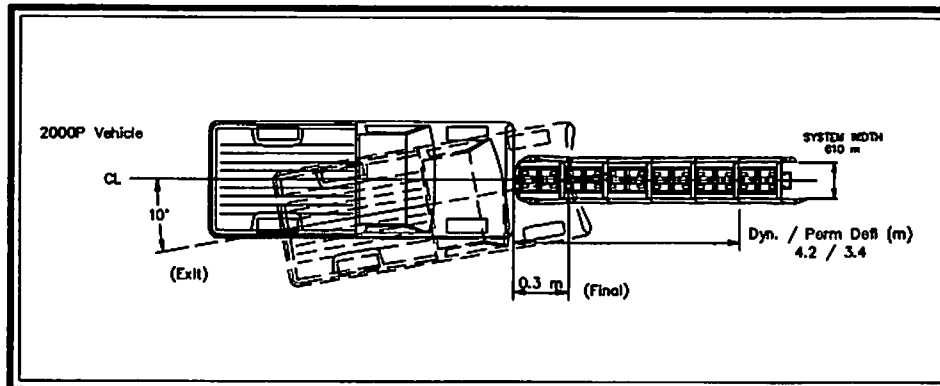
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t = 0.240 sec

t = 0.360 sec

t = 0.480 sec

t = 0.600 sec



QuadGuard II System  
QS2405



E-TECH Testing Services, Inc.

QuadGuard II System Crash Test Results - 10 of 69

**General Information**

Test Agency .....	E-TECH Testing Services, Inc.
Test Designation .....	NCIHRP 350 Test 3-31
Test No. ....	01-4309-001
Date .....	1/5/06
Test Article	
Type .....	Energy Absorption System
.....	QuadGuard II System QS2405
.....	
Installation Length, (mm) .....	5 bay 5830 mm long 610 mm wide
Material and key elements .....	5 bay system, 6 energy
.....	absorbing cartridges (3) Type II
.....	and (3) Type I.
.....	P.C. Concrete, clean
Foundation Type and Condition .....	Unreinforced 27.6 Mpa concrete,
.....	clean and dry, with (46) 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 .....	1988 Chevrolet Pickup
.....	
Mass (kg)	
Curb .....	1861
Test inertial .....	1984
Dummy .....	N/A
Gross Static .....	1984

**Impact Conditions**

Speed (km/h) .....	101.1
Angle (deg) .....	0
Impact Severity (kJ) .....	781.6

**Exit conditions**

Speed (km/h) .....	N/A
Angle (deg - veh. c.g.) .....	N/A

**Occupant Risk Values**

Impact Velocity (m/s)	
x-direction .....	9.6
y-direction .....	0.5
Ridedown Acceleration (g's)	
x-direction .....	-17.3
y-direction .....	3.5

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

THIV (km/h) .....	34.7
PHID (g's) .....	17.4
ASI .....	1.3

**Post-Impact Vehicular Behavior (deg - rate gyro)**

Maximum Roll Angle .....	3.2
Maximum Pitch Angle .....	-8.6
Maximum Yaw Angle .....	-10.2

**Test Article Deflections (m)**

Dynamic .....	4.2
Permanent .....	3.4

**Vehicle Damage (Primary Impact)**

Exterior	
VDS .....	FC-3
CDC .....	12FCEW3
Interior	
VCDI .....	AS0000000
Maximum Deformation (mm) .....	Negligible

Figure 1. Summary of Results - QuadGuard II System Test 01-4309-001





t = 0.000 sec

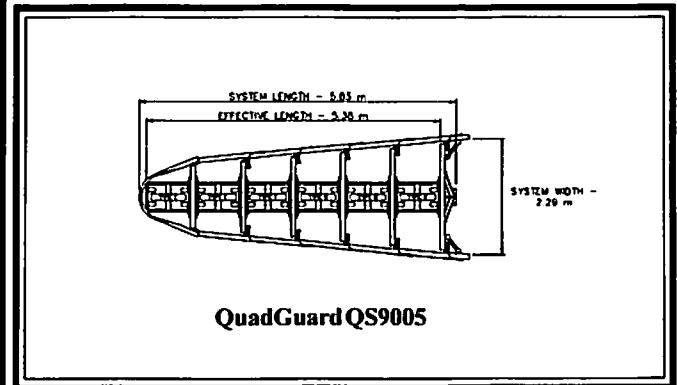
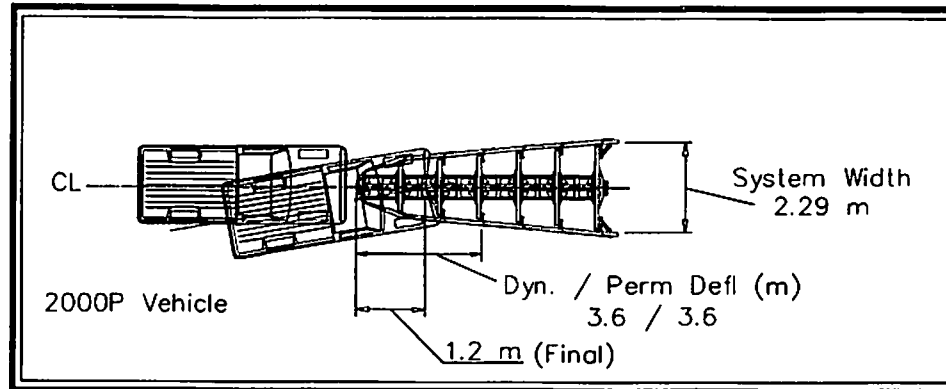
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t = 0.276 sec

t = 0.414 sec

t = 0.552 sec

t = 0.965 sec



E-TECH Testing Services, Inc.

QuadGuard II System Crash Test Results - 16 of 69

**General Information**

Test Agency ..... E-TECH Testing Services, Inc.  
 Test Designation ..... NCHRP 350 Test 3-31  
 Test No. .... 01-4309-006  
 Date ..... 11/04/08

**Test Article**

Type ..... Energy Absorption System  
 QuadGuard II System QS2405

**Installation Length, (mm)**

5 bay 5.83 m long 2.29 m wide

**Material and key elements**

5 bay system, 6 energy absorbing cartridges (3) Type II and (3) Type I.

**Foundation Type and Condition**

Unreinforced 27.6 Mpa concrete, clean and dry, with (46) 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 ..... 1991 GMC C2500

**Mass (kg)**

Curb ..... 1840  
 Test inertial ..... 2000  
 Dummy ..... N/A  
 Gross Static ..... 2000

**Impact Conditions**

Speed (km/h) ..... 99.7  
 Angle (deg) ..... 0  
 Impact Severity (kJ) ..... 766.5

**Exit conditions**

Speed (km/h) ..... N/A  
 Angle (deg - vch. c.g.) ..... N/A

**Occupant Risk Values**

Impact Velocity (m/s)  
 x-direction ..... 10.0  
 y-direction ..... 0.0

**Ridedown Acceleration (g's)**

x-direction ..... -17.0  
 y-direction ..... -3.3

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

THIV (km/h) ..... 36.1  
 PHD (g's) ..... 17.1  
 ASI ..... 1.3

**Post-Impact Vehicular Behavior (deg - rate gyro)**

Maximum Roll Angle ..... -2.6  
 Maximum Pitch Angle ..... 30.6  
 Maximum Yaw Angle ..... -2.3

**Test Article Deflections (m)**

Dynamic ..... 3.6  
 Permanent ..... 3.6

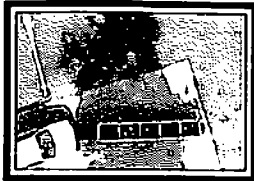
**Vehicle Damage (Primary Impact)**

Exterior  
 VDS ..... FC-4  
 CDC ..... 12FCEW4

**Interior**

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

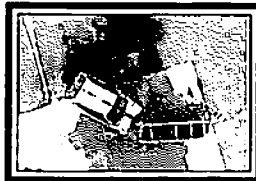
**Figure 6. Summary of Results - QuadGuard II System Test 01-4309-006**



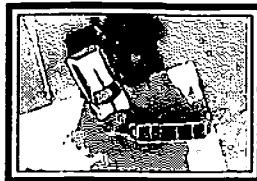
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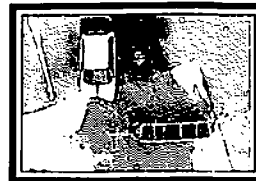
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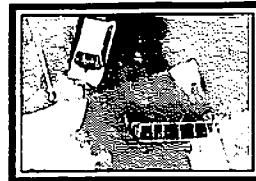
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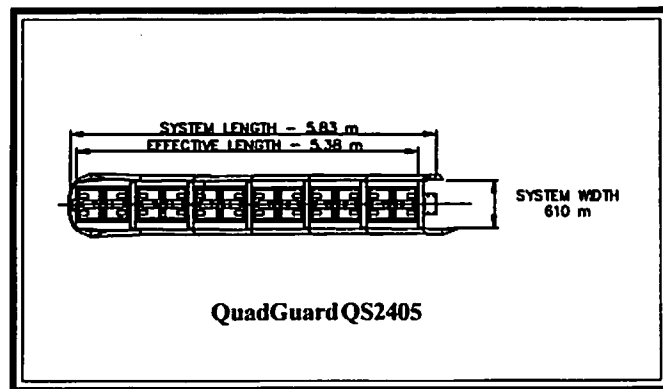
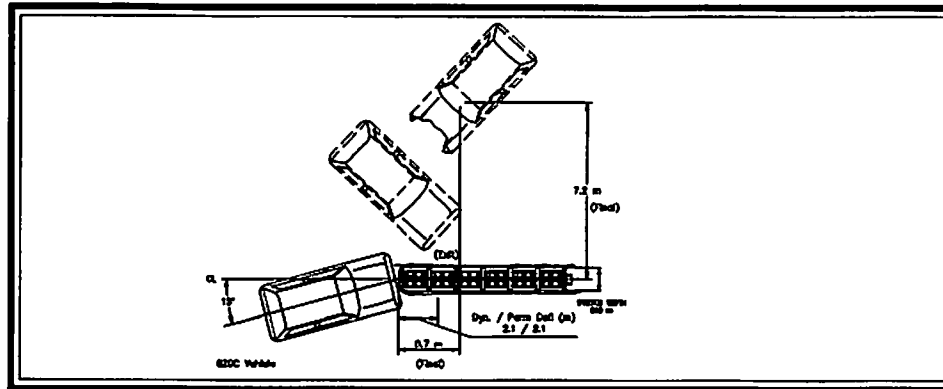
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t = 0.680 sec



t = 0.851 sec



QuadGuard QS2405

**General Information**

Test Agency .....	E-TECH Testing Services, Inc.
Test Designation .....	NCHRP 350 Test 3-32
Test No. ....	01-4309-002
Date .....	6/04/08
Test Article	
Type .....	Energy Absorption System
.....	QuadGuard System QS2405
.....	
Installation Length, (mm) .....	5 bay 5830 mm long 610 mm wide
Material and key elements .....	5 bay system, 6 energy absorbing cartridges (3) Type II and (3) Type I.
.....	P.C. Concrete, clean
.....	
Foundation Type and Condition .....	Unreinforced 27.6 Mpa concrete, clean and dry, with (46) 19 mm x 178 mm ASTM A193 Grade B-7 threaded studs and MP-3 Anchoring System
.....	
.....	
.....	
Test Vehicle	
Type .....	Production Model
Designation .....	820C
Model .....	1988 Ford Festiva
.....	
Mass (kg)	
Curb .....	818
Test inertial .....	845
Dummy .....	75
Gross Static .....	920

**Impact Conditions**

Speed (km/h) .....	98.3
Angle (deg) .....	15
Impact Severity (kJ) .....	316.6

**Exit conditions**

Speed (km/h) .....	N/A
Angle (deg - veh. c.g.) .....	N/A

**Occupant Risk Values**

Impact Velocity (m/s)	
x-direction .....	12.4
y-direction .....	0.1
Ridedown Acceleration (g's)	
x-direction .....	-17.4
y-direction .....	-5.1

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

THIV (km/h) .....	45.4
PHD (g's) .....	17.4
ASI .....	1.3

**Post-Impact Vehicular Behavior (deg - rate gyro)**

Maximum Roll Angle .....	25.7
Maximum Pitch Angle .....	-12.1
Maximum Yaw Angle .....	191.8

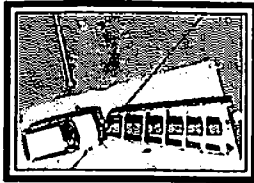
**Test Article Deflections (m)**

Dynamic .....	2.1
Permanent .....	2.1

**Vehicle Damage (Primary Impact)**

Exterior	
VDS .....	FC-3
CDC .....	12FCEW3
Interior	
VCDI .....	AS0000000
Maximum Deformation (mm) .....	Negligible

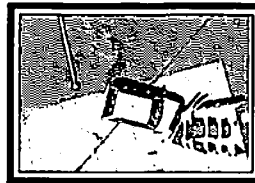
Figure 11. Summary of Results - QuadGuard II System Test 01-4309-002



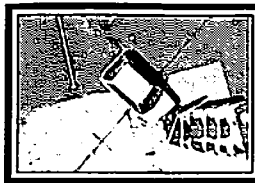
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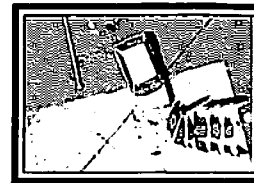
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t = 0.236 sec



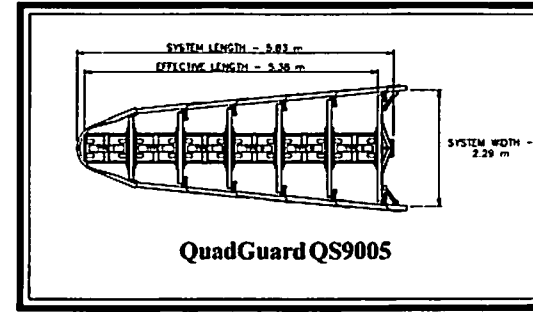
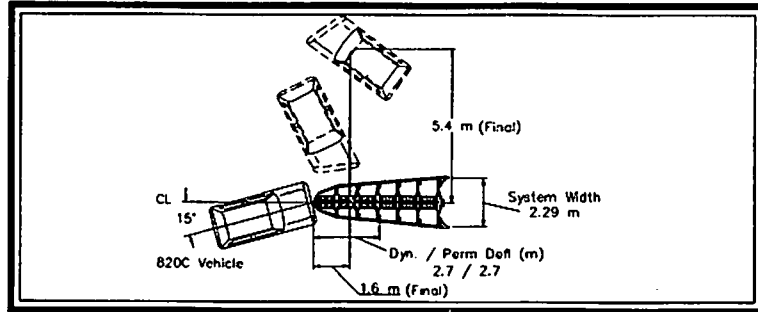
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t = 1.295 sec



QuadGuard QS9005

**General Information**

Test Agency .....	E-TECH Testing Services, Inc.
Test Designation .....	NCHRP 350 Test 3-32
Test No. ....	01-4309-005
Date .....	8/13/08
<b>Test Article</b>	
Type .....	Energy Absorption System
.....	QuadGuard II System QS9005
.....	
Installation Length, (mm) .....	5 bay 5.83 m long 2.29 m wide
<b>Material and key elements</b> .....	5 bay system, 6 energy
.....	absorbing cartridges (3) Type II
.....	and (3) Type I.
<b>Foundation Type and Condition</b> .....	Unreinforced 27.6 Mpa concrete,
.....	clean and dry, with (46) 19 mm x
.....	178 mm ASTM A193 Grade B-7
.....	threaded studs and
.....	MP-3 Anchoring System
<b>Test Vehicle</b>	
Type .....	Production Model
Designation .....	820C
Model .....	1990 Ford Festiva
.....	
Mass (kg)	
Curb .....	852
Test inertial .....	827
Dummy .....	75
Gross Static .....	902

**Impact Conditions**

Speed (km/h) .....	97.7
Angle (deg) .....	15
Impact Severity (kJ) .....	304.3

**Exit conditions**

Speed (km/h) .....	N/A
Angle (deg - veh. c.g.) .....	N/A

**Occupant Risk Values**

Impact Velocity (m/s)	
x-direction .....	11.7
y-direction .....	-0.1
Ridedown Acceleration (g's)	
x-direction .....	-17.4
y-direction .....	-3.1

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

THIV (km/h) .....	42.6
PHD (g's) .....	17.7
ASI .....	1.3

**Post-Impact Vehicular Behavior (deg - rate gyro)**

Maximum Roll Angle .....	30.9
Maximum Pitch Angle .....	13.7
Maximum Yaw Angle .....	221.1

**Test Article Deflections (m)**

Dynamic .....	2.7
Permanent .....	2.7

**Vehicle Damage (Primary Impact)**

Exterior	
VDS .....	FC-3
CDC .....	01FCEW3
Interior	
VCDI .....	AS0000000
Maximum Deformation (mm) .....	Negligible

QuadGuard II System Crash Test Results - 28 of 69

E-TECH Testing Services, Inc.

Figure 16. Summary of Results - QuadGuard II System Test 01-4309-005



t = 0.000 sec

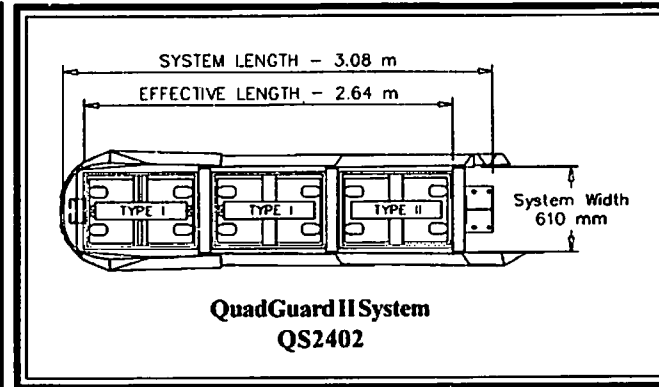
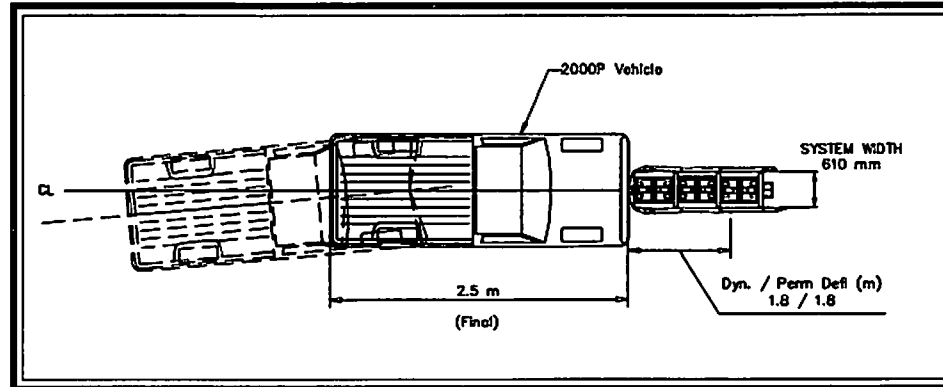
t = 0.133 sec

t = 0.266 sec

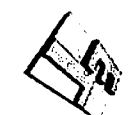
t = 0.399 sec

t = 0.532 sec

t = 1.920 sec



QuadGuard II System  
QS2402

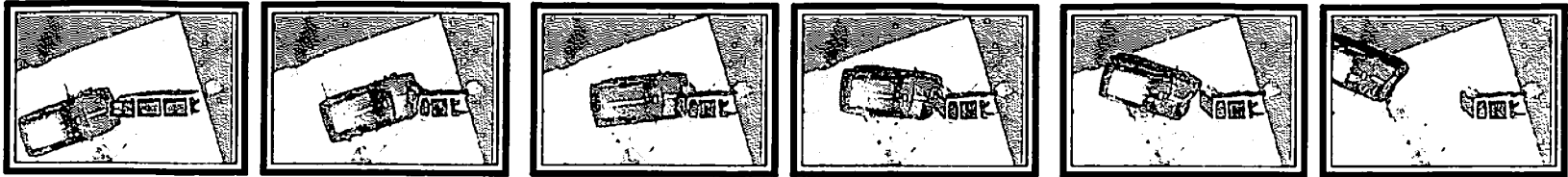


E-TECH Testing Services, Inc.

QuadGuard II Crash Test Results - 9 of 43

<b>General Information</b>		<b>Impact Conditions</b>	
Test Agency .....	E-TECH Testing Services, Inc.	Speed (km/h) .....	68.3
Test Designation .....	NCJHRP 350 Test 2-31	Angle (deg) .....	0
Test No. ....	01-4309-003	Impact Severity (kJ) .....	361.0
Date .....	7/16/08	<b>Exit conditions</b>	
<b>Test Article</b>		Speed (km/h) .....	N/A
Type .....	Energy Absorption System	Angle (deg - veh. c.g.) .....	N/A
	QuadGuard II System QS2402	<b>Occupant Risk Values</b>	
<b>Installation Length, (mm)</b> .....		Impact Velocity (m/s)	
	2 bay 3080 mm long 610 mm wide	x-direction .....	10.7
<b>Material and key elements</b> .....		y-direction .....	-0.7
	2 bay system, 3 energy absorbing cartridges (1) Type II and (2) Type I.	Ridedown Acceleration (g's)	
<b>Foundation Type and Condition</b> .....		x-direction .....	-19.4
	Unreinforced 27.6 Mpa concrete, clean and dry, with (26) 19 mm x 178 mm ASTM A193 Grade B-7 threaded studs and MP-3 Anchoring System	y-direction .....	5.9
<b>Test Vehicle</b>		<b>European Committee for Normalization (CEN) Values</b>	
Type .....	Production Model	THIV (km/h) .....	38.7
Designation .....	2000P	PHD (g's) .....	19.9
Model .....	1989 Chevrolet Pickup	ASI .....	1.3
Mass (kg)		<b>Post-Impact Vehicular Behavior (deg - rate gyro)</b>	
Curb .....	1961	Maximum Roll Angle .....	1.5
Test inertial .....	2005	Maximum Pitch Angle .....	5.4
Dummy .....	N/A	Maximum Yaw Angle .....	-4.7
Gross Static .....	2005	<b>Test Article Deflections (m)</b>	
		Dynamic .....	1.8
		Permanent .....	1.8
		<b>Vehicle Damage (Primary Impact)</b>	
		Exterior	
		VDS .....	FC-3
		CDC .....	12FCEW3
		Interior	
		VCDI .....	AS000000
		Maximum Deformation (mm) .....	Negligible

Figure 1. Summary of Results - QuadGuard II System Test 01-4309-003



t = 0.000 sec

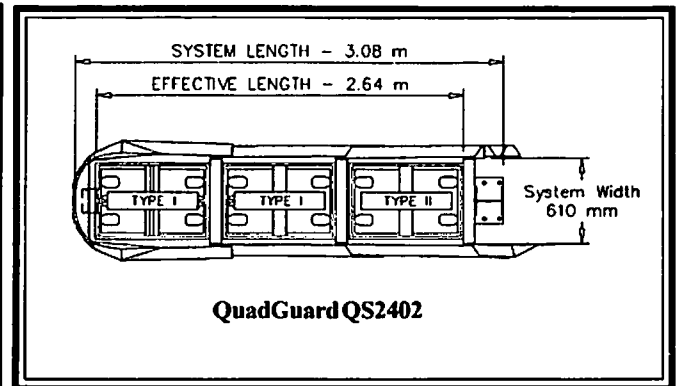
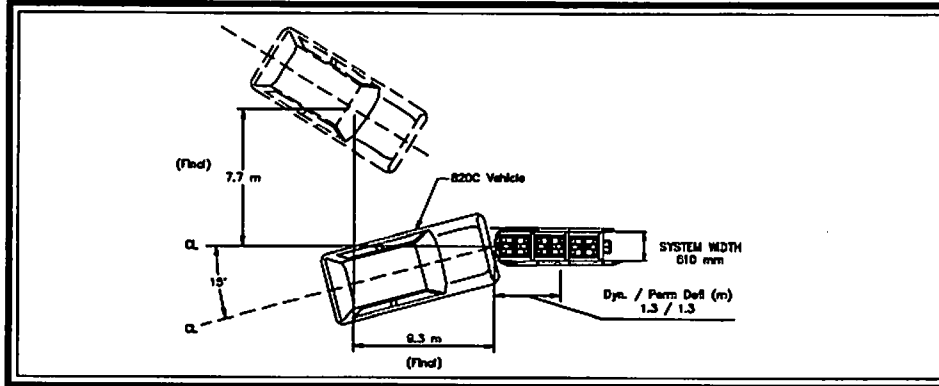
t = 0.125 sec

t = 0.250 sec

t = 0.375 sec

t = 0.500 sec

t = 1.285 sec



QuadGuard QS2402

E-TECH Testing Services, Inc.

QuadGuard II Crash Test Results - 15 of 43

**General Information**

Test Agency .....	E-TECH Testing Services, Inc.
Test Designation .....	NCHRP 350 Test 2-32
Test No. ....	01-4309-004
Date .....	7/22/08
Test Article	
Type .....	Energy Absorption System
.....	QuadGuard System QS2402
.....	
Installation Length, (mm) .....	2 bay 3080 mm long 610 mm wide
Material and key elements .....	2 bay system, 3 energy
.....	absorbing cartridges (1) Type II
.....	and (2) Type I.
.....	
Foundation Type and Condition .....	Unreinforced 27.6 Mpa concrete,
.....	clean and dry, with (26) 19 mm x
.....	178 mm ASTM A193 Grade B-7
.....	threaded studs and
.....	MP-3 Anchoring System

**Test Vehicle**

Type .....	Production Model
Designation .....	820C
Model .....	1990 Ford Festiva
.....	
Mass (kg)	
Curb .....	838
Test inertial .....	818
Dummy .....	75
Gross Static .....	993

**Impact Conditions**

Speed (km/h) .....	67.7
Angle (deg) .....	15
Impact Severity (kJ) .....	144.6

**Exit conditions**

Speed (km/h) .....	N/A
Angle (deg - veh. c.g.) .....	N/A

**Occupant Risk Values**

Impact Velocity (m/s)	
x-direction .....	10.8
y-direction .....	-0.5
Ridedown Acceleration (g's)	
x-direction .....	-17.8
y-direction .....	-6.2

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

THIV (km/h) .....	39.0
PHD (g's) .....	18.0
ASI .....	1.5

**Post-Impact Vehicular Behavior (deg - rate gyro)**

Maximum Roll Angle .....	7.3
Maximum Pitch Angle .....	11.3
Maximum Yaw Angle .....	47.0

**Test Article Deflections (m)**

Dynamic .....	1.3
Permanent .....	1.3

**Vehicle Damage (Primary Impact)**

Exterior	
VDS .....	FC-3
CDC .....	12FCEW3
Interior	
VCDI .....	AS000000
Maximum Deformation (mm) .....	Negligible

Figure 6. Summary of Results - QuadGuard II System Test 01-4309-004





