

April 30, 2002

Refer to: HSA-10/CC73A

Barry D. Stephens, P.E.  
Senior Vice President of Engineering  
Energy Absorption Systems, Inc.  
3617 Cincinnati Avenue  
Rocklin, CA 95765

Dear Mr. Stephens:

In your April 5 letter, you requested the Federal Highway Administration's review and acceptance of your REACT 350 (120") and the REACT 350 (96") Systems as meeting the National Cooperative Highway Research Program (NCHRP) Report 350 evaluation criteria for Test Level 3 (TL-3) crash cushions. Your REACT 350 (60") has previously been tested and accepted at this same test level. To support your new request, you provided Mr. Richard Powers of my staff copies of your March 2002 engineering summary "REACT 350 (120") (10 Foot [3050 mm] Wide System) Qualification to NCHRP Report 350 Test Level 3" which included the March 2002 report by E-TECH Testing Services, Inc. entitled "NCHRP Report 350 Crash Test Results for the REACT 350 (120") System," and a videotape showing the full-scale tests that were conducted.

The TL-3 REACT 350 (120") consists of an array of High Density Polyethylene (HDPE) cylinders like those used with the REACT 350 (60"). Likewise, the internal struts, the monorail, and the monorail guides are similar to those components in the 60" wide design. The space frame diaphragms to which the cylinders are connected vary only in width from the REACT 350 (60") diaphragms. The cylinders are arranged in thirteen rows of two cylinders each, plus three nose cylinders, making the unit 9820-mm (32'-2") long. The nose cylinders are 36" in diameter and 32" tall and each has a wall thickness of 0.878". The cylinders in rows 1-3 are 24" in diameter, have a wall thickness of 0.74 inches and are also 32 inches tall. The cylinders in rows 4-9 are the same thickness and diameter but 40 inches high. Those in rows 10-13 are also 24" in diameter and 40 inches high but their wall thickness increases to 1.14 inches. All cylinders in rows 4 through 13 have two-part (18 gauge and 14 gauge) steel "wheel deflectors" bolted to their outboard surfaces to minimize the snagging potential in redirective hits. All cylinders in rows 5-13 contain self-restoring, hinged internal steel struts to provide redirection in side impacts. The two cylinders in each row are attached to steel space frame diaphragms that slide along a steel monorail similar to the monorail used with the QuadGuard family of impact attenuators. Your specifications require the monorail to be bolted to a 200 mm (8 inch) concrete foundation using 19 mm (0.75 inch) diameter by 191 mm (7.5 inch) long ASTM A-193 Grade B7 polyester grouted studs. Enclosure 1 is a schematic drawing of the tested unit.

Since the REACT 350 (120") System is classified as a redirective, non-gating crash cushion, the recommended NCHRP Report 350 test matrix consists of eight tests. Four tests were run and successfully completed. My staff agreed beforehand that both head-on tests (tests 3-30 and 3-31), test 3-36 (820-kg vehicle/100 km/h impact speed/15 degree impact angle at the Critical Impact Point) and test 3-37 (2000-kg vehicle/100 km/h/20 degree impact at the same location) could be waived. Test 3-39, the reverse direction impact, was waived because the rearmost corner of the REACT 350 (120") is effectively shielded by the concrete backup structure and there are no external components on the cylinders that might cause an impacting vehicle to snag. Tests actually conducted were 3-32, 3-33, a "modified" test 3-33 (essentially the same as test 3-36) and test 3-38. All Report 350 evaluation criteria were met in each test. Enclosure 2 contains summary information on the four tests that were successfully conducted.

Based on staff review of the information you submitted, I agree that the REACT 350 (120") System, when attached to a 1525-mm (10 foot) wide reinforced and anchored concrete backup, meets the appropriate

evaluation criteria for an NCHRP Report 350 TL-3 crash cushion and may be used on the National Highway System (NHS) when selected by a transportation agency. I also agree that the REACT 350 (96") may be considered a TL-3 crash cushion without additional testing. This determination is based on your statement that the only difference between the 96" and 120" units is the width of the space frame diaphragms, and on the results of the tests identified above plus testing done previously on the REACT 350 (60"). Since the REACT 350 series of crash cushions remain proprietary devices, the use of any of these designs 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.

Sincerely yours,

(original signed by A. George Ostensen)

A. George Ostensen  
Program Manager, Safety

2 Enclosures



D. Illustrations

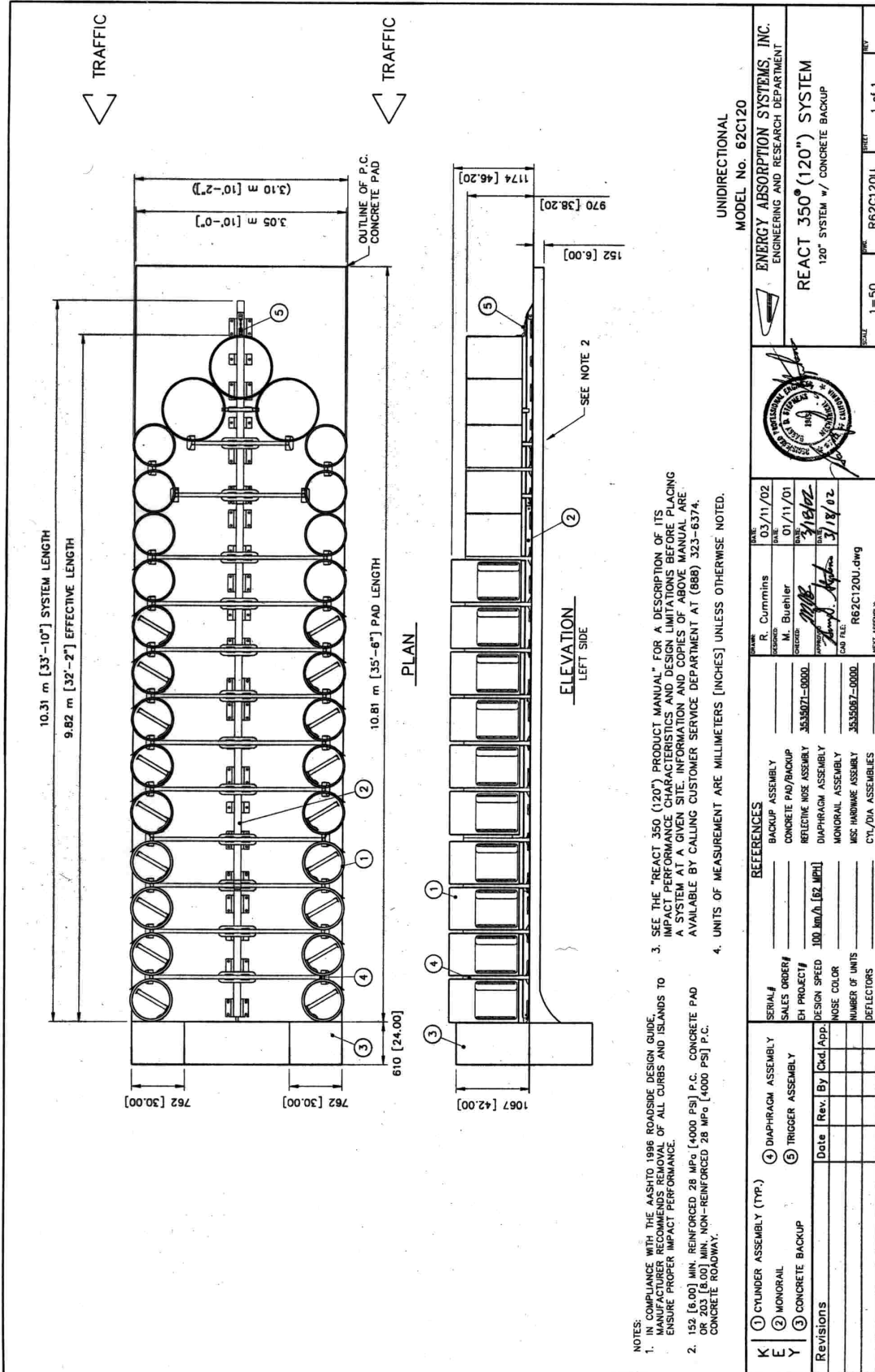
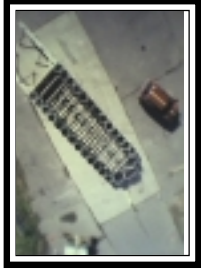
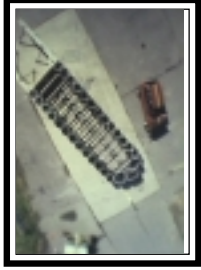


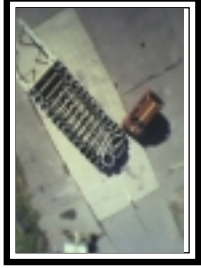
Illustration D-1. REACT 350 (120'') System Drawing (1 of 1)



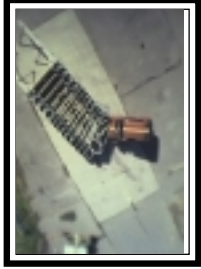
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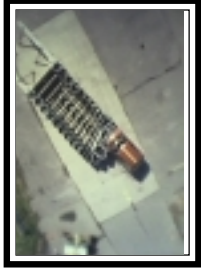
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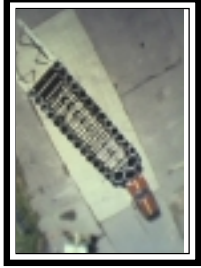
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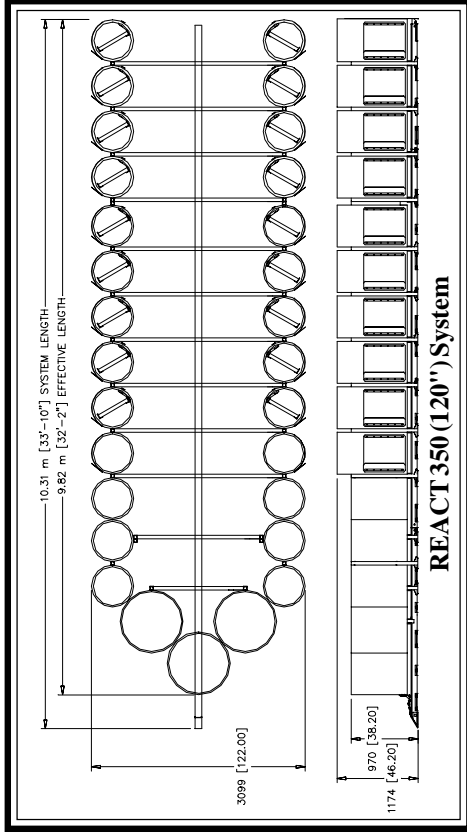
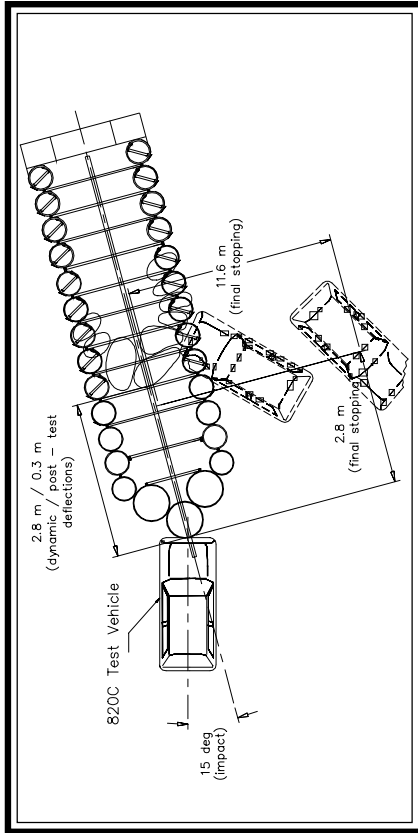
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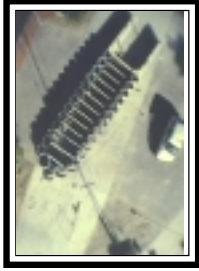


**General Information**

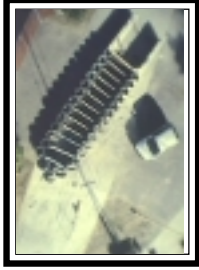
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Test Designation .....	NCHRP 350 Test 3-32
Test No. ....	01-4314-003
Date .....	02/08/02
Test Article .....	
Type .....	Energy Absorption Systems, Inc.
Installation Length, (mm) .....	REACT 350 (120'')
Material and key elements .....	9804 (effective length)
.....	2 column, 13 row (29 tot. w/nose)
.....	610 mm OD HDPE energy
.....	absorbing cylinders
.....	Portland Cement Concrete,
.....	MP-3 Anchoring System
Foundation Type and Anchoring .....	
Test Vehicle .....	
Type .....	Production Model
Designation .....	820C Small Car
Model .....	1988 Ford Festiva
Mass (kg) .....	
Curb .....	780
Test inertial .....	821
Dummy .....	75
Gross Static .....	896
Impact Conditions .....	
Speed (km/h) .....	101.1
Angle (deg) .....	15
Impact Severity (kJ) .....	323.4

Exit conditions .....	
Speed (km/h) .....	N/A
Angle (deg) .....	N/A
Occupant Risk Values .....	
Impact Velocity (m/s) .....	11.0
x-direction .....	1.3
y-direction .....	-11.0
Ridedown Acceleration (g/s) .....	-6.4
x-direction .....	
y-direction .....	
European Committee for Normalization (CEN) Values .....	
THIV (km/h) .....	40.1
PHD (g/s) .....	11.5
ASI .....	1.2
Test Article Deflections (m) .....	
Dynamic .....	2.8
Permanent .....	0.3
Vehicle Damage .....	
Exterior .....	
VDS .....	FD-4
CDC .....	12FDEW4
Interior .....	
OCDI .....	AS0000000
Post-Impact Vehicular Behavior (deg - rate gyro) .....	
Maximum Roll Angle .....	-58.7
Maximum Pitch Angle .....	-25.0
Maximum Yaw Angle .....	-244.8

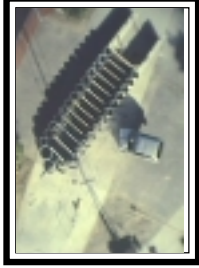
Figure 1. Summary of Results - REACT 350 (120'') System Test 01-4314-003



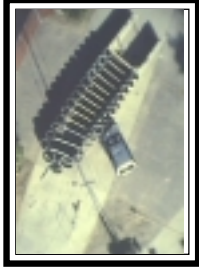
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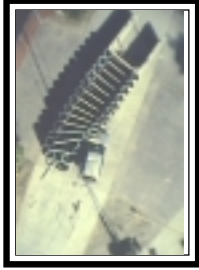
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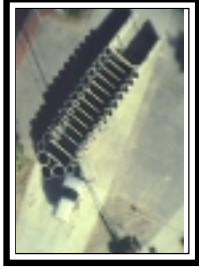
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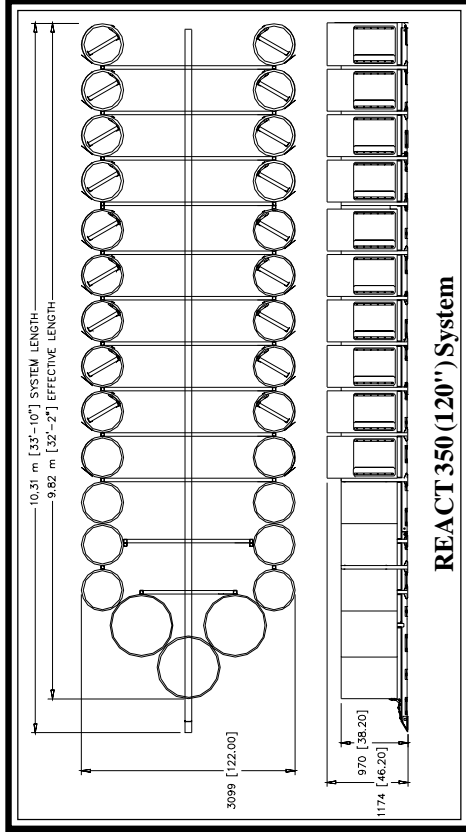
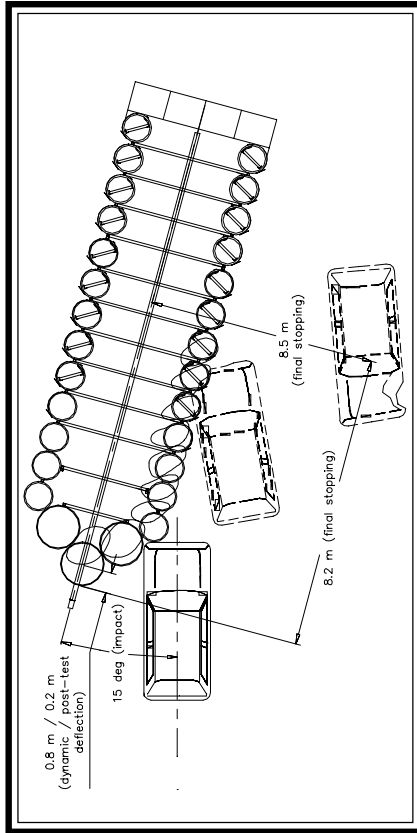
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t = 0.960 sec



t = 1.20 sec



REACT 350 (120'') System

**General Information**

Test Agency ..... E-TECH Testing Services, Inc.  
 Test Designation ..... NCHRP 350 Test 3-32(Modified)  
 Test No. .... 01-4314-004  
 Date ..... 02/28/02

Test Article Type ..... Energy Absorption Systems, Inc.  
 REACT 350 (120'')  
 Installation Length, (mm) ..... 9804 (effective length)  
 Material and key elements ..... 2 column, 13 row (29 tot. w/nose)  
 ..... 610 mm OD HDPE energy  
 ..... absorbing cylinders  
 ..... Portland Cement Concrete,  
 Foundation Type and Anchoring ..... MP-3 Anchoring System

Test Vehicle Type ..... Production Model  
 Designation ..... 820C Small Car  
 Model ..... 1989 Ford Festiva  
 Mass (kg) Curb ..... 793  
 Test inertial ..... 827  
 Dummy ..... 75  
 Gross Static ..... 902

Impact Conditions Speed (km/h) ..... 97.0  
 Angle (deg) ..... 15  
 Impact Severity (kJ) ..... 300.3

Exit conditions Speed (km/h) ..... N/A  
 Angle (deg) ..... N/A

Occupant Risk Values Impact Velocity (m/s) x-direction ..... 11.9  
 y-direction ..... 4.2  
 Ridedown Acceleration (g's) x-direction ..... -15.9  
 y-direction ..... 3.5

European Committee for Normalization (CEN) Values THIV (km/h) ..... 45.6  
 PHD (g's) ..... 16.0  
 ASI ..... 1.2

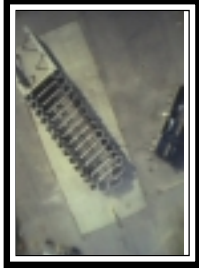
Test Article Deflections (m) Dynamic ..... 0.8  
 Permanent ..... 0.2

Vehicle Damage Exterior VDS ..... LFQ-4  
 CDC ..... 11FDEW3  
 Interior OCIDI ..... AS0000000

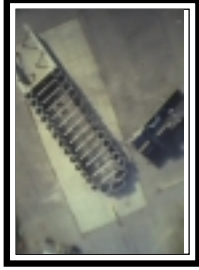
Post-Impact Vehicular Behavior (deg - rate gyro) Maximum Roll Angle ..... -46.4  
 Maximum Pitch Angle ..... -16.1  
 Maximum Yaw Angle ..... -270.2

Figure 6. Summary of Results - REACT 350 (120'') System Test 01-4314-004

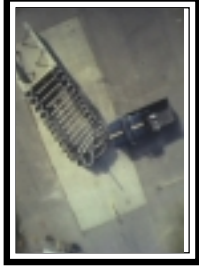




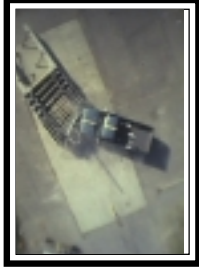
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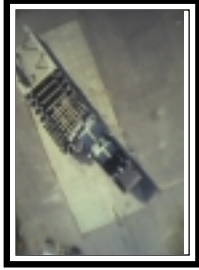
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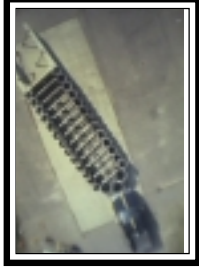
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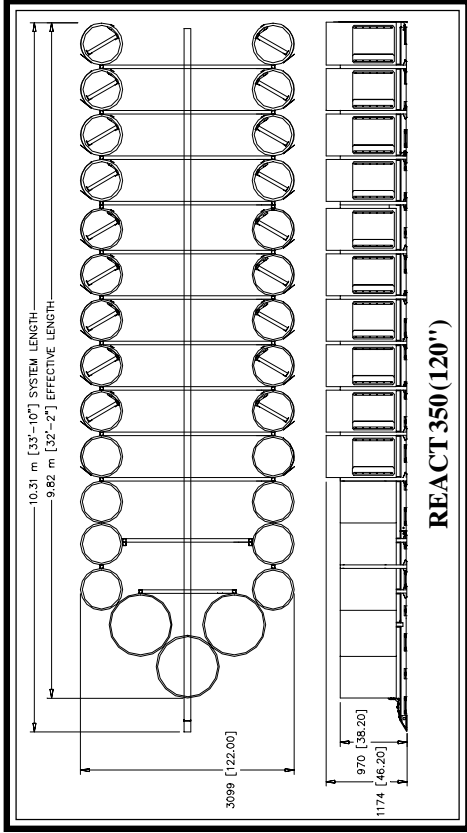
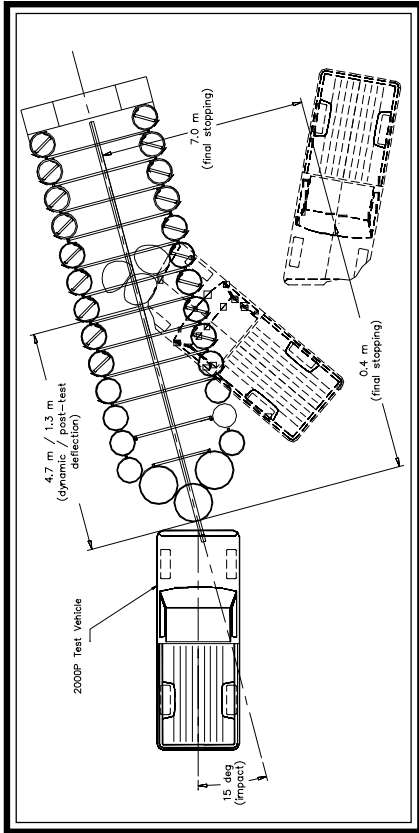
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t = 1.152 sec



t = 1.44 sec



**General Information**

Test Agency .....  
 Test Designation .....  
 Test No. ....  
 Date .....  
 Test Article .....

E-TECH Testing Services, Inc.  
 NCHRP 350 Test 3-33  
 01-4314-002  
 02/06/02

Type .....  
 Installation Length, (mm) .....  
 Material and key elements .....  
 .....  
 Foundation Type and Anchoring .....

Energy Absorption Systems, Inc.  
 REACT 350 (120'')  
 9804 (effective length)  
 2 column, 13 row (29 tot. w/nose)  
 610 mm OD HDPE energy  
 absorbing cylinders  
 Portland Cement Concrete,  
 MP-3 Anchoring System

Test Vehicle  
 Type .....  
 Designation .....  
 Model .....  
 Mass (kg)  
 Curb .....

Production Model  
 2000P Pickup Truck  
 1990 GMC C2500

Test inertial .....  
 Dummy .....  
 Gross Static .....  
 Impact Conditions  
 Speed (km/h) .....  
 Angle (deg) .....  
 Impact Severity (kJ) .....

1957  
 1984  
 N/A  
 1984  
 101.8  
 15  
 792.6

Exit conditions  
 Speed (km/h) .....  
 Angle (deg) .....

N/A  
 N/A

**Occupant Risk Values**

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

9.3  
 -0.2  
 -9.4  
 -4.0

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

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

33.6  
 9.4  
 0.8

**Test Article Deflections (m)**

Dynamic .....  
 Permanent .....  
 Vehicle Damage  
 Exterior .....

4.7  
 1.3

VDS .....  
 CDC .....

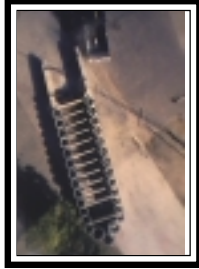
FD-4  
 I2FDEW4

**Interior**

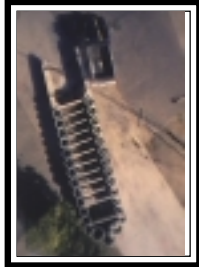
OCDI .....  
 Post-Impact Vehicular Behavior (deg - rate gyro)  
 Maximum Roll Angle .....  
 Maximum Pitch Angle .....  
 Maximum Yaw Angle .....

AS0000000  
 -16.8  
 -9.3  
 -171.8

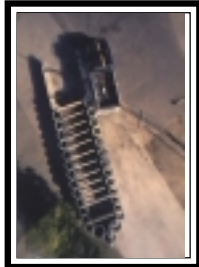
Figure 11. Summary of Results - REACT 350 (120'') System Test 01-4314-002



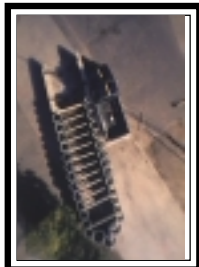
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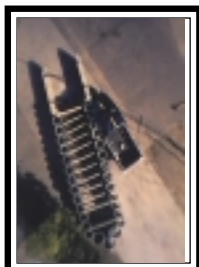
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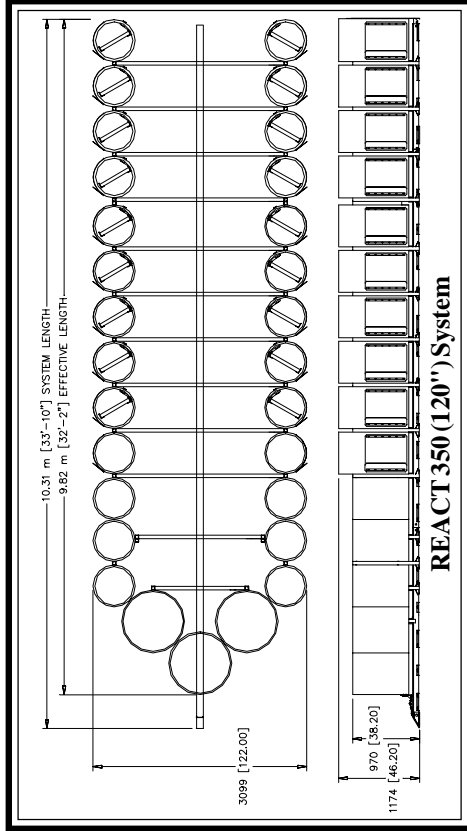
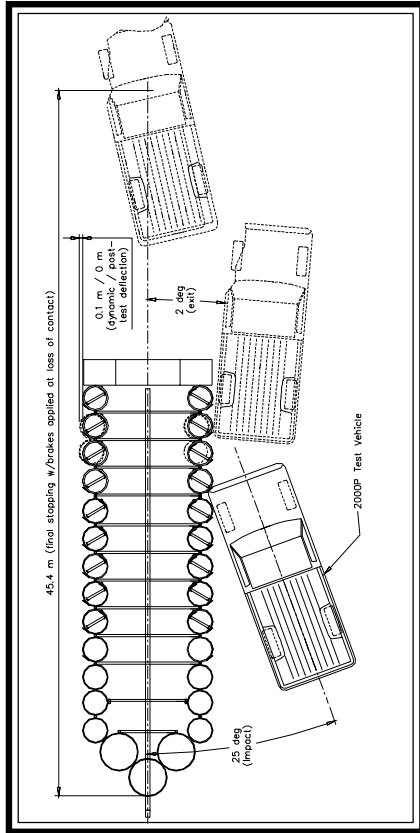
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t = 0.384 sec



t = 0.480 sec



**General Information**

Test Agency .....  
 Test Designation .....  
 Test No. ....  
 Date .....  
 Test Article .....

Type .....  
 Installation Length, (mm) .....  
 Material and key elements .....

Foundation Type and Anchoring .....

Test Vehicle  
 Type .....  
 Designation .....  
 Model .....  
 Mass (kg) .....

Curb .....  
 Test inertial .....  
 Dummy .....  
 Gross Static .....

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

E-TECH Testing Services, Inc.  
 NCHRP 350 Test 3-38  
 01-4314-001  
 12/12/01

Energy Absorption Systems, Inc.  
 REACT 350 (120'')  
 9804 (effective length)  
 2 column, 13 row (29 tot. w/nose)  
 610 mm OD HDPE energy  
 absorbing cylinders  
 Portland Cement Concrete,  
 MP-3 Anchoring System

Production Model  
 2000P Pickup Truck  
 1990 GMC C2500

1918  
 1984  
 N/A  
 1984

101.1  
 20  
 91.4

Exit conditions  
 Speed (km/h) .....  
 Angle (deg) .....

Occupant Risk Values  
 Impact Velocity (m/s)  
 x-direction .....

Ridedown Acceleration (g's)  
 x-direction .....  
 y-direction .....

European Committee for Normalization (CEN) Values  
 THIV (km/h) .....  
 PHD (g's) .....

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

Vehicle Damage  
 Exterior  
 VDS .....  
 CDC .....

Interior  
 OCIDI .....

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

66.3  
 2

8.0  
 7.5

-14.8  
 11.4

38.9  
 18.2  
 1.9

0.1  
 0.0

LFQ-5  
 ILLDEW4

LF1010000

-0.2  
 36.8 (max 5 deg at exit)  
 27.5

Figure 16. Summary of Results - REACT 350 (120'') System Test 01-4314-001