



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

1200 New Jersey Ave., SE
Washington, D.C. 20590

December 13, 2010

In Reply Refer To:
HSST/CC-113

Mr. Gerrit Dyke, P.E.
Barrier Systems, Inc.
3333 Vaca Valley Parkway, Suite 800
Vacaville, CA 95688

Dear Mr. Dyke:

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 system:	Raptor Crash Cushion
Type of system:	Crash Cushion for narrow vertical objects
Test Level:	NCHRP Report 350 Test Level 1 (TL-1)
Testing conducted by:	Safe Technologies, Inc.
Task Force 13 Designator:	SCI25
Date of request:	June 1, 2010

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

Decision

The following device was found acceptable, with details provided below:

- TL-1 Raptor Crash Cushion

Requirements

Roadside safety devices should meet the guidelines contained in the NCHRP Report 350 or the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware. The FHWA Memorandum "Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.



Description

The Raptor Crash Cushion is a non-redirective gating crash cushion. The Raptor consists of two identical halves that are installed back to back around a hazard, and connected to become a single complete system. The two halves are held together using ten connectors with twenty bolts and washers. There is no separate anchoring because the system is designed to sit directly on the ground. The Raptor is designed primarily to deflect impacting vehicles by rotating upon impact. Enclosure 1 illustrates details of this system.

Crash Testing

The Raptor crash cushion system was crash tested according to NCHRP Report 350 test designations 1-41, 1-42, and 1-43 by Safe Technologies Inc. Enclosures 2 through 4 summarize the results of the tests.

Findings

According to NCHRP Report 350, tests 1-40 through 1-44 are to be conducted for TL-1 non-redirective gating crash cushion evaluation. The Raptor system was crash tested under all of these required tests, except for tests 1-40 and 1-44. The system described above and shown in Enclosure 1 passed all tests that were conducted. Occupant Impact Velocities (OIV) associated with tests 1-41 and 1-42 were 12 m/s, which is the maximum allowed for OIV. The OIV associated with test 1-43 was estimated at 10 m/s. The Occupant Ridedown Acceleration (ORA) for all tests were below the “preferred” limit defined in NCHRP 350.

In your letter you have requested tests 1-40 and 1-44 be waived. The waiver of test 1-40 is accepted on the grounds that test 1-42 is historically more critical than test 1-40. Test 1-44 is intended to demonstrate whether the system will redirect the errant vehicle or cushion its impact, or a combination of both. The main purpose of the Raptor crash cushion system is to shield a vertical column that may be struck head-on by absorbing and dissipating the kinetic energy of impacting vehicles, or by rotating and deflecting the vehicle from a head-on impact with the hazard. Therefore, the re-redirective capability of the system to withstand a hit on the side is not as critical as its energy absorbing or rotational capability. Consequently, I concur that test 1-44 can be waived given the successful results of test 1-43.

In your letter you have also requested FHWA’s acceptance based on the following installation considerations for the Raptor system:

- The Raptor crash cushion is applicable to fixed luminaires, sign support, columns, trees, utility poles, or other structures that fit the geometric and dimensional limitations of the device, up to 23 inches by 24 inches.
- The Raptor crash cushion fully encases the base of narrow vertical hazards and does not require attachment to the roadway or foundation.
- The Raptor crash cushion is a symmetrical design and performs similarly if impacted from either longitudinal “end” direction, and must be oriented accordingly in relation to the approach traffic direction to the applicable hazard.

The above installation considerations are all accepted. However, it should be noted that the Raptor must be installed on a clean and level surface that is capable of supporting the weight of the system and permits the system to rotate during oblique impacts.

Therefore, the system described in the requests above and detailed in the enclosed drawings is acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency.

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

- This acceptance is limited to the crashworthiness characteristics of the systems 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 system 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 system 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-113 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 Raptor is a patented product and considered proprietary. If proprietary systems 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 system for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the

candidate system, 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.

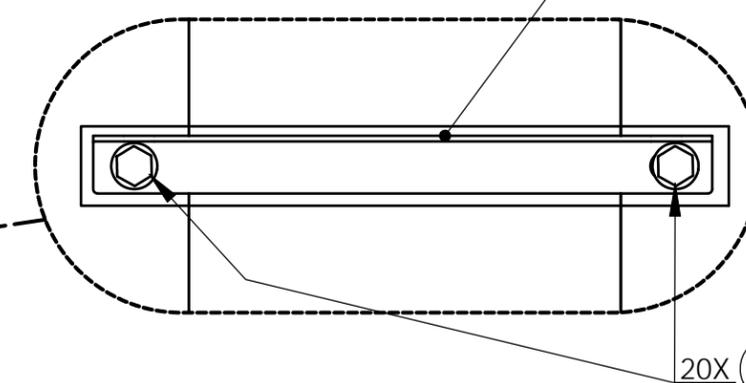
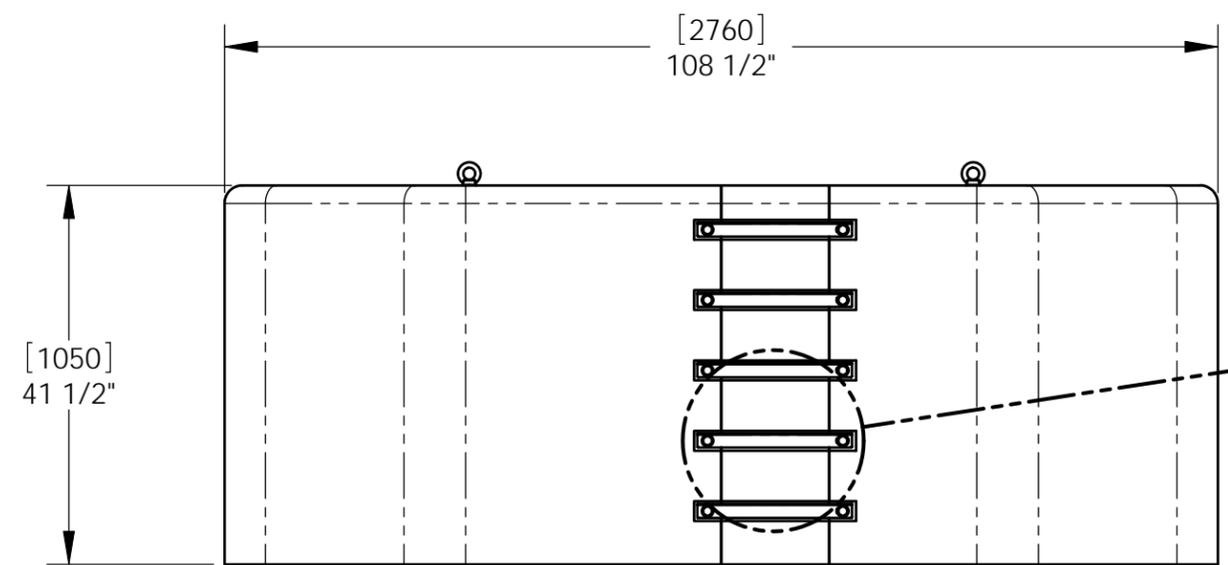
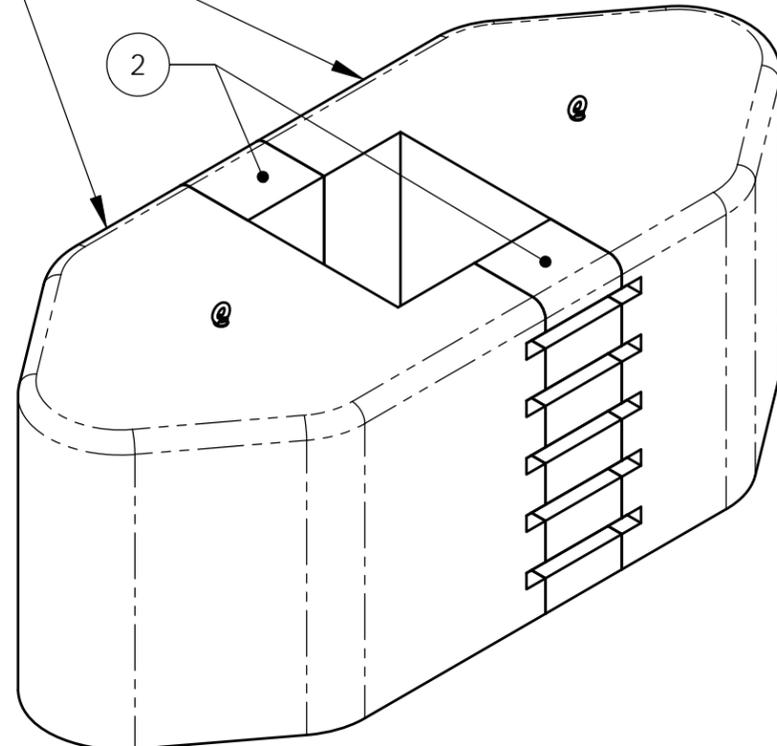
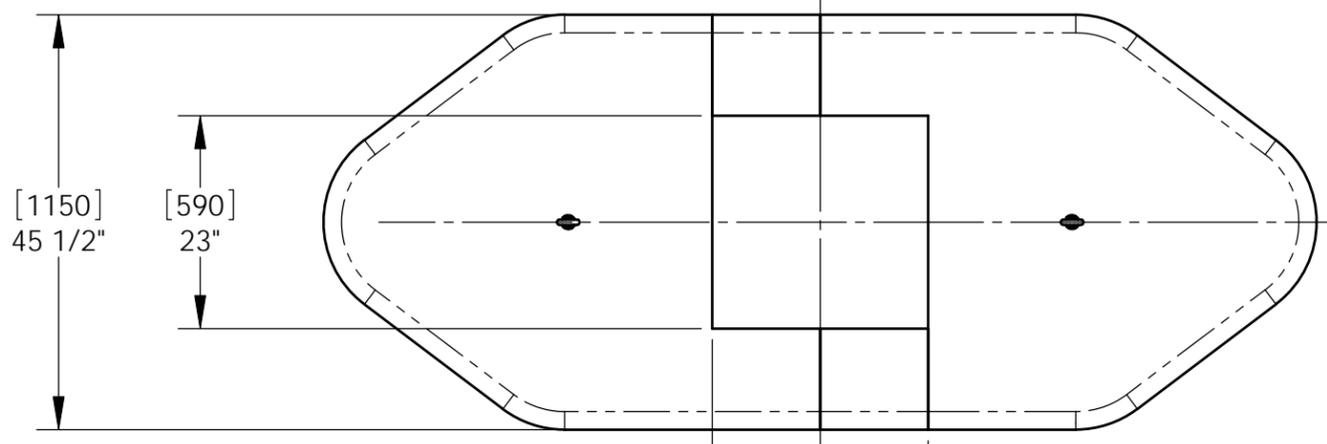
Sincerely yours,

A handwritten signature in blue ink that reads "Michael S. Griffith". The signature is written in a cursive style with a large initial "M" and a stylized "S".

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures

Find No.	QTY	Description	UOM	No.
1	2	Shell, Black, Raptor	EACH	B091226
2	2	Packer Piece, Black, Raptor	EACH	B091228
3	10	Long Connector, Raptor	EACH	B091231
4	20	C-Scr HH M16-2.0x40 Cl8.8 MGal	EACH	2000292
5	20	Wshr 16mm Class 8.8 Galv	EACH	2001145

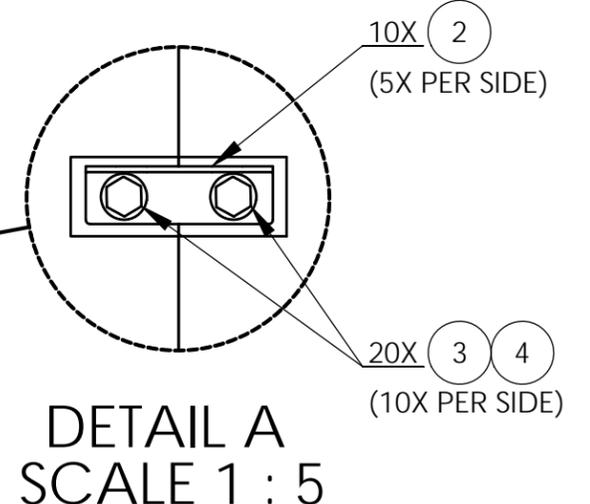
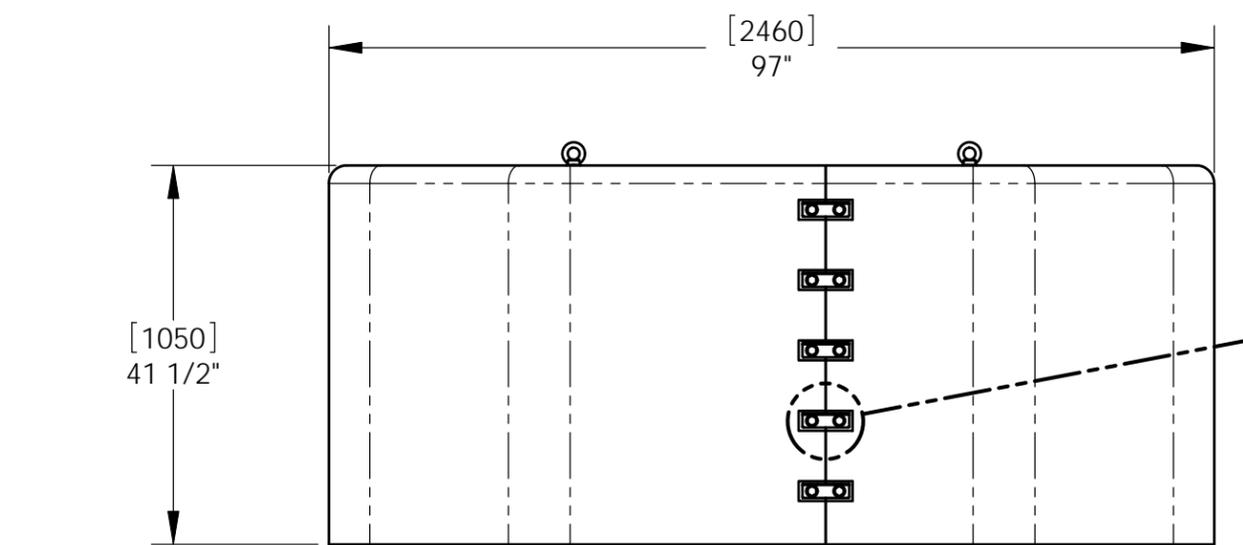
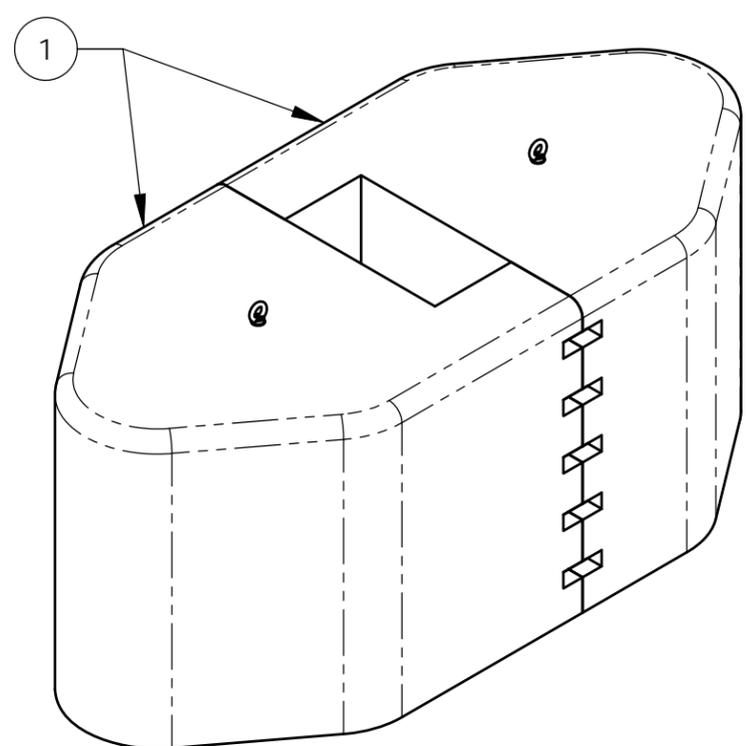
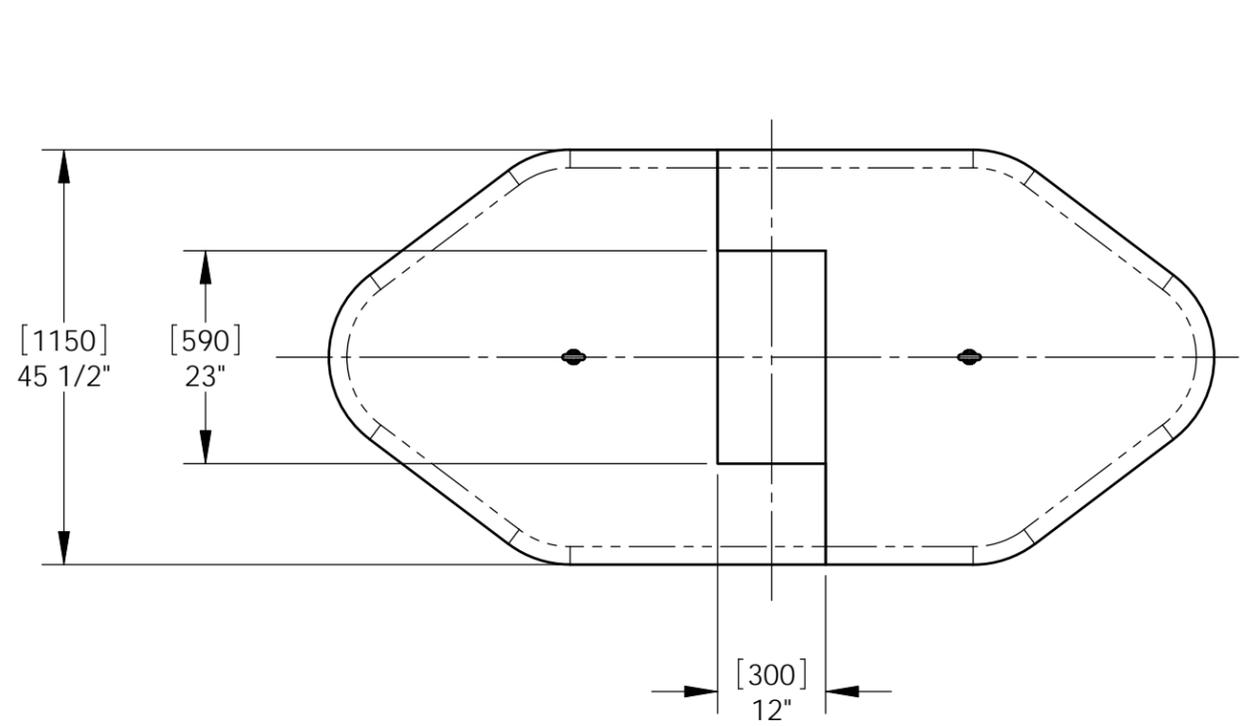


DETAIL A
SCALE 1 : 5

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APPROVALS		THIRD ANGLE PROJECTION		TITLE			
DRAWN BY: AEM				RAPTOR, 600mm, BLACK			
DRAWN DATE: 6/1/10				SIZE	DWG NO.	REV.	
APPR'D BY: GAD				B	RAP600B-US	0	
APPR'D DATE: 6/1/10		DO NOT SCALE DRAWING		REV	ECN#	DATE	SCALE 1:20
						SHEET 1 OF 1	

Enclosure 1

Find No.	QTY	Description	UOM	No.
1	2	Shell, Black, Raptor	EACH	B091226
2	10	Short Connector, Raptor	EACH	B091230
3	20	C-Scr HH M16-2.0x40 Cl8.8 MGal	EACH	2000292
4	20	Wshr 16mm Class 8.8 Galv	EACH	2001145



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DRAWN DATE:	6/1/10
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APPR'D DATE:	6/1/10

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FRACTIONS	DECIMAL	ANGLES
±1/16	.XX = ±.03	±1/2°
	.XXX = ±.010	

INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-1994

THIRD ANGLE PROJECTION

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REV	ECN#	DATE

		3333 Vaca Valley Parkway Ste 800 Vacaville, CA 95688 Tel: 888-800-3691 www.barriersystemsinc.com	
TITLE			
RAPTOR, 300mm, BLACK			
SIZE	DWG NO.	REV.	
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4

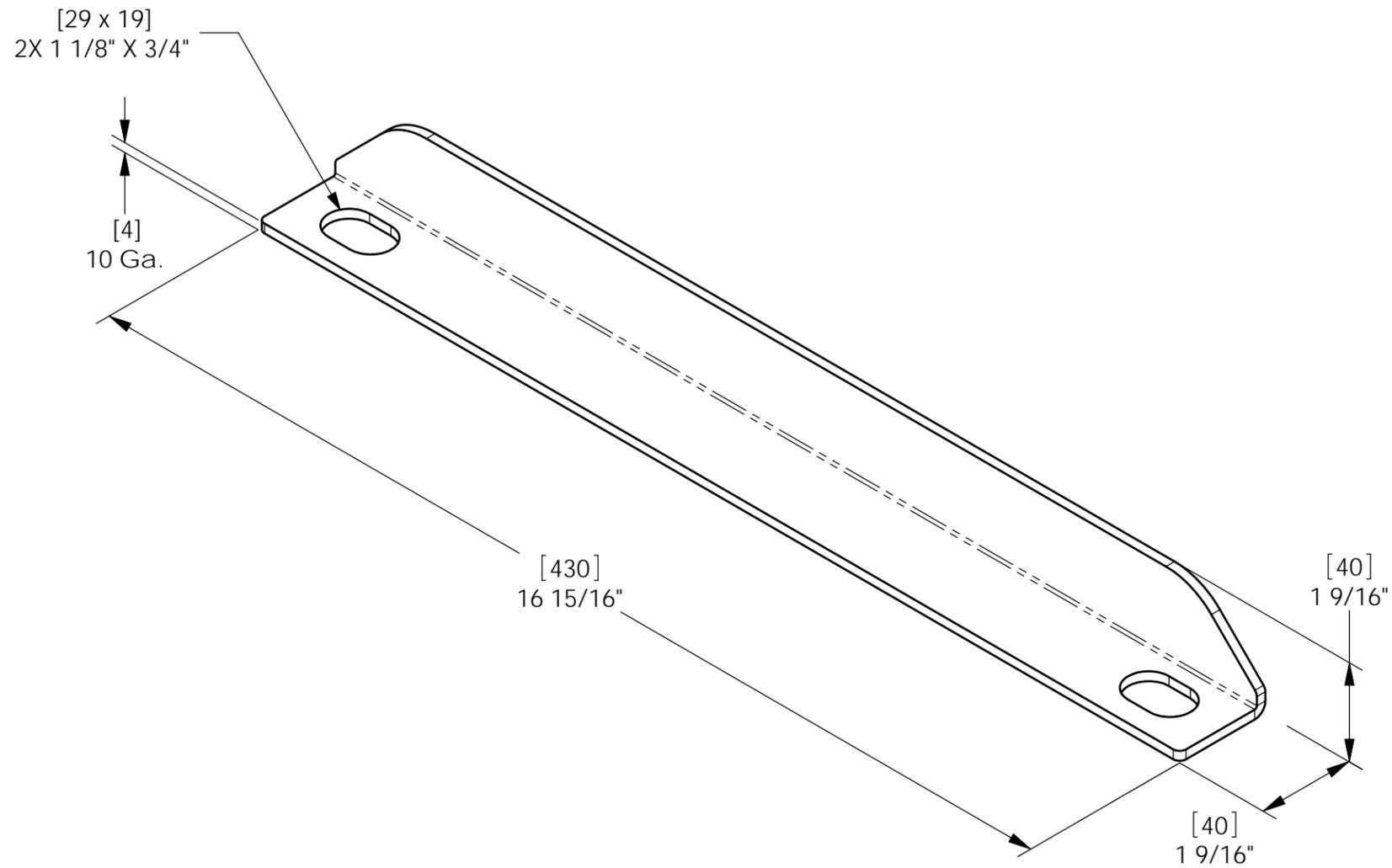
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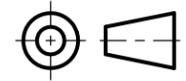
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NOTES: UNLESS OTHERWISE SPECIFIED

- 1. MATERIAL: SHEET 10 Ga Hr A569.
- 2. FINISH: HOT DIPPED GALVANIZED PER ASTM A123.



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APPROVALS		INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-1994		SHORT CONNECTOR, RAPTOR			
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APPR'D DATE: 6/1/10		DO NOT SCALE DRAWING	REV	ECN#	DATE	SCALE 1:2	SHEET 1 OF 1

Enclosure 1

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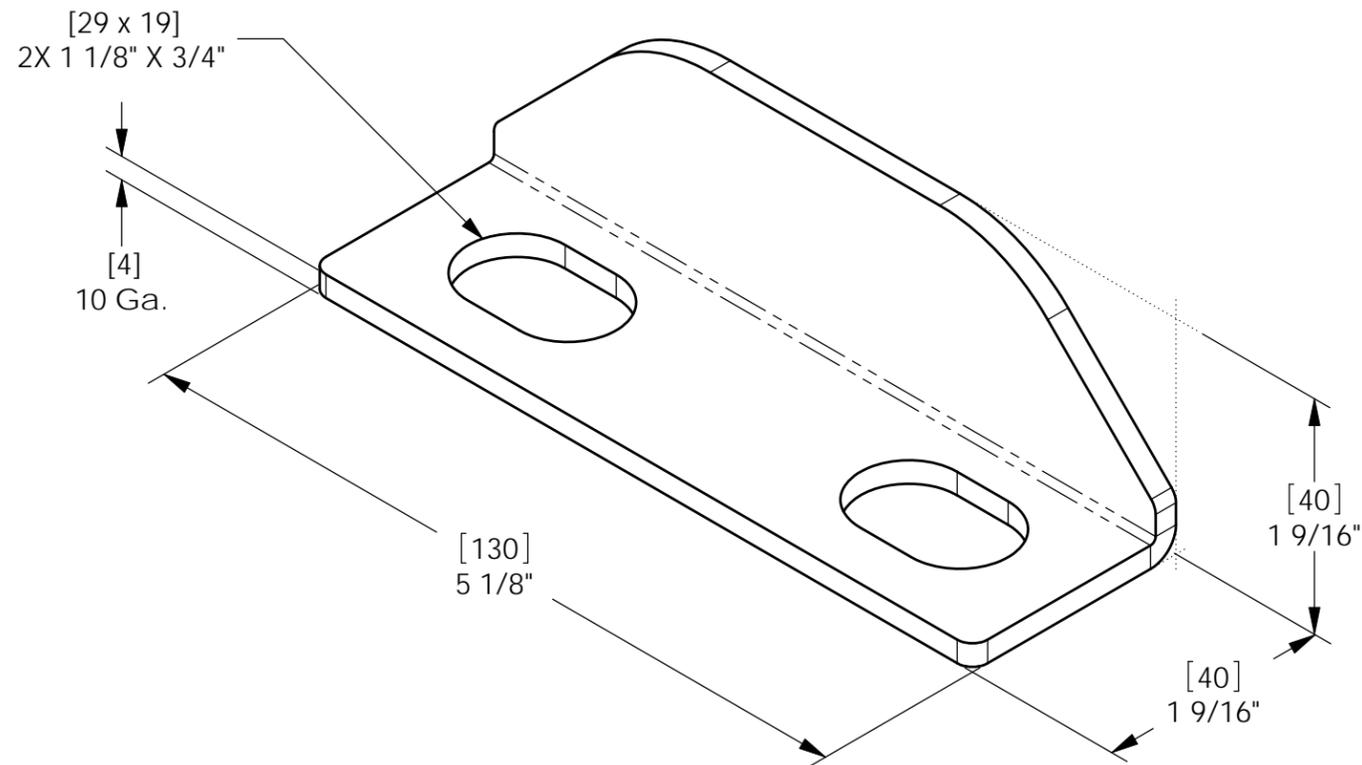
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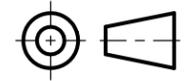
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- 2. FINISH: HOT DIPPED GALVANIZED PER ASTM A123.



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APPROVALS		INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-1994		TITLE	
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Enclosure 1

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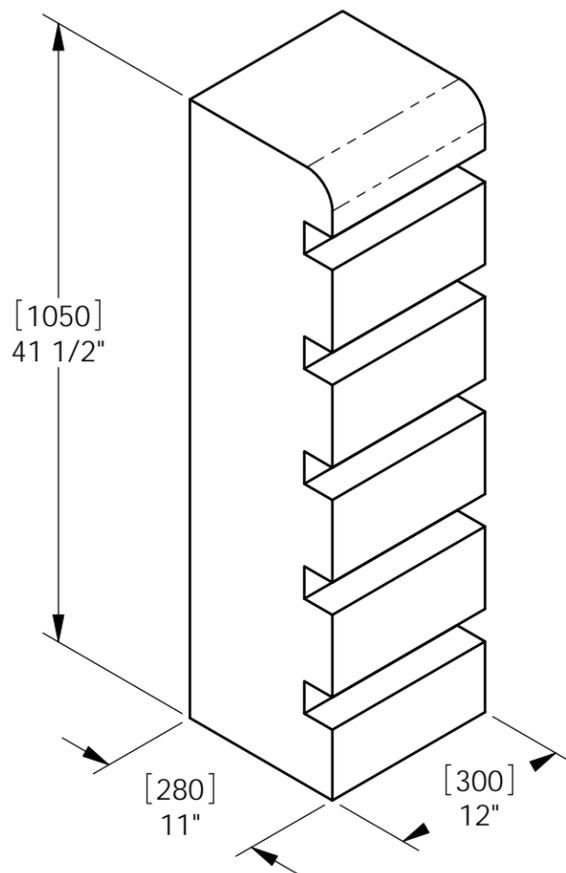
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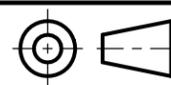
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THIRD ANGLE PROJECTION



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TITLE

PACKER PIECE, BLACK, RAPTOR

APPROVALS

DRAWN BY: AEM

DRAWN DATE: 6/1/10

APPR'D BY: GAD

APPR'D DATE: 6/1/10

SIZE	DWG NO.	REV.
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SCALE 1:10 SHEET 1 OF 1

Enclosure 1

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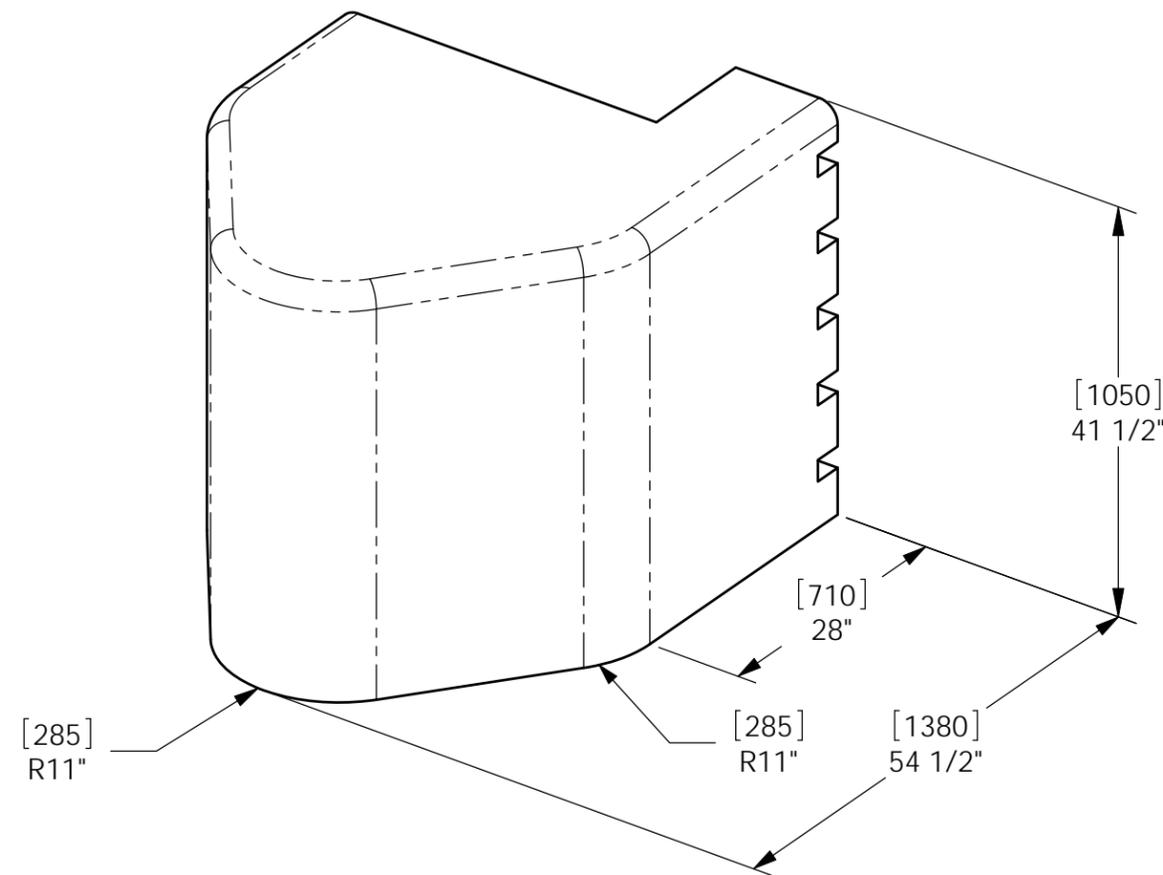
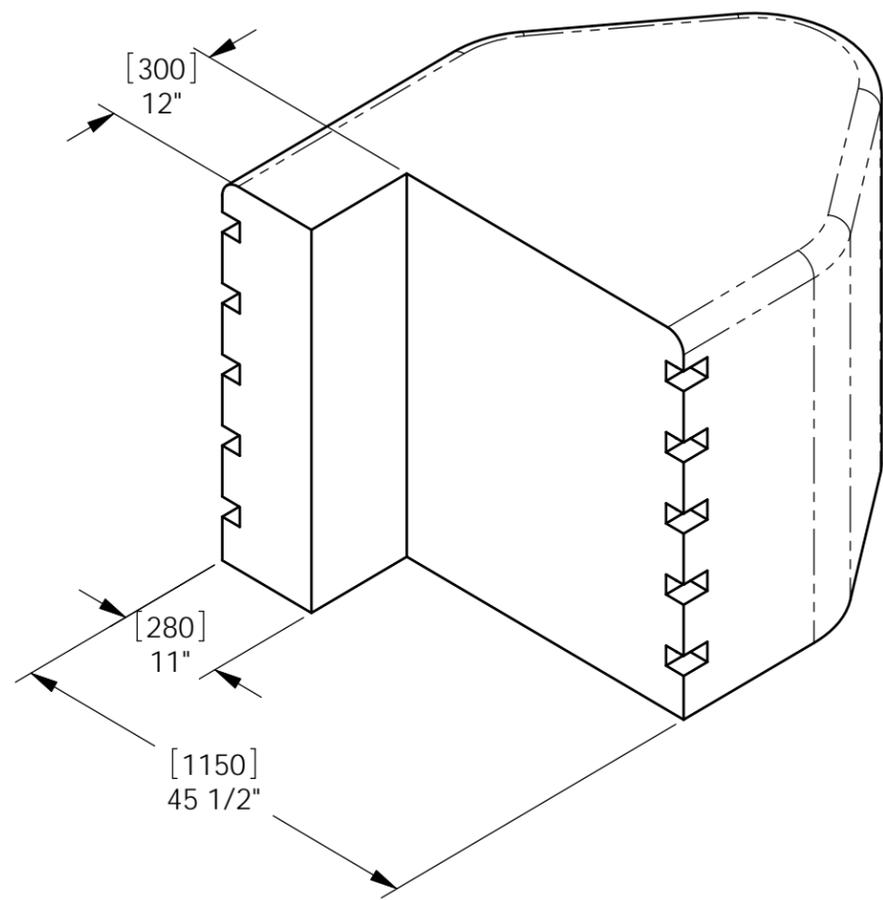
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 TOLERANCES PER ASME
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DRAWN DATE:	6/1/10
APPR'D BY:	GAD
APPR'D DATE:	6/1/10

THIRD ANGLE PROJECTION

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REV	ECN#	DATE

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 Vacaville, CA 95688
 Tel: 888-800-3691
 www.barriersystemsinc.com

TITLE
SHELL, BLACK, RAPTOR

SIZE B	DWG NO. B091226-US	REV. 0
SCALE 1:16	SHEET 1 OF 1	

Enclosure 1

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Figure 1. Summary of Results, Raptor™ Test # RAP02

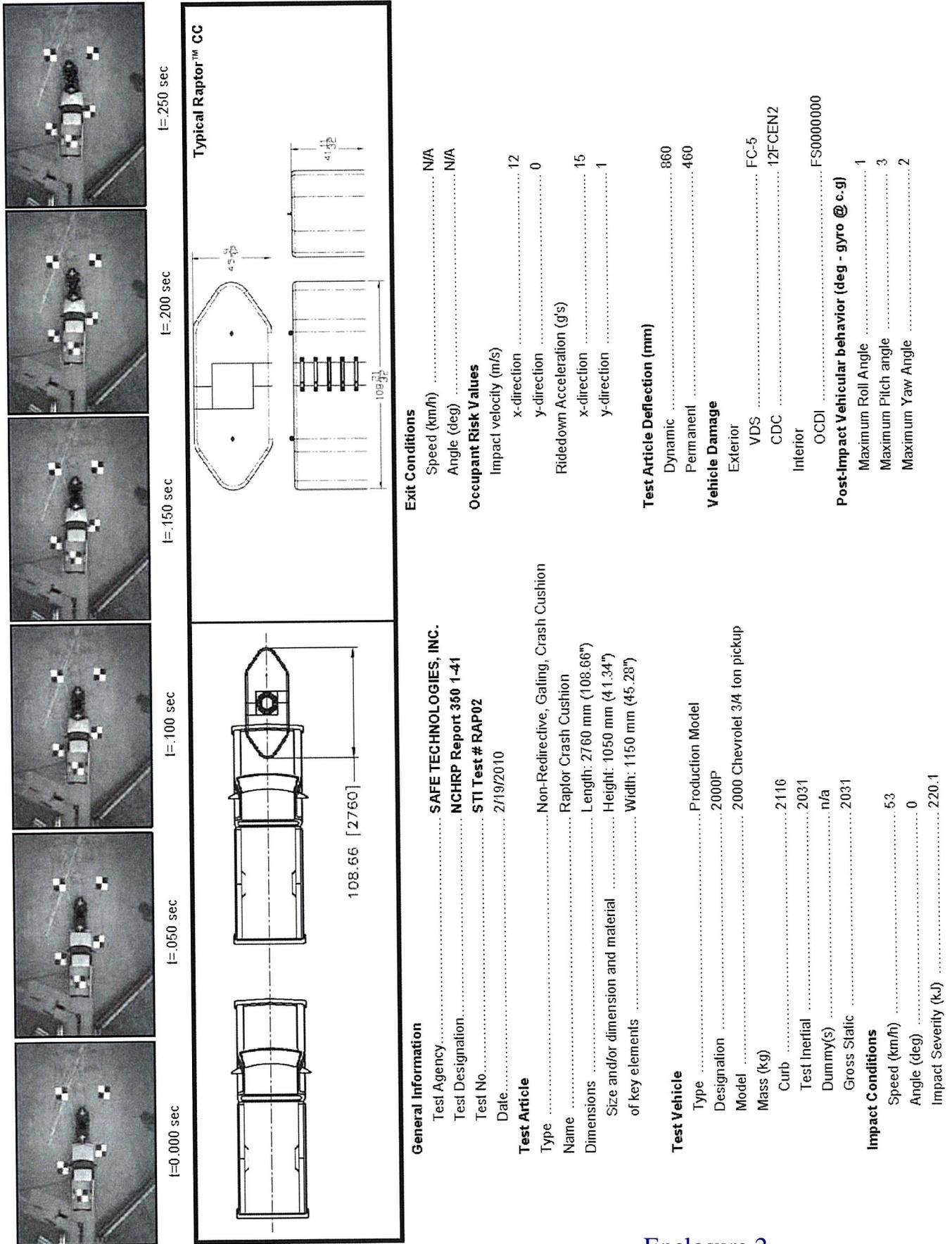
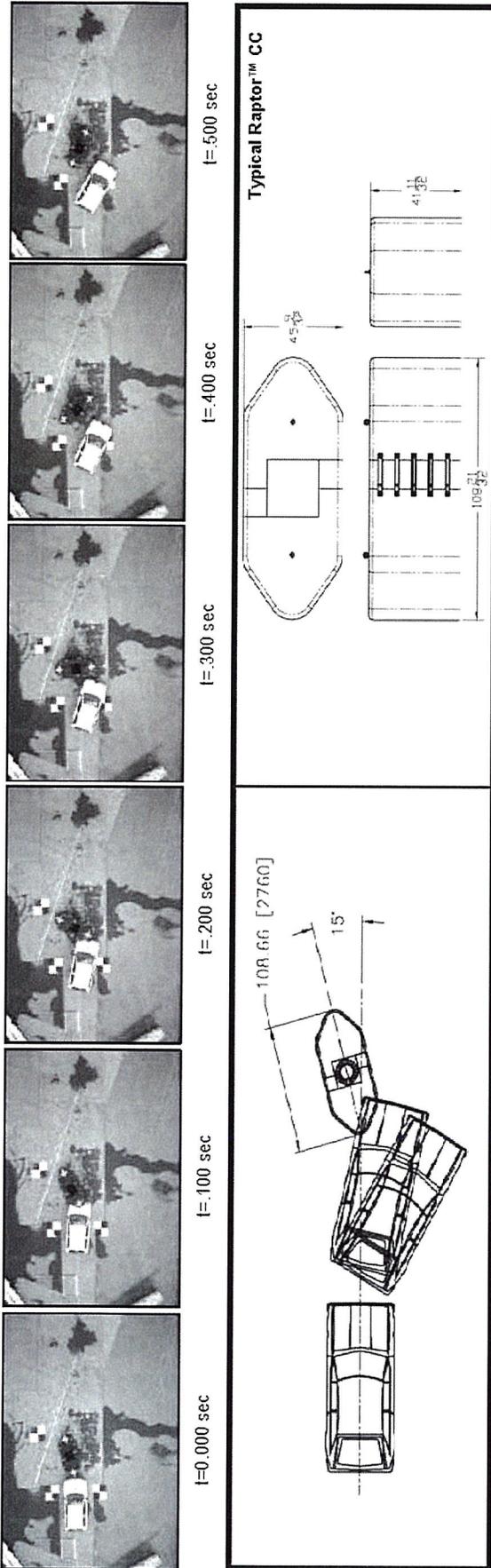


Figure 11. Summary of Results, Raptor™ Test # RAP04



General Information

Test Agency SAFE TECHNOLOGIES, INC.
 Test Designation NCHRP Report 350 1-42
 Test No. STI Test # RAP04
 Date 3/5/2010

Test Article

Type Non-Redirective, Gating, Crash Cushion
 Name Raptor Crash Cushion
 Dimensions Length: 2760 mm (108.66")
 Size and/or dimension and material Height: 1050 mm (41.34")
 of key elements Width: 1150 mm (45.28")

Test Vehicle

Type Production Model
 Designation 820C
 Model 1992 Ford Festiva
 Mass (kg)

Curb 756
 Test Inertial 825
 Dummy(s) 75
 Gross Static 900

Impact Conditions

Speed (km/h) 48
 Angle (deg) 15
 Impact Severity (k-J) 74.6

Exit Conditions

Speed (km/h) N/A
 Angle (deg) N/A

Occupant Risk Values

Impact velocity (m/s)
 x-direction 12
 y-direction 2
 Ridedown Acceleration (g's)
 x-direction 8
 y-direction 5

Test Article Deflection (mm)

Dynamic 309
 Permanent 6

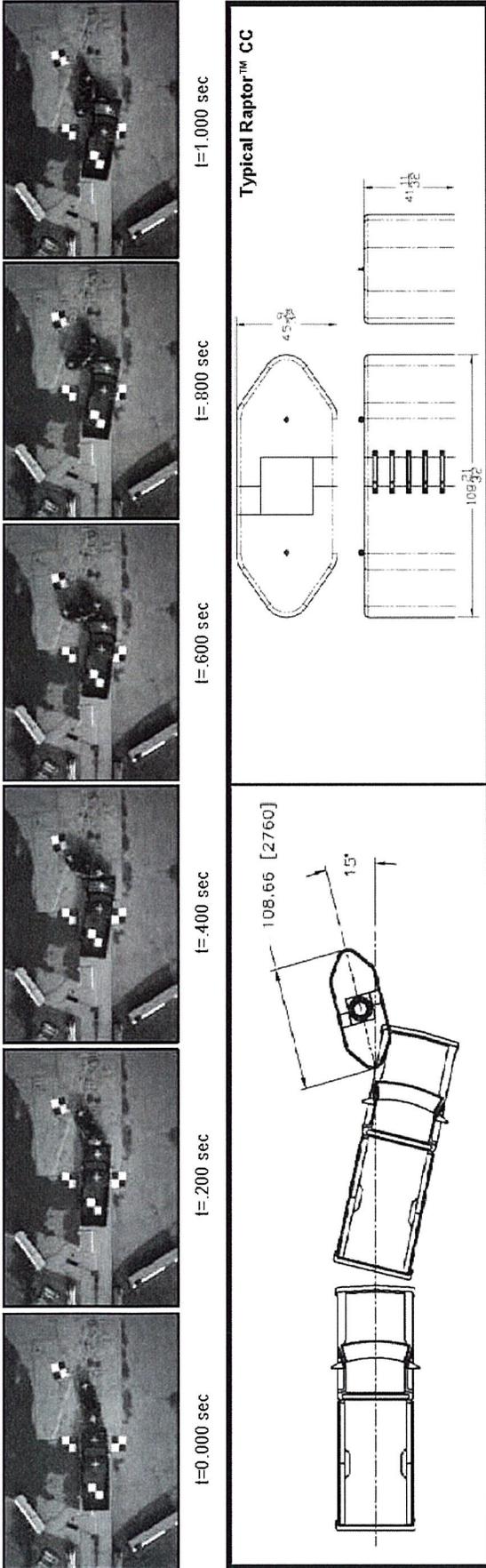
Vehicle Damage

Exterior
 VDS FC-4
 CDC 12FCEN2
 Interior
 OCDI FS0000000

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

Maximum Roll Angle 6
 Maximum Pitch angle 4
 Maximum Yaw Angle 39

Figure 6. Summary of Results, Raptor™ Test # RAP03



General Information

Test Agency..... **SAFE TECHNOLOGIES, INC.**
 Test Designation..... **NCHRP Report 350 1-43**
 Test No..... **STI Test # RAP03**
 Date..... **2/25/2010**

Test Article

Type **Non-Redirective, Gating, Crash Cushion**
 Name **Raptor Crash Cushion**
 Dimensions **Length: 2760 mm (108.66")**
 Size and/or dimension and material **Height: 1050 mm (41.34")**
 of key elements **Width: 1150 mm (45.28")**

Test Vehicle

Type **Production Model**
 Designation **2000P**
 Model **1995 Chevrolet 3/4 ton pickup**
 Mass (kg)
 Curb **1840**
 Test Inertial **2012**
 Dummy(s) **n/a**
 Gross Static **2012**

Impact Conditions

Speed (km/h) **51**
 Angle (deg) **15**
 Impact Severity (k-J) **204.3**

Exit Conditions

Speed (km/h) **N/A**
 Angle (deg) **N/A**

Occupant Risk Values

Impact velocity (m/s)
 x-direction **10**
 y-direction **2**
 Ridedown Acceleration (g/s)
 x-direction **8**
 y-direction **4**

Test Article Deflection (mm)

Dynamic **300**
 Permanent **72**

Vehicle Damage

Exterior
 VDS **FL-4**
 CDC **11FLEW2**
 Interior
 OC DI **LF0000000**

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

Maximum Roll Angle **0**
 Maximum Pitch angle **0**
 Maximum Yaw Angle **2**