



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

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

February 10, 2016

In Reply Refer To:  
HSST/ B-258

Mr. John Wright  
Indiana Department of Transportation  
100 N. Senate Ave.  
Indianapolis, IN 46204

Dear Mr. Wright:

This letter is in response to your September 3, 2015 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number B-258 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

### **Decision**

The following devices are eligible, with details provided in the form which is attached as an integral part of this letter:

- Indiana Anchored Temporary Concrete Barrier

### **Scope of this Letter**

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

### **Eligibility for Reimbursement**

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH). Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system:	Indiana Anchored Temporary Concrete Barrier
Type of system:	Precast concrete F-Shape barrier, using J-J Hook connection, bent angle plates at third points of each barrier unit, wedge anchor studs, and bolt down top plates
Test Level:	MASH Test Level 3
Testing conducted by:	Texas Transportation Institute
Task Force 13 Designator:	NA
Date of request:	September 3, 2015
Date initially acknowledged:	October 21, 2015
Date of completed package:	February 2, 2016

FHWA concurs with the recommendation of the accredited crash testing laboratory as stated within the attached form.

### **Full Description of the Eligible Device**

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

### **Notice**

If a manufacturer makes any modification to any of their roadside safety hardware that has an existing eligibility letter from FHWA, the manufacturer must notify FHWA of such modification with a request for continued eligibility for reimbursement. The notice of all modifications to a device must be accompanied by:

- Significant modifications – For these modifications, crash test results must be submitted with accompanying documentation and videos.
- Non-signification modifications – For these modifications, a statement from the crash test laboratory on the potential effect of the modification on the ability of the device to meet the relevant crash test criteria.

FHWA's determination of continued eligibility for the modified hardware will be based on whether the modified hardware will continue to meet the relevant crash test criteria.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of the MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.

### **Standard Provisions**

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-258 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 upon request.
- This 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.
- If the subject device is a patented product it may be considered to be proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid 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.

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 distinct "S" and "G".

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

Enclosures

## Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

<b>Submitter</b>	Date of Request:	September 03, 2015	<input checked="" type="radio"/> New <input type="radio"/> Resubmission
	Name:	John Wright	
	Company:	Indiana Department of Transportation	
	Address:	100 N. Senate Ave., Indianapolis, IN 46204	
	Country:	USA	
	To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'B': Barriers (Roadside, Median, Bridge Railings)	<input checked="" type="radio"/> Physical Crash Testing <input type="radio"/> Engineering Analysis	Indiana Temporary Anchored Concrete Barrier	AASHTO MASH	TL3

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

Identification of the individual or organization responsible for the product:

Contact Name:	John Wright	Same as Submitter <input checked="" type="checkbox"/>
Company Name:	Indiana Department of Transportation	Same as Submitter <input checked="" type="checkbox"/>
Address:	100 N. Senate Ave., Indianapolis, IN 46204	Same as Submitter <input checked="" type="checkbox"/>
Country:	USA	Same as Submitter <input checked="" type="checkbox"/>
Enter below all disclosures of financial interests as required by the FHWA 'Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.		
<p>In regard to the Indiana DOT Temporary Anchored Concrete Barrier, TTI Proving Ground had/has no financial interests. Indiana DOT contracted for the service of crash testing this barrier according to specifications for American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) Test 3-11, for which TTI Proving Ground was compensated for the cost to perform the test. No consulting relationships, research funding or other forms of research support, patents, copyrights, other intellectual property interests, licenses, contractual relationships, business ownership or investment interests are retained for the TTI Proving Ground.</p>		

## PRODUCT DESCRIPTION

<input checked="" type="radio"/> New Hardware or Significant Modification	<input type="radio"/> Modification to Existing Hardware	
<p>INDOT conducted three tests for this Temporary Anchored Concrete Barrier system. All three tests used a standard 31 inch F-shape concrete barrier. Each barrier segment was 10 ft long, 31 inches tall and 24 inches wide at the bottom, tapering to 10 inches wide at the top. Due to different barrier wall suppliers, some barriers had a 3 inch reveal and some had a 2 inch reveal. Placement of those segments are detailed in each report. All barrier used J-J hooks for connection.</p> <p>Test 1 (Test Report # 690900-IND1) – conducted Jan. 8th, 2015. This test utilized a 90° bent angle plate at each joint. This test failed and is not part of this request. Photos, video and the report are attached for viewing purposes. This was the barrier that Indiana currently uses and had been used for some time with no reported flaws.</p> <p>Test 2 ( Test Report # 690900-IND2) – conducted April 16th, 2015. This test utilized three bent angle plates per barrier and a 4 bolt top plate recessed into the barrier. The top plate holes were formed into the concrete using ferrule loops as discussed in the report. The test passed but we noticed a construction problem where it was hard to line up the 4 top plate bolts due to variances in the J-J hook installation. Also the ferrule loops were poured into the concrete barrier, so could not use existing temporary barrier and convert it into the anchor barrier, so, we preceded with a third test.</p> <p>Test 3 (Test Report # 690900-IND3) – conducted May 19th, 2015. This test utilized three bent angle plates per barrier and a 2 bolt top plate connecting the barriers that were not recessed. The top plate holes were pre-drilled and expansion anchors were inserted as discussed in the report. Note that the top plate bolts were tightened with no specific torque value.</p>		

## CRASH TESTING

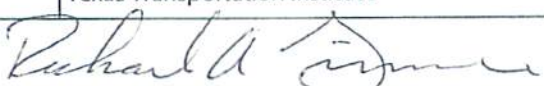
A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-10 (1100C)	<p>For anchored precast barrier systems, MASH Test 3-11 (2270 kg. Pickup @ 100 km/hr @ 25 degrees impact angle), which was performed for this project, is the critical test for barrier strength. Mash Test 3-10 (1100 kg small car @ 100 km/hr @ 25 degrees impact angle) is critical for vehicle stability and occupant risk. For MASH Test 3-10, and anchored barrier like the one tested for this project, the barrier lateral deflection is typically small and the barrier behaves more like a rigid barrier.</p> <p>A rigid New Jersey Barrier has been successfully tested to MASH 3-10 Specification (see Midwest Roadside Safety Facility Test Report 2214NJ-1). Other successful small car tests were reported on the F-Shape Barrier and New Jersey Safety Shape barrier. They are referenced as follows:</p> <p>1.) TTI no. 7069-3 reported in two volumes FHWA-RD93-058, "Testing of New Bridge Rail and Transitions Designs, Volume 1: Technical Report "FHWA-RD-93-064 "testing of New Bridge Rail and Transition Designs Volume 7: Appendix F 32-inch (813-mm) F-Shape Bridge Railing".</p> <p>2.) 42-inch Safety Shape Test with Small Car – TTI Test No. 4348-1 reported in "Development of High-Performance Median Barrier"</p> <p>For Test Report 2214NJ-1, the safety shape barrier was impacted by a 2579-lb passenger car at 60.8 mph and 26.1 degrees impact angle. This test was successful with respect to MASH criteria. While MASH Test 3-10 has not been performed to date on a rigid F-Shape barrier, the F-Shape has been successfully tested with an 817 kg. small car at 60 mph and 21.4 degrees impact angle and reported in Project 7069-3 herein. A comparable test on the New Jersey Shape was performed at a lesser 15 degree impact angle and reported in Project 4348-1 (843 kg. small car at 62.6 mph at 15.0 degrees impact angle). This test was also deemed successful.</p> <p>TTI has reviewed the data summaries for the small car tests provided herein on the F-Shape and New Jersey Shape. Based on the results of these tests, the F-Shape performed better for the small cars tests (more stable) even with a higher impact angle. Therefore, under the MASH guidelines, the F-Shape should perform better than the New Jersey Shape barrier which has been successfully tested to MASH. Therefore, the MASH Test 3-10 was deemed unnecessary for this testing.</p>	Non-Critical, not conducted

Required Test Number	Narrative Description	Evaluation Results
3-11 (2270P)	<p>TL-3 test of a 31 inch F-shape concrete barrier. . Each barrier segment was 10 ft long, 31 inches tall and 24 inches wide at the bottom, tapering to 10 inches wide at the top.</p> <p>Test 1 (Test Report # 690900-IND1) – report submitted for viewing purposes only.</p> <p>Test 2 ( Test Report # 690900-IND2) – The Indiana Anchored Temporary Barrier with wedge anchor studs contained and redirected the 2270P vehicle. Maximum dynamic deflection during the test was 11.9 inches. Maximum occupant impact velocity and subsequent ride down accelerations were 15.1 ft/s longitudinal OIV, 24.6 ft/s lateral OIV and 5.1 G longitudinal RDA and 11.2 G lateral RDA. No deformation or intrusion of the occupant compartment occurred. The 2270P vehicle remained upright during and after the collision event. Maximum roll was 18° and maximum pitch was 18°. Occupant risk factors are within limits specified in MASH. The test was successful for a TL-3 crash test.</p> <p>Test 3 (Test Report # 690900-IND3) – The Indiana Anchored Temporary Barrier with wedge anchor studs contained and redirected the 2270P vehicle. Maximum dynamic deflection during the test was 13.3 inches. Maximum occupant impact velocity and subsequent ride down accelerations were 16.7 ft/s longitudinal OIV, 24.3 ft/s lateral OIV and 8.9 G longitudinal RDA and 10.8 G lateral RDA. No detached elements, fragments or other debris was present to penetrate or to show potential for penetrating the occupant department, or to present hazzard to others in the area. The 2270P vehicle remained upright during and after the collision event. Maximum roll was 26° and maximum pitch was 25°. Occupant risk factors are within limits specified in MASH. The test was successful for a TL-3 crash test.</p>	PASS
3-20 (1100C)	Not relevant, transition not tested for this system	Non-Critical, not conducted
3-21 (2270P)	Not relevant, transition not tested for this system	Non-Critical, not conducted

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):



Laboratory Name:	Texas Transportation Institute	
Laboratory Signature:		
Address:	Roadside Safety & Physical Security Texas A&M University System 3135 TAMU College Station, TX 77843-3135	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input type="checkbox"/>
Accreditation Certificate Number and Dates of current Accreditation period :	ISO 17025 Laboratory Testing Certificate # 3821.01 Accreditation date 02/19/2015 through 04-30/2017	

Submitter Signature\*:  2016.02.02  
07:01:57 -05'00'

Submit Form

## ATTACHMENTS

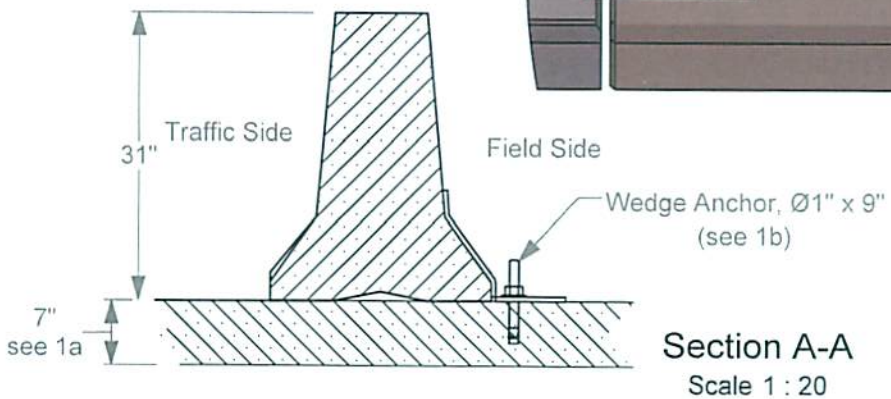
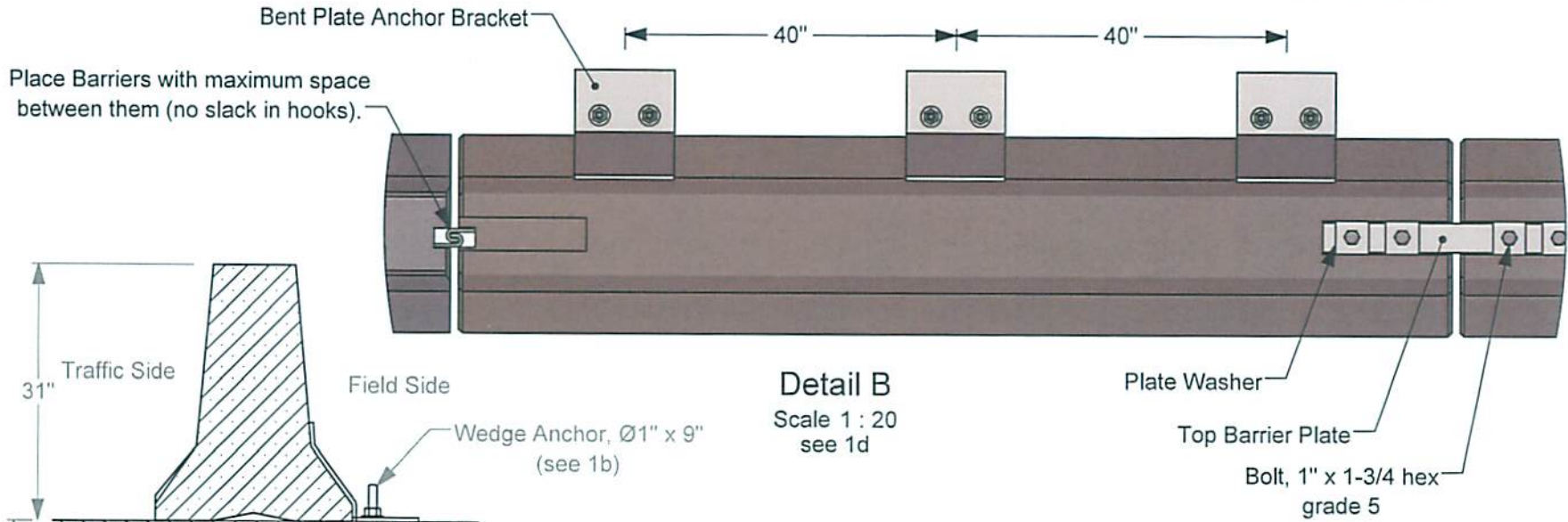
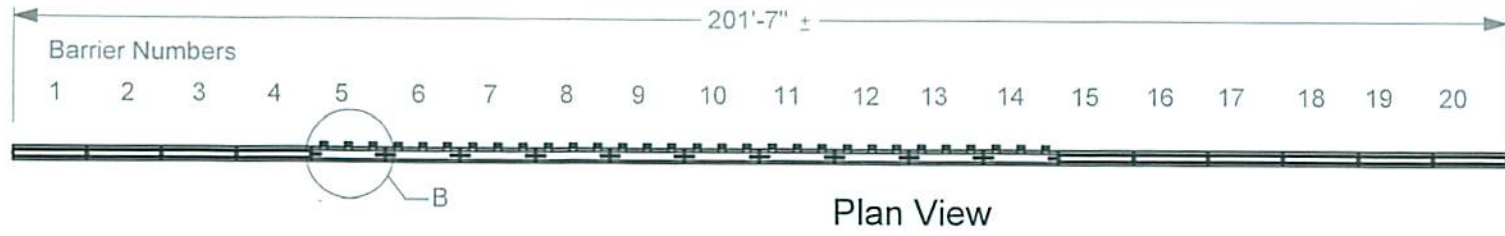
Attach to this form:

- 1) Additional disclosures of related financial interest as indicated above.
- 2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
- 3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [[Hardware Guide Drawing Standards](#)]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

**FHWA Official Business Only:**

Eligibility Letter		AASHTO TF13	Key Words
Number	Date	Designator	

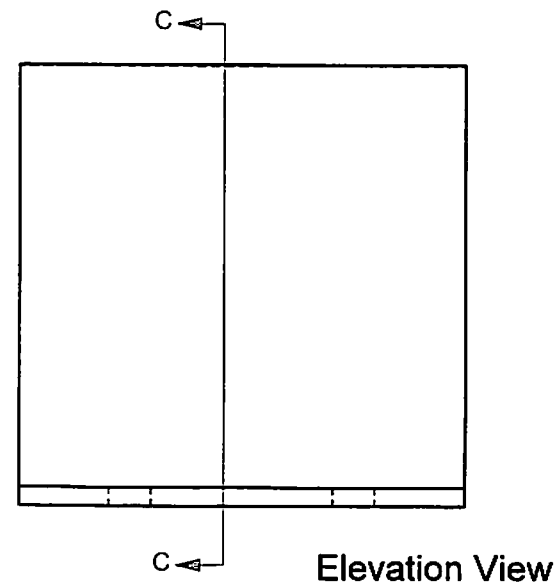
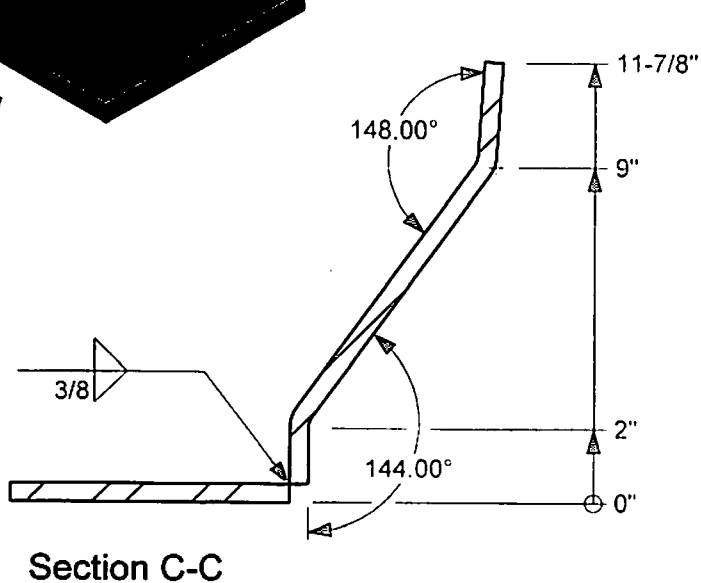
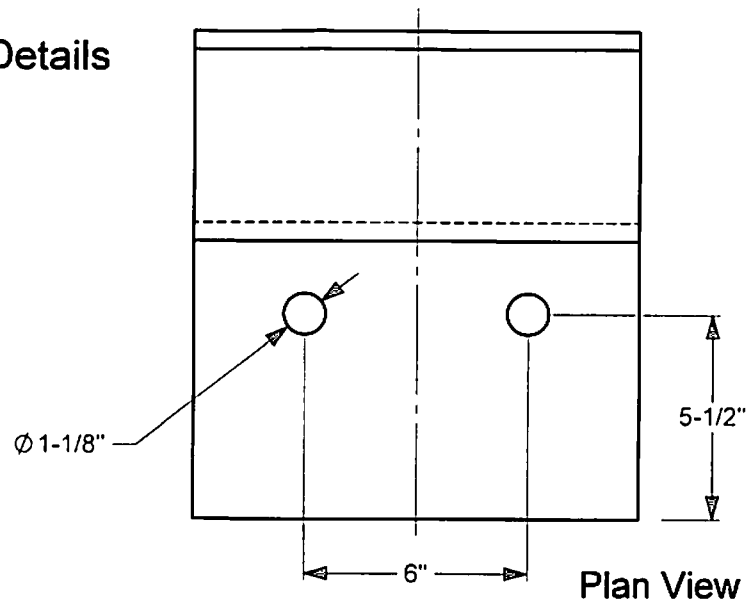
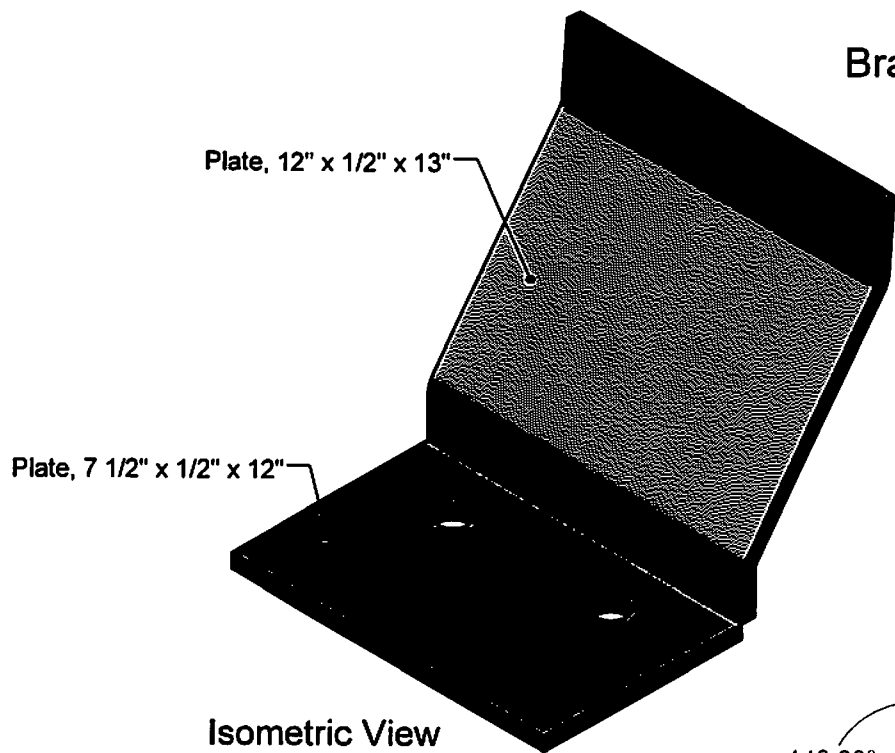
# Test Installation



- 1a. Nominal concrete apron thickness. Actual thickness may be up to 1" greater or less.
- 1b. Install Wedge Anchors according to manufacturer's instructions with 4-1/2" embedment. Two at each Bracket. Tighten to 250ft/lbs (minimum according to manufacturer's specifications).
- 1c. Barriers 1 - 4 and 15 - 20 were used in a previous test. Barriers 5 - 14 are new. Anchor Brackets are at Barriers 5 - 14, as shown in Plan View.
- 1d. Typical Bracket and Top Plate positions shown in Plan View and Detail B. Top Plates at each joint from 5-6 to 13-14.

		Roadside Safety and Physical Security Division Proving Ground -	
Project	690900-IND-2	Indiana Barriers	
Drawn By	GES	Scale 1:300	Sheet 1 of 6 Test Installation
Approved:			Date: 2015-04-15

# Bracket Details

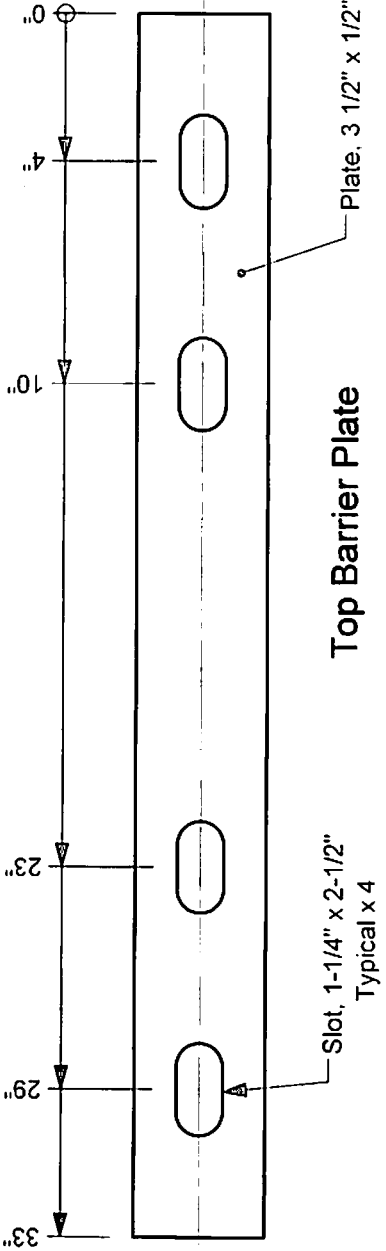


2a. This part was supplied by the client. Material specifications were not provided.

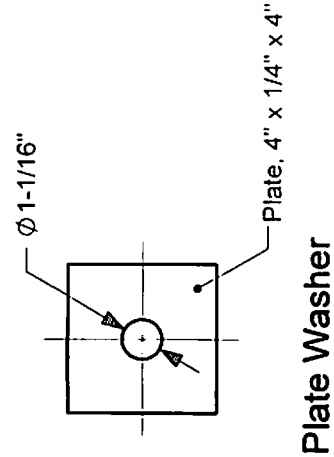


Roadside Safety and  
Physical Security Division -  
Proving Ground

# Connector Hardware



**Top Barrier Plate**



**Plate Washer**

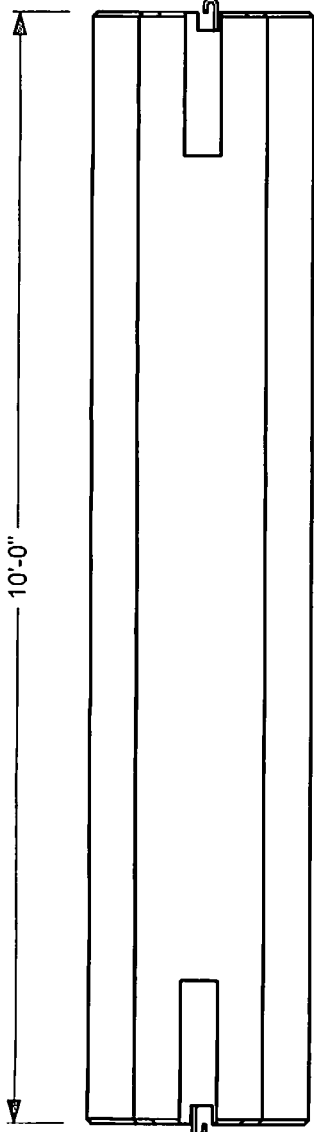


Roadside Safety and  
Physical Security Division -  
Proving Ground

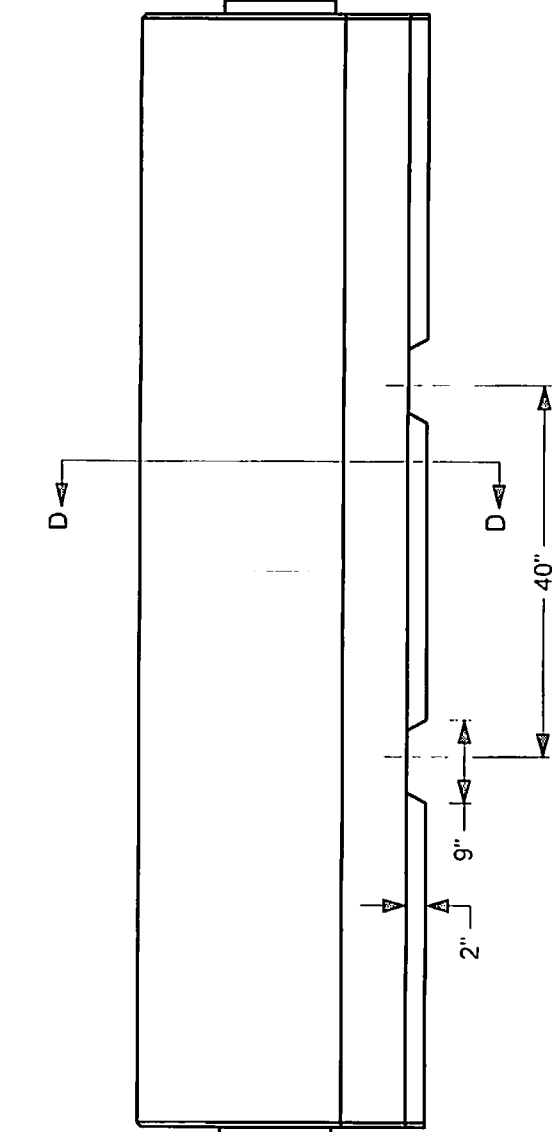
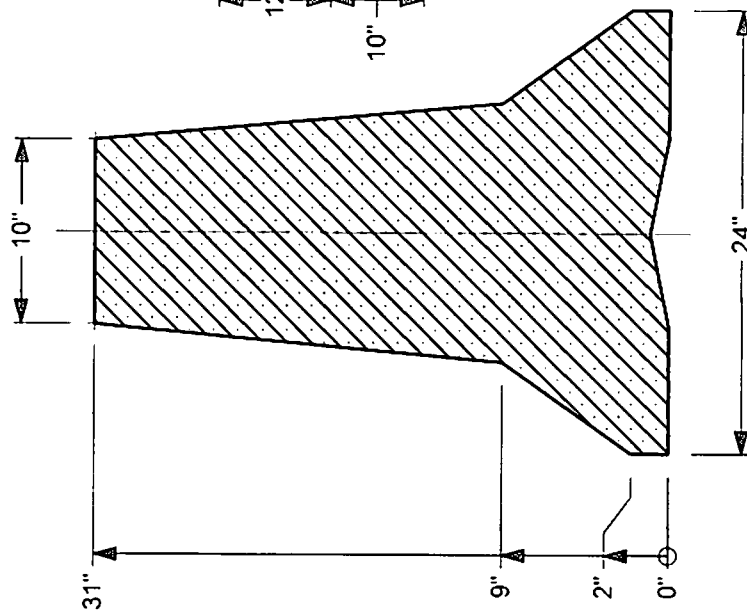
Project 690900-IND-2 Indiana Barriers 2015-04-14  
Drawn By GES Scale 1:5 Sheet 3 of 6 Connector Straps

3a. These parts were supplied by the client. Material specifications were not provided.

# Barriers 5-14



Plan View



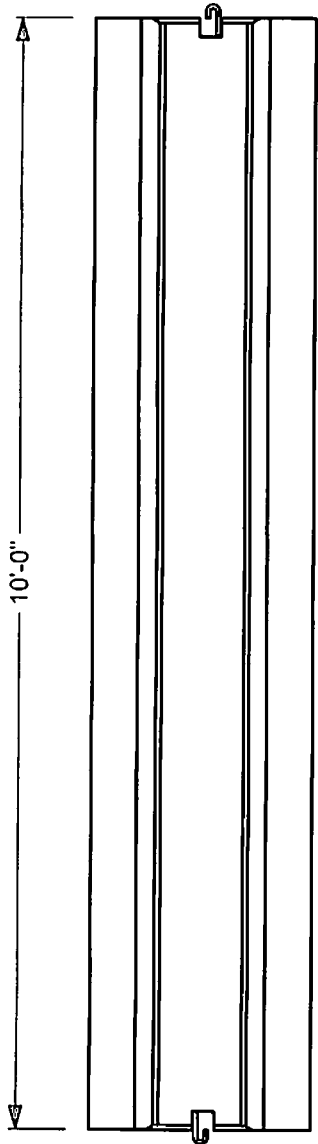
Elevation View



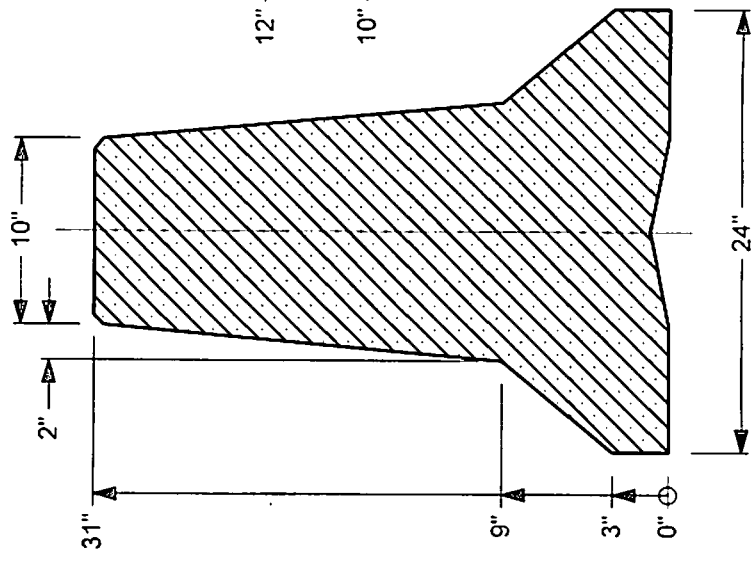
Roadside Safety and  
Physical Security Division -  
Proving Ground

Project 690900-IND-2 Indiana Barriers 2015-04-14  
Drawn By GES Scale 1:20 Sheet 4 of 6 Barriers 5-14

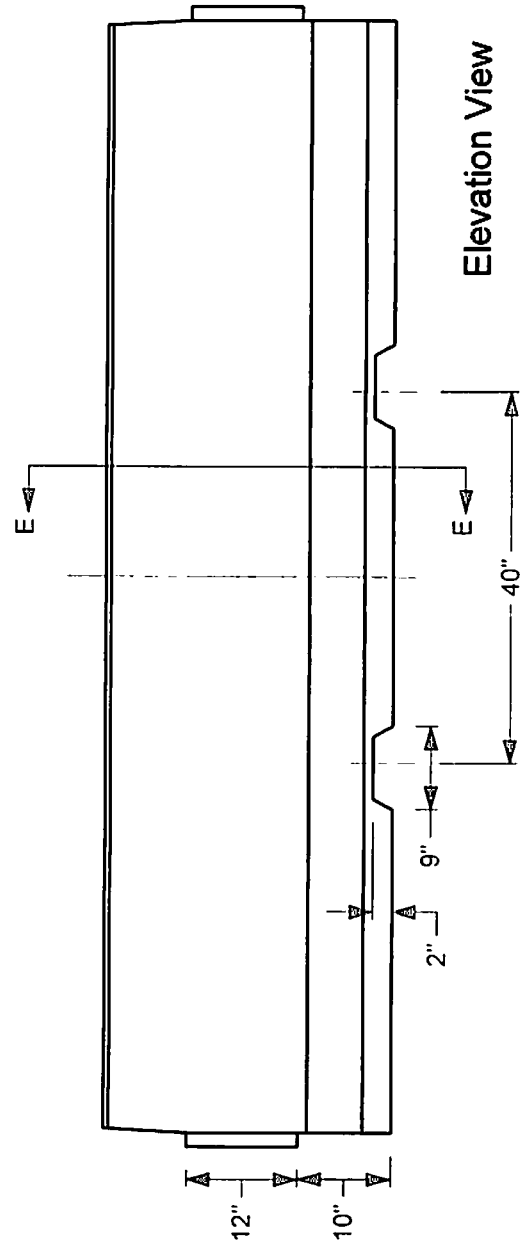
**Barriers 1-4 and 15-20**



**Plan View**

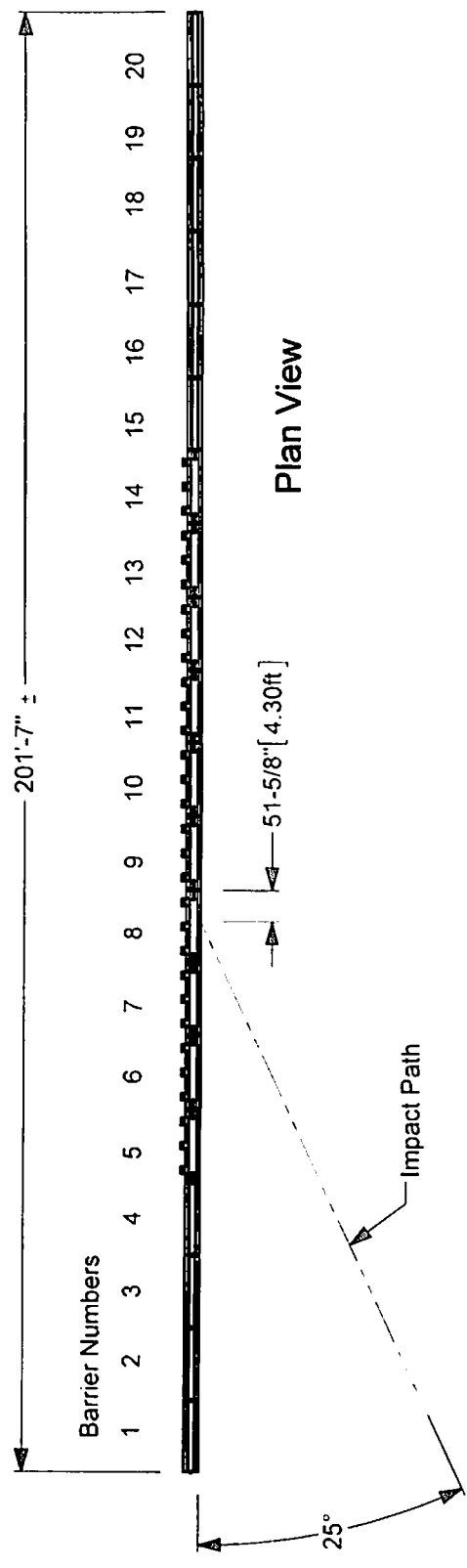


**Section E-E**  
Scale 1 : 10

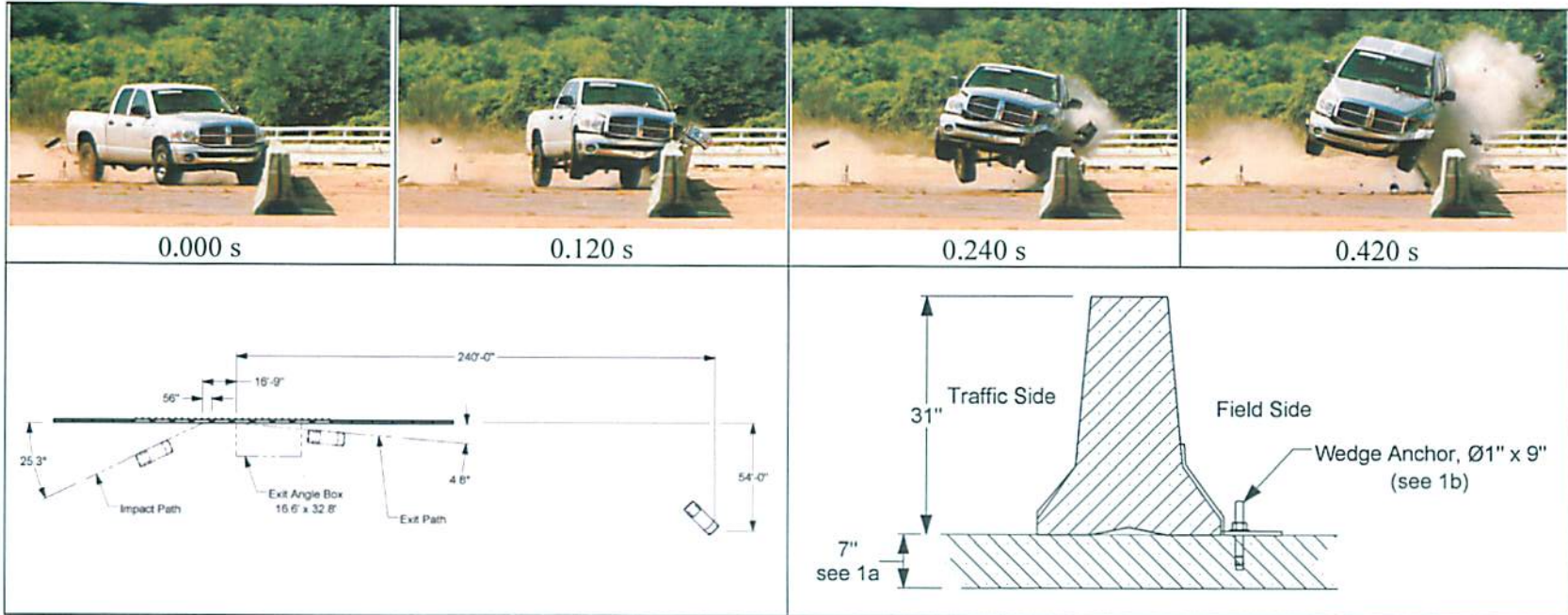


**Elevation View**

# Impact Path







**General Information**

Test Agency..... Texas A&M Transportation Institute (TTI)  
 Test Standard Test No. .... MASH Test 3-11  
 TTI Test No. .... 690900-IND2  
 Date ..... 2015-04-16

**Test Article**

Type..... Temporary Concrete Barrier  
 Name..... Indiana Anchored Temporary Barrier with Wedge Anchor Studs and Top Connectors  
 Installation Length ..... 201.6 ft  
 Material or Key Elements ... 9 ft-11 inch F-shape concrete barriers anchored with steel anchor brackets, wedge anchor studs, 4-bolt top plates in pockets

**Soil Type and Condition**..... Concrete pavement, dry

**Test Vehicle**

Type/Designation..... 2270P  
 Make and Model ..... 2008 Dodge Ram 1500 Pickup  
 Curb ..... 4899 lb  
 Test Inertial..... 5044 lb  
 Dummy ..... No dummy  
 Gross Static ..... 5044 lb

**Impact Conditions**

Speed ..... 62.7 mi/h  
 Angle ..... 25.3 degrees  
 Location/Orientation ..... 4.7 upstrm 8-9  
**Impact Severity** ..... 121.1 kip\*ft (+5%)

**Exit Conditions**

Speed ..... 53.8 mi/h  
 Angle ..... 4.8 degrees

**Occupant Risk Values**

Longitudinal OIV ..... 15.1 ft/s  
 Lateral OIV ..... 24.6 ft/s  
 Longitudinal RDA..... 5.1 G  
 Lateral RDA ..... 11.2 G  
 THIV ..... 31.9 km/h  
 PHD ..... 11.7 G  
 ASI ..... 1.64  
 Longitudinal 50-ms Average..... 7.7 G  
 Lateral 50-ms Avg ..... 12.5 G  
 Vertical 50-ms Avg ..... 4.1 G

**Post-Impact Trajectory**

Stopping Distance ..... 240 ft downstrm  
 54 ft twd traffic

**Vehicle Stability**

Maximum Yaw Angle..... 54 degrees  
 Maximum Pitch Angle..... 18 degrees  
 Maximum Roll Angle ..... 18 degrees  
 Vehicle Snagging ..... No  
 Vehicle Pocketing..... No

**Test Article Deflections**

Dynamic ..... 11.9 inches  
 Permanent..... 11.9 inches  
 Working Width ..... 28.1 inches

**Vehicle Damage**

VDS ..... 11LFQ5  
 CDC ..... 11FLEW4  
 Max. Exterior Deformation..... 12.0 inches  
 OCDI ..... FS0000000  
 Max. Occupant Compartment Deformation..... None

Figure 5.9. Summary of Results for MASH Test 3-11 on Indiana Anchored Temporary Barrier with Wedge Anchor Studs.



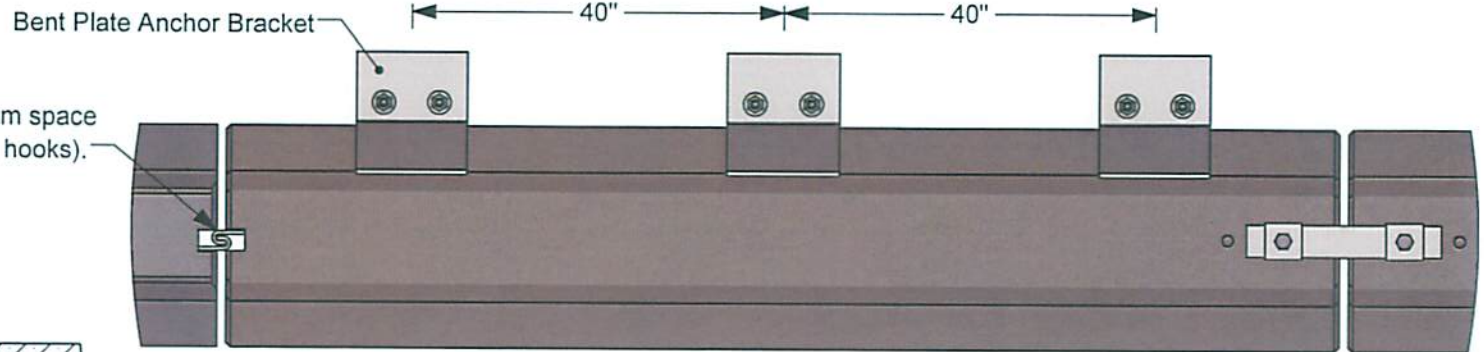
# Test Installation



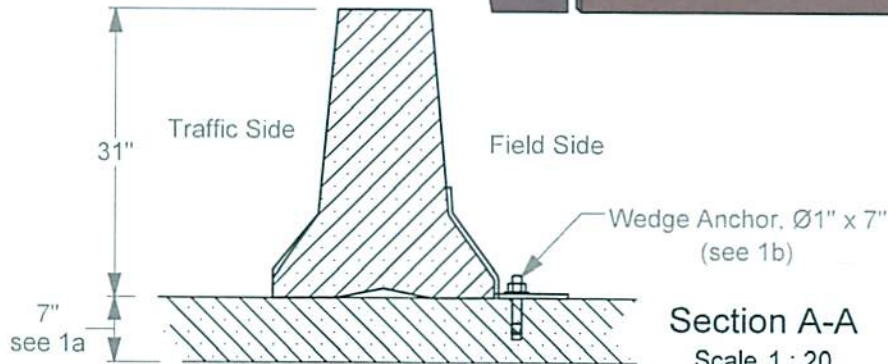
Plan View



Elevation View

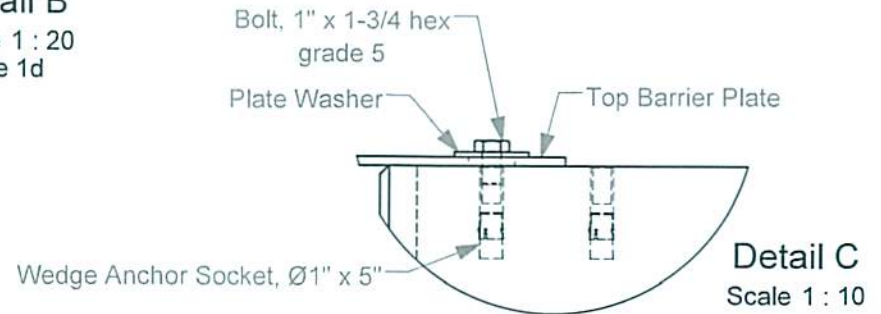


Place Barriers with maximum space between them (no slack in hooks).



Section A-A  
Scale 1 : 20

Detail B  
Scale 1 : 20  
see 1d



Detail C  
Scale 1 : 10

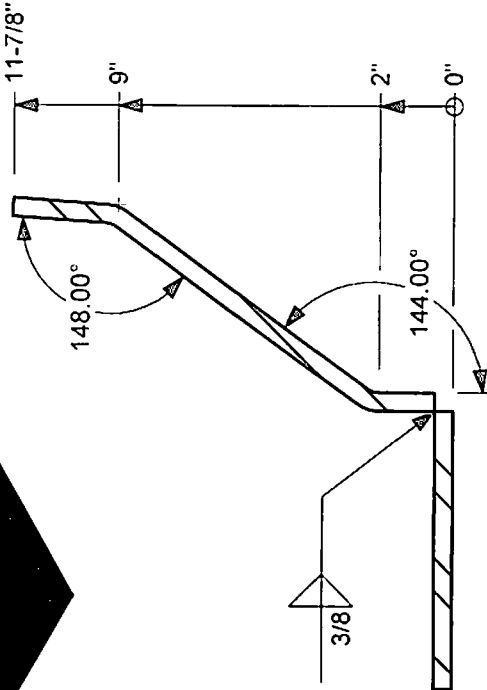
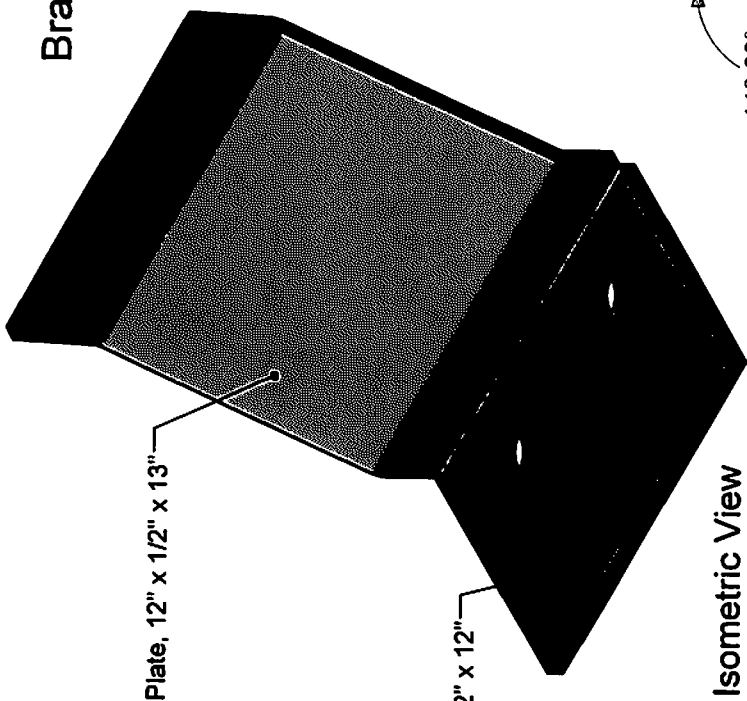
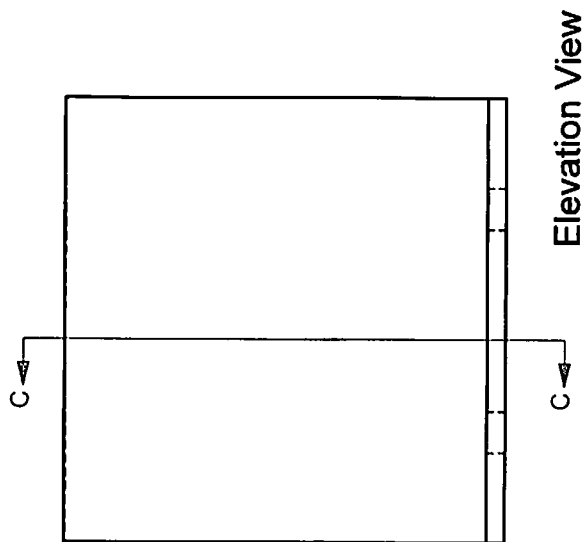
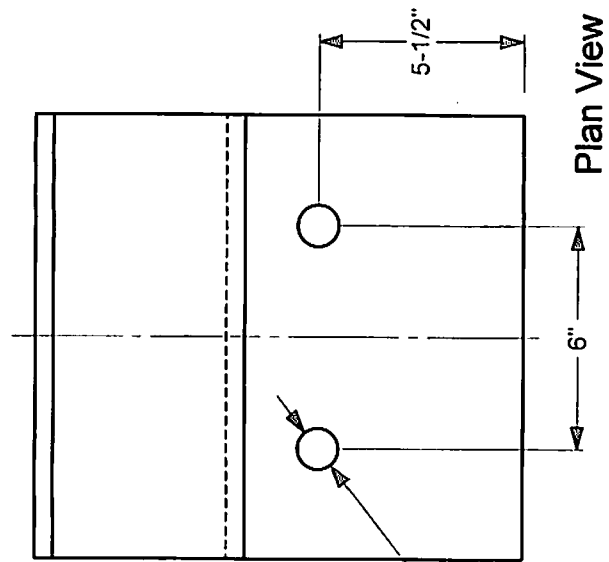
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- 1b. Install Wedge Anchors according to manufacturer's instructions with 4-1/2" embedment. Two at each Bracket. Tighten to 250ft/lbs (minimum according to manufacturer's specifications).
- 1c. Barriers 1 - 4 and 15 - 20 were used in a previous test. Barriers 5 - 14 are new. Anchor Brackets are at Barriers 5 - 14, as shown in Plan View.
- 1d. Typical Bracket and Top Plate positions shown in Plan View and Detail B.



Roadside Safety and Physical Security Division Proving Ground -

Project	690900-IND-3	Indiana Barriers
Drawn By	GES	Scale 1:300 Sheet 1 of 6 Test Installation
Approved:	William Williams: <i>William Williams</i>	Date: 2015-05-14

### Bracket Details



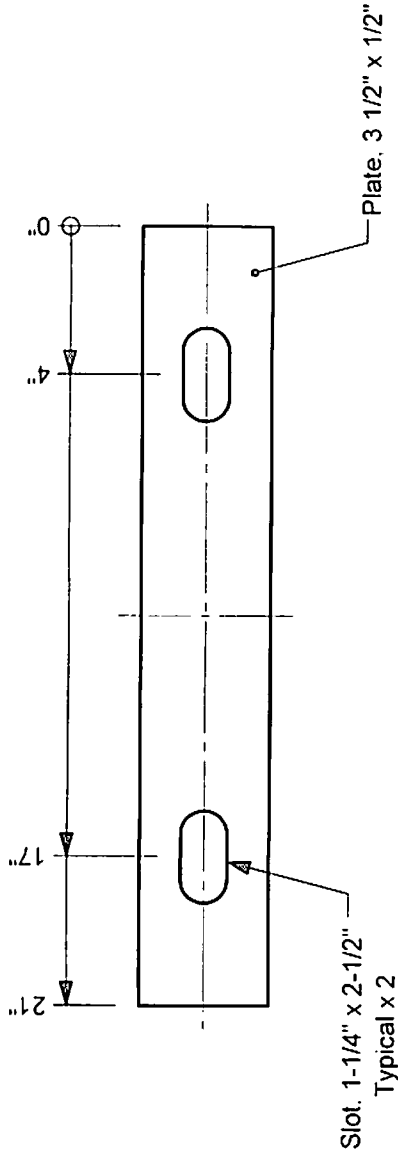
2a. This part was supplied by the client. Material specifications were not provided.



Roadside Safety and  
Physical Security Division -  
Proving Ground

Project 690900-IND-3 Indiana Barriers  
Drawn By GES Scale 1:5 Sheet 2 of 6 Bracket Details  
2015-05-14

# Connector Hardware



Top Barrier Plate



Wedge Anchor Socket,  $\varnothing 1" \times 5"$   
(Internal threads not shown)

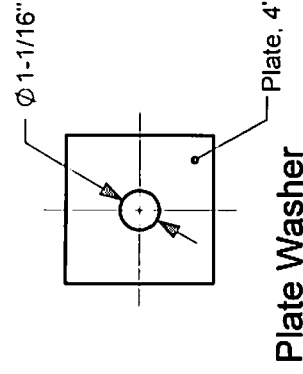


Plate Washer

3a. These parts were supplied by the client. Material specifications were not provided.

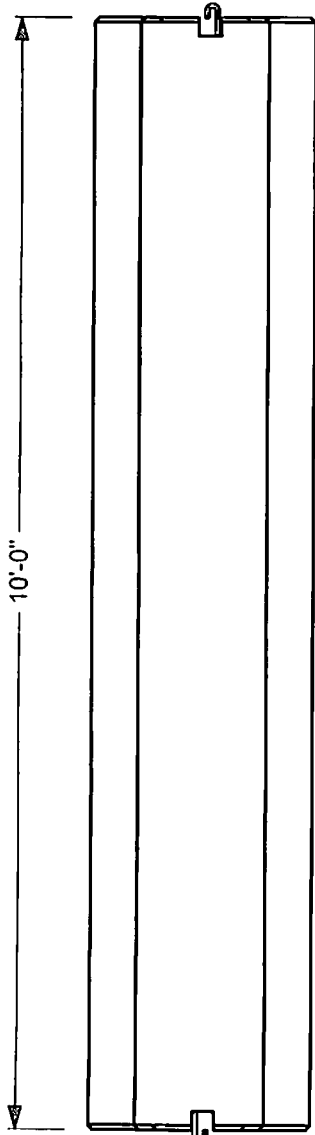


Roadside Safety and  
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Proving Ground

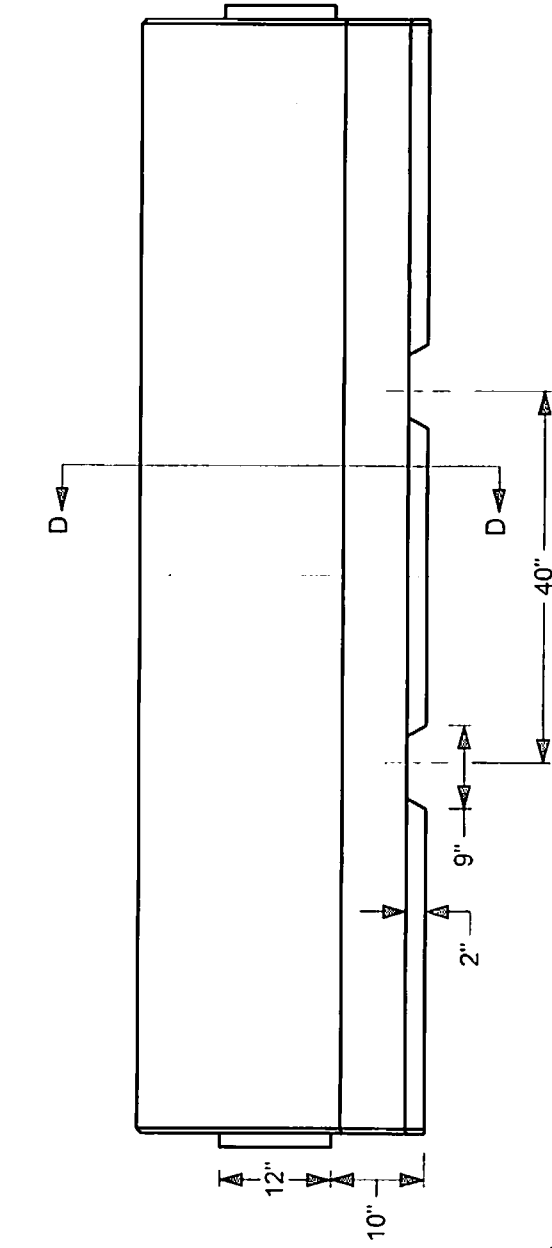
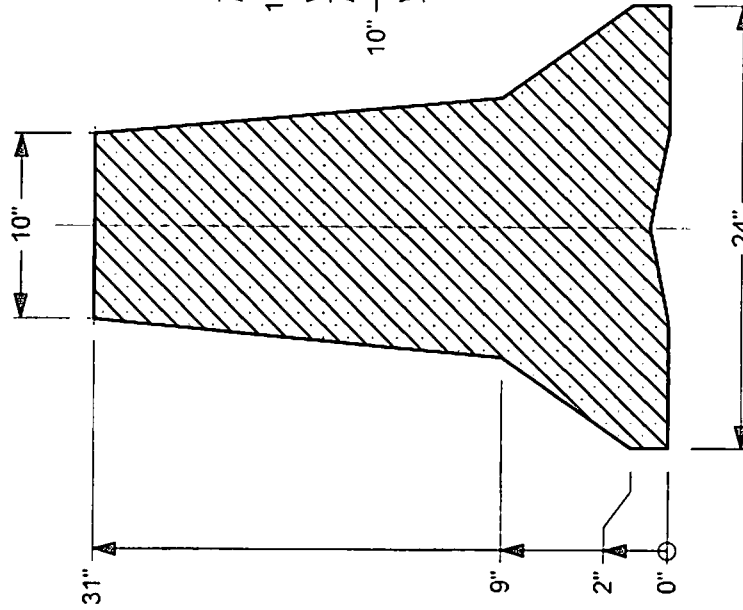
Project 690900-IND-3 Indiana Barriers  
Drawn By GES Scale 1:5 Sheet 3 of 6

2015-05-14  
Connector Hardware

# Barriers 5-14



Plan View



Elevation View



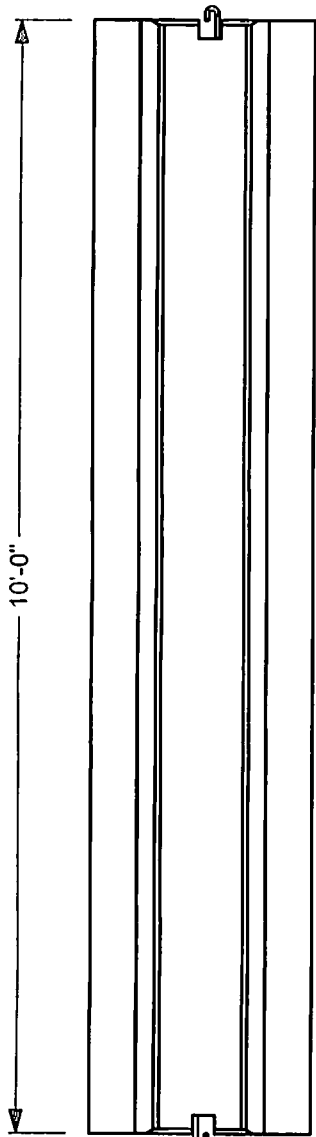
Roadside Safety and  
Physical Security Division -  
Proving Ground

Project 690900-IND-3 Indiana Barriers

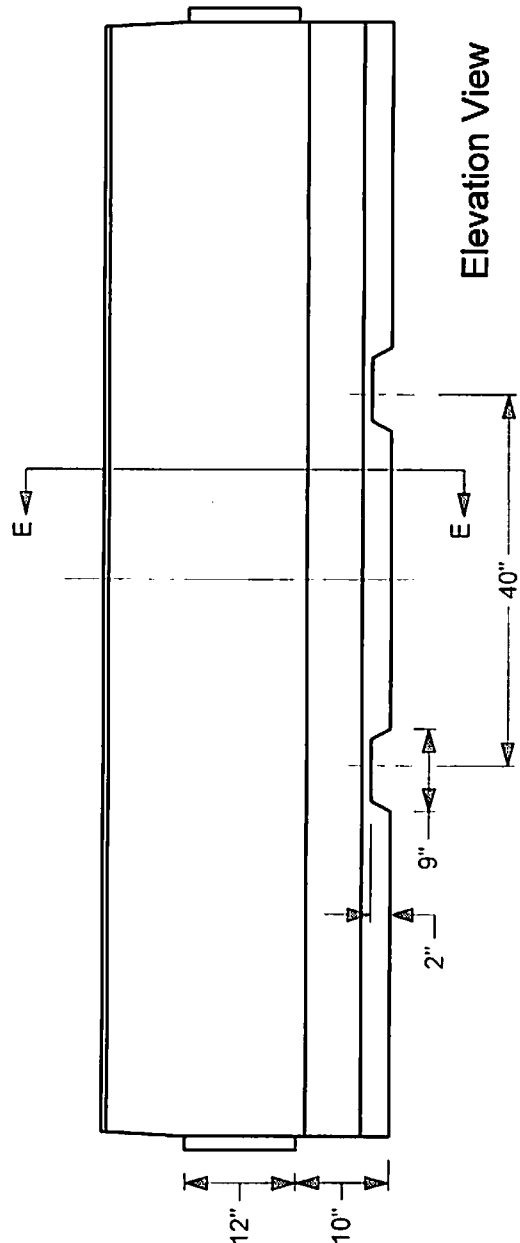
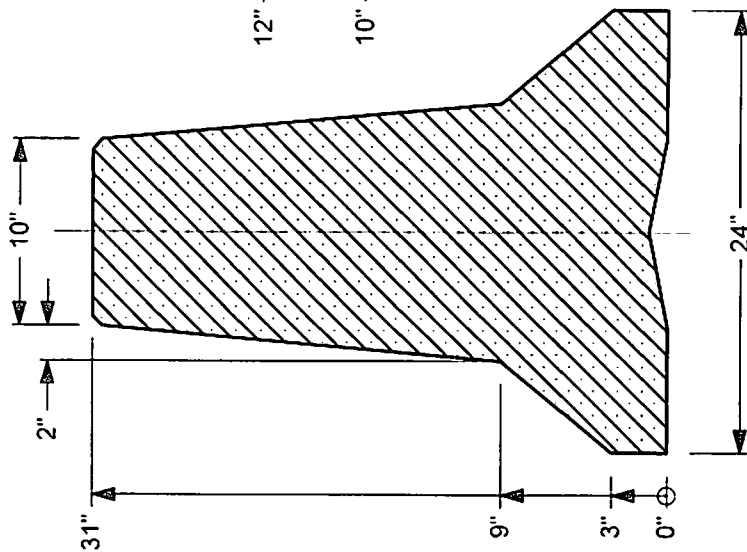
Drawn By GES Scale 1:20 Sheet 4 of 6 Barriers 5-14

2015-05-14

# Barriers 1-4 and 15-20



Plan View



Elevation View

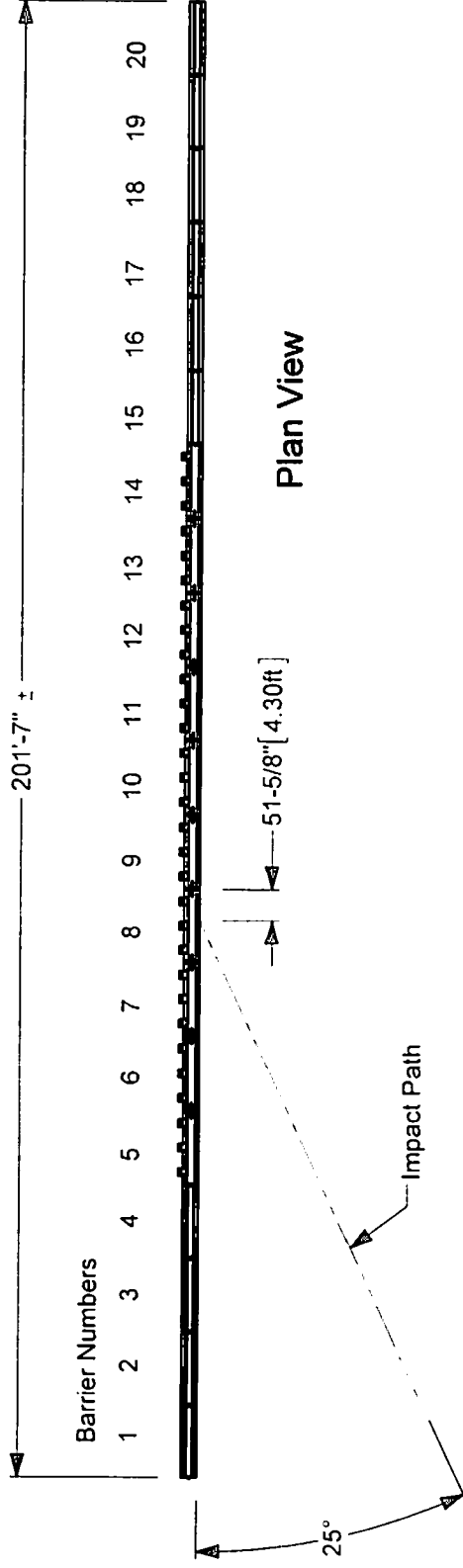


Roadside Safety and  
Physical Security Division -  
Proving Ground

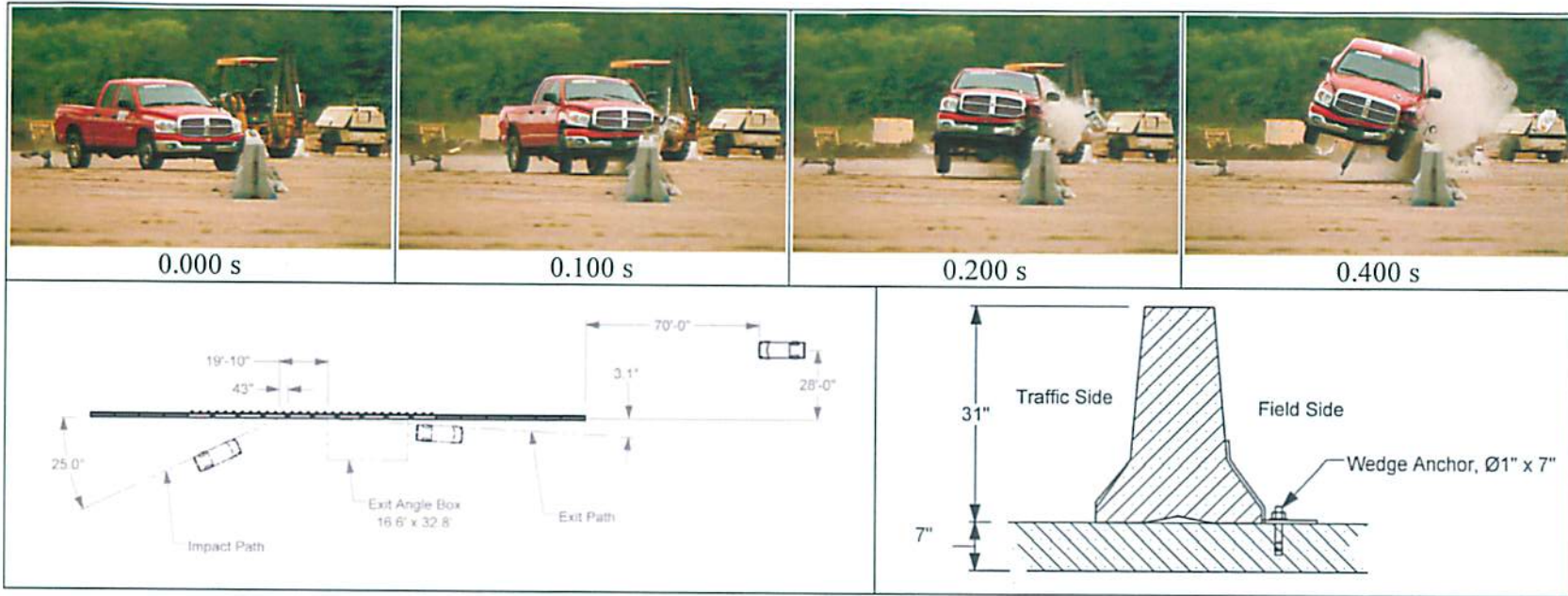
Project 690900-IND-3 Indiana Barriers  
Drawn By GES Scale 1:20 Sheet 5 of 6 Barriers 1-4 and 15-20

2015-05-14

# Impact Path







<b>General Information</b>		<b>Impact Conditions</b>	<b>Post-Impact Trajectory</b>
Test Agency .....	Texas A&M Transportation Institute (TTI)	Speed.....	62.5 mi/h
Test Standard Test No. ....	MASH Test 3-11	Angle.....	26.1 degrees
TTI Test No. ....	690900-IND3	Location/Orientation .....	43 inches
Date .....	2015-05-19		upstrm of 8-9
<b>Test Article</b>		<b>Impact Severity</b> .....	126.9 kip-ft
Type.....	Temporary Concrete Barrier	<b>Exit Conditions</b> .....	(+9.9%)
Name .....	Indiana Anchored Temporary Barrier with	Speed.....	53.9 mi/h
Installation Length .....	Wedge Anchor Studs and Modified Top	Angle .....	3.8 degrees
	Connectors	<b>Occupant Risk Values</b>	
Material or Key Elements ....	10-ft F-shape concrete barriers anchored	Longitudinal OIV .....	16.7 ft/s
	with steel anchor brackets, wedge anchor	Lateral OIV .....	24.3 ft/s
	studs, and 2-bolt top plates	Longitudinal RDA.....	8.9 G
<b>Soil Type and Condition</b> .....	Concrete pavement, dry	Lateral RDA.....	10.8 G
		THIV .....	31.7 km/h
<b>Test Vehicle</b>		PHD .....	11.8 G
Type/Designation .....	2270P	ASI .....	1.66
Make and Model.....	2008 Dodge Ram 1500 Pickup	<b>Max. 0.050-s Average</b>	
Curb .....	4956 lb	Longitudinal.....	-7.8 G
Test Inertial .....	5021 lb	Lateral.....	12.7 G
Dummy.....	No dummy	Vertical.....	-4.5 G
Gross Static.....	5021 lb	<b>Test Article Deflections</b>	
		Dynamic.....	
		Permanent.....	
		Working Width.....	
		<b>Vehicle Damage</b>	
		VDS.....	11LFQ4
		CDC .....	11FLEW3
		Max. Exterior Deformation.....	20.0 inches
		OCDI .....	LF0000000
		Max. Occupant Compartment	
		Deformation.....	1.25 inches

Figure 5.10. Summary of Results for MASH Test 3-11 on the Indiana Anchored Temporary Barrier with Wedge Anchor Studs and Modified Top Connection.



Texas A&M Transportation Institute  
3135 TAMU  
College Station, TX 77843-3135

979-845-6375  
Fax: 979-845-6107  
<http://tti.tamu.edu/crashtesting>

November 4, 2015

Nick Artimovich  
Federal Highway Administration  
Office of Safety Design  
U. S. Department of Transportation – HSSD  
1200 New Jersey Avenue, SE  
Washington, DC 20590

RE: Test No. 690900-IND3 Financial Information

Dear Mr. Artimovich:

In an e-mail dated October 21, 2015, to Mr. Rick Drumm of Indiana Department of Transportation, you requested additional information regarding the financial interest that the crash test laboratory had/has in the product for which Indiana DOT was requesting a letter of eligibility.

The e-mail stated that financial interests include but are not limited to —

- (i) Compensation, including wages, salaries, commissions, professional fees, or fees for business referrals;
- (ii) Consulting relationships
- (iii) Research funding or other forms of research support;
- (iv) Patents, copyrights, and other intellectual property interests;
- (iv) Licenses or contractual relationships; or
- (v) Business ownership and investment interests.

In regard to the Indiana DOT Temporary Anchored Concrete Barrier, TTI Proving Ground had/has no financial interests. Indiana DOT contracted for the service of crash testing this barrier according to specifications for American Association of State Highway and Transportation Officials (AASHTO) *Manual for Assessing Safety Hardware (MASH)* Test 3-11, for which TTI Proving Ground was compensated for the cost to perform the test.

No consulting relationships, research funding or other forms of research support, patents, copyrights, other intellectual property interests, licenses, contractual relationships, business ownership or investment interests are retained for the TTI Proving Ground.

If further information is needed, please feel free to contact TTI Proving Ground by phone at 979-845-6388 or e-mail [d-zimmer@tti.tamu.edu](mailto:d-zimmer@tti.tamu.edu).

Sincerely,

Richard A. Zimmer  
Proving Ground Director

*A better job done safer and sooner.*

TTI Proving Ground  
3100 SH 47, Bldg. 7091  
Bryan, TX 77807





Texas A&M Transportation Institute  
3135 TAMU  
College Station, TX 77843-3135

979-845-6375  
Fax: 979-845-6107  
<http://tti.tamu.edu>

November 30, 2015

Indiana Department of Transportation  
100 North Senate Avenue  
Indiana Government Center North Room N644  
Indianapolis, IN 46204

Attention: Mr. John Wright

Subject: MASH Test 3-11 of the Indiana Anchored Temporary Concrete Barrier

John,

This letter is in response to your e-mail dated October 22, 2015. The purpose of this letter is to address/respond to two of the four comments from this e-mail. The remaining two comments will be addressed separately by other(s) in a separate letter. TTI performed two successful crash tests with respect to MASH Test Level 3 on the Indiana Anchored Temporary Concrete Barrier with wedge anchor studs and top barrier plates (see TTI test reports 690900-IND2 and dated 2015-04-16, and 690900-IND3 and dated 2015-05-19).

ITEM 2: A statement is needed from TTI that MASH Test 3-10 is not a critical test for a concrete safety-shape barrier.

TTI RESPONSE: The tests reported herein correspond to Test 3-11 of MASH (5000-lb pickup, 62 mi/h, 25 degrees). This test was deemed sufficient to evaluate the impact performance of the temporary concrete barrier with anchor plates and bent plate anchor brackets. Due to higher impact energy, the test with the 5000-lb pickup truck will result in greater load on the anchoring pins, lateral barrier deflection, and vehicle instability. The barrier is expected to behave nearly rigidly when impacted by the lighter 2425-lb passenger car. In the past, a rigid New Jersey barrier, which is generally considered to be more critical in terms of vehicle stability than the F-shape barrier, has been successfully tested under MASH Test 3-10 conditions (Midwest Roadside Safety Facility test 2214NJ-1). Thus, only MASH test 3-11 was conducted on the Indiana Anchored Temporary Concrete Barrier.

ITEM 3: A response from TTI to John Wright's letter of 7/27/2015 regarding recess for the top plate and ferrule loops versus field-drilled holes.

TTI RESPONSE: As a result of the crash tests conducted on April 16, 2015 and May 19, 2015, there were some minor differences in the top plate configuration. Test 2 utilized a 4-bolt top plate system with a recessed section for the plate. The bolts were secured to ferrule loops that were formed into the concrete. Test 3 utilized a 2-bolt top plate system with no recessed area for the plate. The bolts were secured into field-drilled holes with expansion anchors.

The anchoring concepts used for each test are described as follows, along with my summary for use of each anchoring system in the field.

1. Test 3 confirmed that the 2-bolt top plate system resulted in a successful crash test; therefore, we believe that either the 4-bolt or the 2-bolt system is satisfactory. No comment needed.
2. Test 2 had a recessed area for the top plate; Test 3 did not. We believe the recessed concrete area is a nonissue and could be used in either case.
3. Test 2 used ferrule loops formed into the concrete; Test 3 used field-drilled holes and expansion anchors to secure the bolts in the top plate. I believe that the top plate anchoring system can use either method. The top plate bolt is not torqued to any specific value, only suggested. Since both systems worked satisfactorily, I believe that the anchoring systems are interchangeable.

If you have any questions, please contact me at 979-862-2297 or via e-mail at [w-williams@tti.tamu.edu](mailto:w-williams@tti.tamu.edu).

Thanks,



William Williams, P.E.  
Associate Research Engineer  
Texas A&M Transportation Institute  
3135 TAMU  
College Station, TX 77843-3135  
(wk.) 979-862-2297  
E-mail: [w-williams@tti.tamu.edu](mailto:w-williams@tti.tamu.edu)





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November 2, 2015

Nick Artimovich  
Federal Highway Administration  
Office of Safety Design  
U. S. Department of Transportation – HSSD  
1200 New Jersey Avenue, SE  
Washington, DC 20590

RE: Test No. 690900-IND3 use of a 2008 pickup truck

Dear Mr. Artimovich:

On May 15, 2015, the Texas A&M Transportation Institute (TTI) performed a TL-3 crash test on the Indiana Anchored Temporary Concrete Barrier with wedge anchor studs and modified top connection (690900-IND3) for the Indiana Department of Transportation. The test passed “preferred” criteria for occupant impact velocity and ridedown acceleration and other requirements specified in *MASH* (see Attachment 1) and a report was generated. Federal Highway Administration (FHWA) has subsequently pointed out that the vehicle used in this test did not meet *MASH* recommendations in regard to age (it was one model year too old). This document is a request for an exception from FHWA, and explains differences and similarities between the 2008 Dodge 1500 quad-cab used in the test and the 2009 model of the same vehicle.

The Dodge 1500 quad-cab, short-bed configuration is a staple for *MASH* testing. This is the truck selected for all 2270P pickup truck testing for the past several years at the TTI Proving Ground due to its availability, cost, and consistency in specifications between trucks. A random sample of 2270P vehicle property data sheets pulled from recent crash test reports is provided in Attachment 2. These data sheets were used to compare key vehicle specifications for model year 2008 and 2009 pickup trucks. As shown in Table 1, key specifications such as CG location (longitudinal and vertical), overall length, and wheelbase remain basically unchanged between the two model years.

Figure 1 shows pictures comparing and contrasting the 2008 and 2009 year models. Changes between the model years are mostly cosmetic with one mechanical difference. The front clip including the bumper and fenders are different between the trucks as shown in Figures 1 and 2.

There was also a change in the rear suspension in the 2009 model year. The leaf spring suspension that is common on most half-ton trucks on the road was changed to a coil spring rear suspension with a panhard type bar that limits lateral movement of the rear axle. This newer style suspension has been marketed as being able to improve the stability of a vehicle while turning compared to a leaf spring suspension. When discussing the new rear suspension in 2009,

*A better job done safer and sooner.*

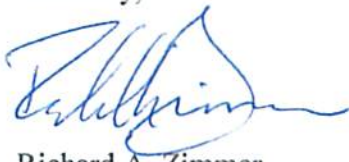
TTI Proving Ground  
3100 SH 47, Bldg. 7091  
Bryan, TX 77807

Edmunds, a popular automotive publication, stated “the real payoff here is superior unladen ride and improved cornering stability.”<sup>1</sup> Figures 3 and 4 show the rear suspensions for the two different model year trucks.

In conclusion, while differences exist between the two vehicle model years, we believe that these differences would not have produced different test results. We respectfully ask that FHWA grant an exception for the use of a 2008 model year pickup truck in the subject test. TTI purchased this vehicle to perform a crash test in the prior year when the project contract was originally signed. Delays in the project led to the test date being pushed into the subsequent calendar year and the error was not caught. After a laboratory investigation, it was determined that an existing test preparation protocol document was not sufficient for preventing this error and this document has since been amended as a result. TTI ensures FHWA that the internal process that permitted this error to occur has been corrected and new procedures now in place will prevent this from occurring again in the future.

If additional information is needed regarding this issue, please do not hesitate to call me at 979-845-6388 or e-mail me at [d-zimmer@tti.tamu.edu](mailto:d-zimmer@tti.tamu.edu).

Sincerely,



Richard A. Zimmer  
Proving Ground Director  
TTI Proving Ground

cc: D. Lance Bullard, Jr., TTI  
John Wright, Indiana DOT  
Roger Bligh, TTI  
William Williams, TTI

T:\M-ProjectFiles\690900-Compliance\IND-IndianaDOT-Williams

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<sup>1</sup> <http://www.edmunds.com/car-reviews/track-tests/2009-dodge-ram-1500-suspension-walkaround.html>

Table 1. Vehicle Properties Comparison.

Property	MASH 2270P (Pickup Truck)	Model Year 2008 (Average of 3 Test Vehicles)	690900-IND3 (Model Year 2008)	Model Year 2009 (Average of 4 Test Vehicles)
<b>MASS, lb</b> Test Inertial Max. Ballast	5000 ± 110 440	5016	5021	5034
<b>DIMENSIONS, inches</b> Wheelbase Front Overhang Overall Length Overall Width Hood Height Track Width <sup>a</sup>	148 ± 12 39 ± 3 237 ± 13 78 ± 2 43 ± 4 67 ± 1.5	140.5 36.0 223.75 78.25 45.8 68.5	140.5 36.0 223.75 78.25 44.5 68.25	140.5 40.0 227.5 78.5 44.5 68.5
<b>CENTER OF MASS LOCATION,<sup>b</sup> inches</b> Aft of Front Axle Above Ground	63 ± 4 28.0	61.30 28.29	62.06 28.5	61.48 28.25
<b>LOCATION OF ENGINE</b>	Front	Front	Front	Front
<b>LOCATION OF DRIVE AXLE</b>	Rear	Rear	Rear	Rear

a Average of front and rear axles.

b For 'test inertial' mass.

c 2270P vehicle must meet minimum c. g. height requirement





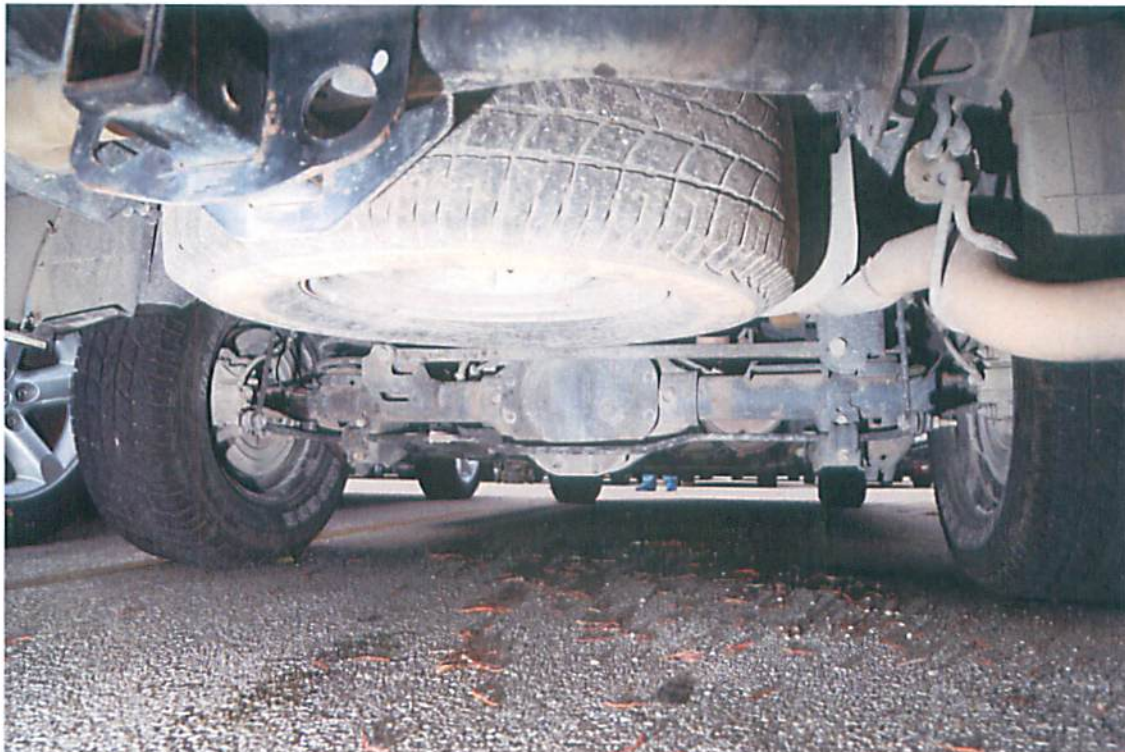
**Figure 1. Model year 2009 on Left, 2008 on Right. Differences in grill, bumper and headlights.**



**Figure 2. Differences between fender lines exist between the 2008 and 2009 year models.**



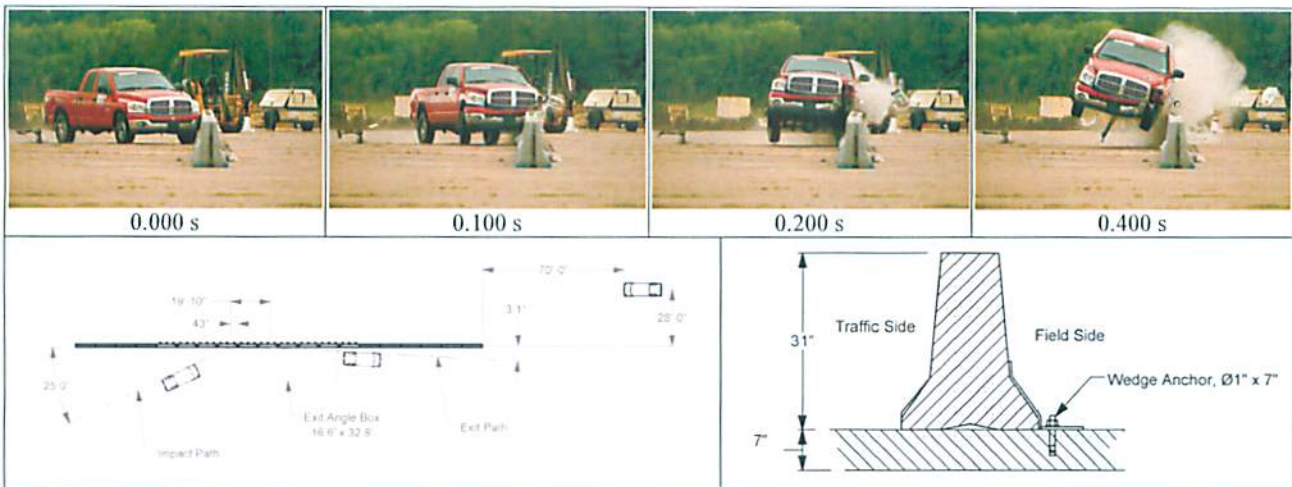
**Figure 3. The 2008 model year employs a leaf spring rear suspension.**



**Figure 4. The 2009 model year employs a coil spring and panhard bar configuration.**

**ATTACHMENT 1: Results of *MASH* Test 3-11 on Indiana  
Temporary Anchored Barrier**





<p><b>General Information</b></p> <p>Test Agency ..... Texas A&amp;M Transportation Institute (TTI)                  Test Standard Test No. .... MASH Test 3-11                  TTI Test No. .... 690900-IND3                  Date ..... 2015-05-19</p> <p><b>Test Article</b></p> <p>Type ..... Temporary Concrete Barrier                  Name ..... Indiana Anchored Temporary Barrier with                  Installation Length ..... Wedge Anchor Studs and Modified Top                  Connectors                  Material or Key Elements .... 10-ft F-shape concrete barriers anchored                  with steel anchor brackets, wedge anchor                  studs, and 2-bolt top plates                  Soil Type and Condition ..... Concrete pavement, dry</p> <p><b>Test Vehicle</b></p> <p>Type/Designation ..... 2270P                  Make and Model ..... 2008 Dodge Ram 1500 Pickup                  Curb ..... 4956 lb                  Test Inertial ..... 5021 lb                  Dummy ..... No dummy                  Gross Static ..... 5021 lb</p>	<p><b>Impact Conditions</b></p> <p>Speed ..... 62.5 mi/h                  Angle ..... 26.1 degrees                  Location/Orientation ..... 43 inches                  upstrm of 8-9</p> <p><b>Impact Severity</b> ..... 126.9 kip-ft                  (+9.9%)</p> <p><b>Exit Conditions</b></p> <p>Speed ..... 53.9 mi/h                  Angle ..... 3.8 degrees</p> <p><b>Occupant Risk Values</b></p> <p>Longitudinal OIV ..... 16.7 ft/s                  Lateral OIV ..... 24.3 ft/s                  Longitudinal RDA ..... 8.9 G                  Lateral RDA ..... 10.8 G                  THIV ..... 31.7 km/h                  PHD ..... 11.8 G                  ASI ..... 1.66</p> <p>Max. 0.050-s Average</p> <p>Longitudinal ..... -7.8 G                  Lateral ..... 12.7 G                  Vertical ..... -4.5 G</p>	<p><b>Post-Impact Trajectory</b></p> <p>Stopping Distance ..... 193.5 ft dnstrm                  28 ft twd field side</p> <p><b>Vehicle Stability</b></p> <p>Maximum Yaw Angle ..... 30 degrees                  Maximum Pitch Angle ..... 25 degrees                  Maximum Roll Angle ..... 26 degrees                  Vehicle Snagging ..... No                  Vehicle Pocketing ..... No</p> <p><b>Test Article Deflections</b></p> <p>Dynamic ..... 13.3 inches                  Permanent ..... 4.5 inches                  Working Width ..... 30.1 inches</p> <p><b>Vehicle Damage</b></p> <p>VDS ..... 11LFQ4                  CDC ..... 11FLEW3                  Max. Exterior Deformation ..... 20.0 inches                  OCDE ..... LF0000000                  Max. Occupant Compartment                  Deformation ..... 1.25 inches</p>
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Figure 5.10. Summary of Results for MASH Test 3-11 on the Indiana Anchored Temporary Barrier with Wedge Anchor Studs and Modified Top Connection.

**Table 6.1. Performance Evaluation Summary for MASH Test 3-11 on the Indiana Anchored Temporary Barrier with Wedge Anchor Studs and Modified Top Connection.**

Test Agency: Texas A&M Transportation Institute

Test No.: 690900-IND3

Test Date: 2015-05-19

<b>MASH Test 3-11 Evaluation Criteria</b>	<b>Test Results</b>	<b>Assessment</b>
<p><b>Structural Adequacy</b>                      A. <i>Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underide, or override the installation although controlled lateral deflection of the test article is acceptable</i></p>	<p>The Indiana Anchored Temporary Barrier with Wedge Anchor Studs and Modified Top Connection contained and redirected the 2270P vehicle. The vehicle did not penetrate, underide, or override the installation. Maximum dynamic deflection during the test was 13.3 inches.</p>	<p>Pass</p>
<p><b>Occupant Risk</b>                      D. <i>Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.</i></p>	<p>No detached elements, fragments, or other debris was present to penetrate or to show potential for penetrating, the occupant compartment, or to present hazard to others in the area.</p>	<p>Pass</p>
<p><i>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.</i></p>	<p>Maximum deformation of the occupant compartment was 1.25 inches in the left lower kick panel area.</p>	<p>Pass</p>
<p>F. <i>The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i></p>	<p>Maximum roll and pitch angles were 26 degrees and 25 degrees, respectively.</p>	<p>Pass</p>
<p>H. <i>Longitudinal and lateral occupant impact velocities should fall below the preferred value of 30 ft/s, or at least below the maximum allowable value of 40 ft/s.</i></p>	<p>Longitudinal OIV was 16.7 ft/s, and lateral OIV was 24.3 ft/s.</p>	<p>Pass</p>
<p>I. <i>Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.49 Gs.</i></p>	<p>Maximum longitudinal RDA was 8.9 Gs, and maximum lateral RDA was 10.8 Gs.</p>	<p>Pass</p>

**ATTACHMENT 2: Random Vehicle Property Sheets for 2008-2009  
2270P Vehicles**

**APPENDIX D. CRASH TEST NO. [REDACTED]**

**D1. VEHICLE PROPERTIES AND INFORMATION**

**Table D.1. Vehicle Properties for Test No. [REDACTED].**

Date: [REDACTED] Test No.: [REDACTED] VIN No.: 1D7HA182485560914  
 Year: 2008 Make: Dodge Model: Ram 1500  
 Tire Size: 265/70R17 Tire Inflation Pressure: 35 psi  
 Tread Type: Highway Odometer: 136075  
 Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

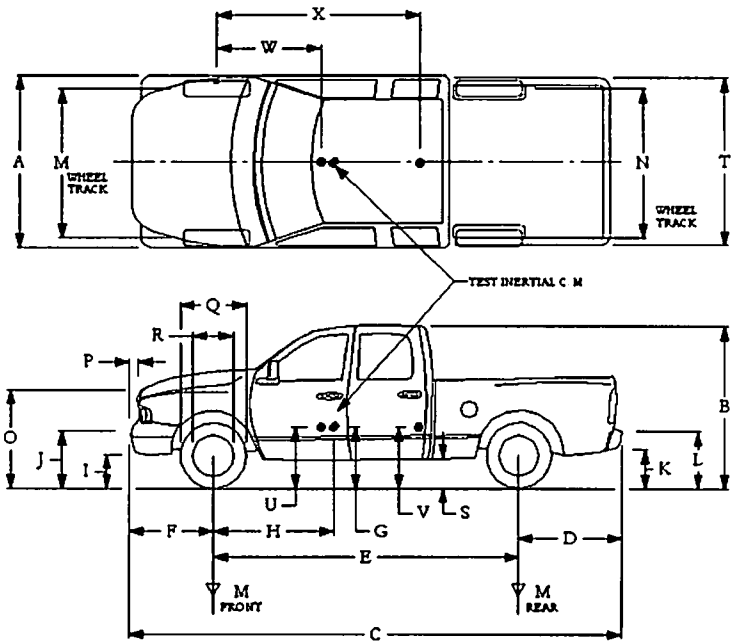
NOTES: \_\_\_\_\_  
 \_\_\_\_\_

Engine Type: V-8  
 Engine CID: 5.7 liter

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:  
None

Dummy Data:  
 Type: None  
 Mass: NA  
 Seat Position: NA



**Geometry: inches**

A	<u>78.25</u>	F	<u>36.00</u>	K	<u>21.00</u>	P	<u>2.88</u>	U	<u>28.50</u>
B	<u>75.00</u>	G	<u>28.50</u>	L	<u>29.50</u>	Q	<u>30.50</u>	V	<u>30.50</u>
C	<u>223.75</u>	H	<u>61.31</u>	M	<u>68.50</u>	R	<u>16.00</u>	W	<u>61.30</u>
D	<u>47.25</u>	I	<u>16.00</u>	N	<u>68.00</u>	S	<u>15.50</u>	X	<u>77.00</u>
E	<u>140.50</u>	J	<u>28.00</u>	O	<u>46.00</u>	T	<u>77.50</u>		
Wheel Center Height Front	<u>14.75</u>	Wheel Well Clearance (Front)	<u>6.00</u>	Bottom Frame Height - Front	<u>18.75</u>				
Wheel Center Height Rear	<u>14.75</u>	Wheel Well Clearance (Rear)	<u>11.00</u>	Bottom Frame Height - Rear	<u>26.00</u>				


RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; M+N/2=67 ±1.5 inches

GVWR Ratings:	Mass: lb	Curb	Test Inertial	Gross Static
Front <u>3700</u>	$M_{front}$	<u>2880</u>	<u>2829</u>	---
Back <u>3900</u>	$M_{rear}$	<u>1978</u>	<u>2194</u>	---
Total <u>6700</u>	$M_{Total}$	<u>4858</u>	<u>5023</u>	---

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

**Mass Distribution:**

lb LF: 1451 RF: 1378 LR: 1047 RR: 1147

 <p><b>Texas A&amp;M Transportation Institute</b> Proving Ground 3100 SH 47, Bldg 7031 Bryan, TX 77807</p> <p>Texas A&amp;M University College Station, TX 77843 Phone 979-845-6375</p>	<p><b>5.4.8.1P Vehicle Parameter Worksheet for 2270P Pickup</b></p>	Doc. No. QPF 5.4.8.1P VPWS	Revision Date: 2012-09-14
		Revised by: W. L. Menges Approved by: R. A. Zimmer	Revision: 7

Vehicle Inventory Number: 1115

Date:                      Test No.:                      VIN No.: 1D7HA18NK45513252

Year: 2008 Make: DODGE Model: Ram 1500

Tire Size: 265/70 R17 Tire Inflation Pressure: 35 PSI

Tread Type: Highway Odometer: 199140

Note any damage to the vehicle prior to test:                     

• Denotes accelerometer location.

NOTES:                     

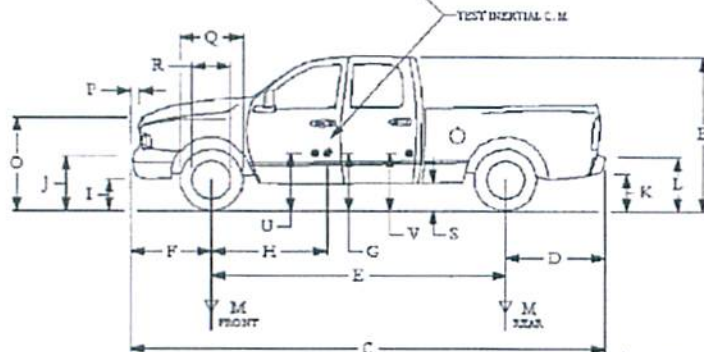
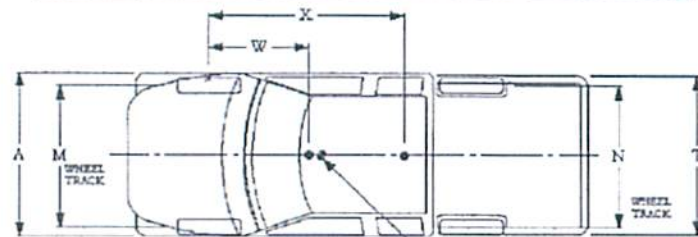
Engine Type: V-8

Engine CID: 4.7L

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:                     

Dummy Data:  
 Type: NONE  
 Mass:                       
 Seat Position:                     



**Geometry:** inches

A	<u>78.25</u>	F	<u>30</u>	K	<u>21</u>	P	<u>2.975</u>	U	<u>28.5</u>
B	<u>75</u>	G	<u>25</u>	L	<u>29.5</u>	Q	<u>30.5</u>	V	<u>30.5</u>
C	<u>223.75</u>	H	<u>61.8/71.6</u>	M	<u>68.5</u>	R	<u>16</u>	W	<u>61.8</u>
D	<u>47.25</u>	I	<u>16</u>	N	<u>6.8</u>	S	<u>15.5</u>	X	<u>77</u>
E	<u>140.5</u>	J	<u>28</u>	O	<u>46</u>	T	<u>77.5</u>		<u>                    </u>
	Wheel Center Height Front <u>14.75</u>		Wheel Well Clearance (Front) <u>6</u>		Bottom Frame Height - Front <u>18.75</u>				
	Wheel Center Height Rear <u>14.75</u>		Wheel Well Clearance (Rear) <u>11</u>		Bottom Frame Height - Rear <u>25</u>				

RANGE LIMIT: A=78 ±12 inches; C=237 ±13 inches; E=148 ±12 inches; F=30 ±3 inches; G=28 inches; H=63 ±4 inches; O=43 ±4 inches; M+N/2=67 ±1.5 inches

<b>GVWR Ratings:</b>	<b>Mass: lb</b>	<b>Curb</b>	<b>Test Inertial</b>	<b>Gross Static</b>
Front <u>3700</u>	M <sub>front</sub>	<u>2852</u>	<u>2804</u>	<u>                    </u>
Back <u>3900</u>	M <sub>rear</sub>	<u>2605</u>	<u>2205</u>	<u>                    </u>
Total <u>6700</u>	M <sub>Total</sub>	<u>4857</u>	<u>5007</u>	<u>                    </u>

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

Mass Distribution:  
 lb LF: 1393 RF: 1411 LR: 1110 RR: 1093

APPENDIX F. CRASH TEST NO. [REDACTED]

F.1 VEHICLE PROPERTIES AND INFORMATION

Table F.1. Vehicle Properties for Test No. [REDACTED]

Date: [REDACTED] Test No.: [REDACTED] VIN No.: 1D7HA18N785614698  
 Year: 2008 Make: Dodge Model: Ram 1500  
 Tire Size: 265/70R17 Tire Inflation Pressure: 35 psi  
 Tread Type: Highway Odometer: 159444  
 Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

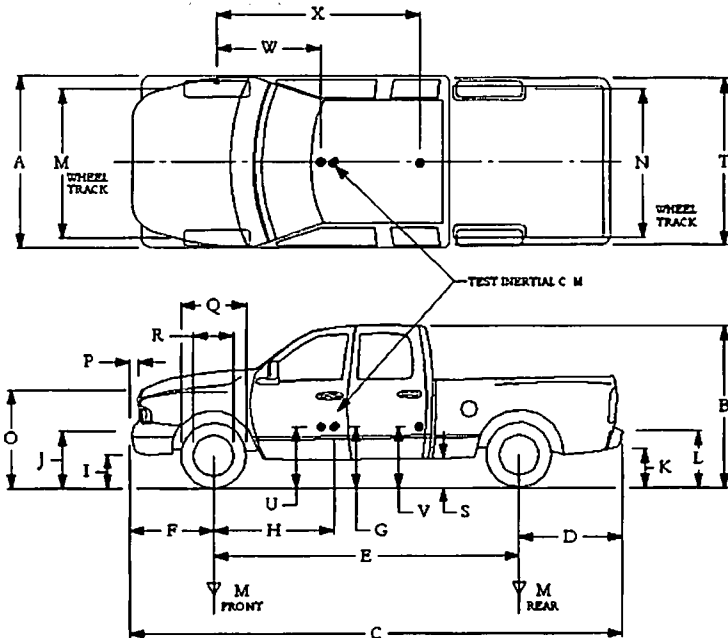
NOTES: NA

Engine Type: V-8  
 Engine CID: 4.7 liter

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:  
 None

Dummy Data:  
 Type: No Dummy  
 Mass: NA  
 Seat Position: NA



Geometry: inches

A	78.25	F	36.00	K	20.25	P	2.88	U	28.50
B	75.00	G	28.38	L	29.00	Q	30.50	V	30.50
C	223.75	H	60.76	M	68.50	R	16.00	W	60.70
D	47.25	I	15.50	N	68.00	S	15.00	X	77.00
E	140.50	J	25.26	O	45.50	T	77.50		
Wheel Center Height Front	14.75	Wheel Well Clearance (Front)	6.00	Bottom Frame Height - Front	18.50				
Wheel Center Height Rear	14.75	Wheel Well Clearance (Rear)	11.00	Bottom Frame Height - Rear	25.00				

RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; M+N/2=67 ±1.5 inches

GVWR Ratings:	Mass: lb	Curb	Test Inertial	Gross Static
Front	3700	M <sub>front</sub>	2885	2849
Back	3900	M <sub>rear</sub>	2076	2171
Total	6700	M <sub>Total</sub>	4961	5020

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

Mass Distribution:  
 lb LF: 1442 RF: 1407 LR: 1078 RR: 1093

**APPENDIX C. CRASH TEST NO. 690900-IND3**

**C.1 VEHICLE PROPERTIES AND INFORMATION**

**Table C.1. Vehicle Properties for Test No. 690900-IND3.**

Date: 2015-05-15 Test No.: 690900-IND3 VIN No.: 1D7HA18N9S555637  
 Year: 2008 Make: Dodge Model: Ram 1500  
 Tire Size: 265/70R17 Tire Inflation Pressure: 35 psi  
 Tread Type: Highway Odometer: 199348  
 Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

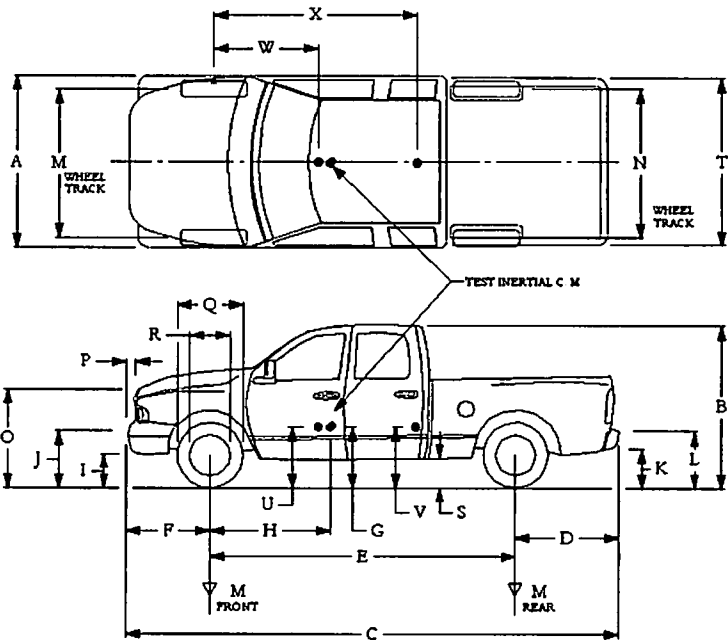
NOTES: None

Engine Type: V-8  
 Engine CID: 4.7 liter

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:  
None

Dummy Data:  
 Type: No Dummy  
 Mass: NA  
 Seat Position: NA



**Geometry: inches**

A	<u>78.25</u>	F	<u>36.00</u>	K	<u>21.50</u>	P	<u>2.88</u>	U	<u>28.50</u>
B	<u>75.00</u>	G	<u>28.50</u>	L	<u>30.00</u>	Q	<u>30.50</u>	V	<u>30.50</u>
C	<u>223.75</u>	H	<u>62.06</u>	M	<u>68.50</u>	R	<u>18.00</u>	W	<u>62.00</u>
D	<u>47.25</u>	I	<u>15.25</u>	N	<u>68.00</u>	S	<u>16.00</u>	X	<u>77.00</u>
E	<u>140.50</u>	J	<u>26.75</u>	O	<u>44.50</u>	T	<u>77.50</u>		
	Wheel Center Height Front	<u>14.75</u>		Wheel Well Clearance (Front)	<u>6.00</u>		Bottom Frame Height - Front	<u>18.50</u>	
	Wheel Center Height Rear	<u>14.75</u>		Wheel Well Clearance (Rear)	<u>11.00</u>		Bottom Frame Height - Rear	<u>25.00</u>	

RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; M+N/2=67 ±1.5 inches


GVWR Ratings:	Mass: lb	Curb	Test Inertial	Gross Static
Front	<u>3700</u>	$M_{front}$ <u>2888</u>	<u>2803</u>	<u>2803</u>
Back	<u>3900</u>	$M_{rear}$ <u>2068</u>	<u>2218</u>	<u>2218</u>
Total	<u>6700</u>	$M_{Total}$ <u>4956</u>	<u>5021</u>	<u>5021</u>

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

**Mass Distribution:**

lb	LF: <u>1428</u>	RF: <u>1375</u>	LR: <u>1097</u>	RR: <u>1121</u>
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 <b>Texas A&amp;M Transportation Institute</b> Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6376	<b>5.4.8.1P Vehicle Parameter Worksheet for 2270P Pickup</b>	Doc. No. QPF 5.4.8.1P VPWS	Revision Date: 2012-09-14
		Revised by: W. L. Menges Approved by: R. A. Zimmer	Revision: 7

Vehicle Inventory Number: 1056  
 Date:                      Test No.:                      VIN No.: 1D3HB1BP39S770531  
 Year: 2009 Make: Dodge Model: Ram 1500  
 Tire Size: 265/70 R17 Tire Inflation Pressure: 35 PSI  
 Tread Type: Highway Odometer: 166178  
 Note any damage to the vehicle prior to test:                     

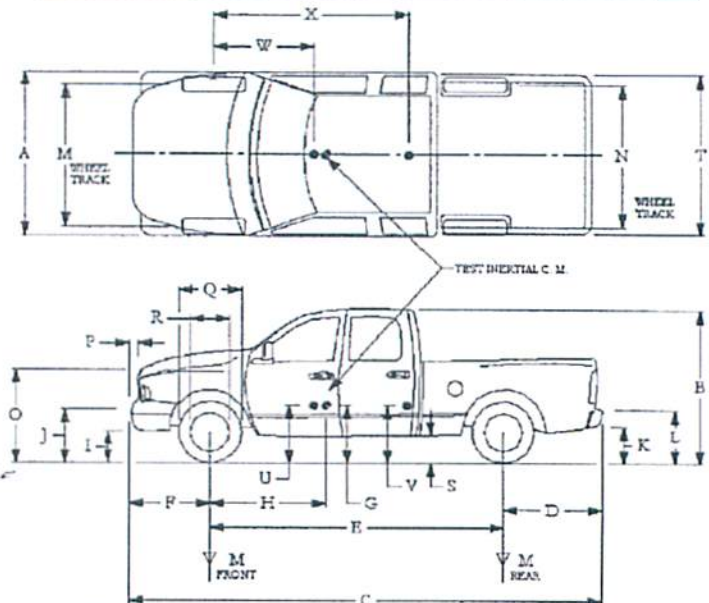
• Denotes accelerometer location.  
 NOTES:                     

Engine Type: V-6  
 Engine CID: 4.7L

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:  
                    

Dummy Data:  
 Type: None + 50 clearance  
 Mass: 165 lbs  
 Seat Position: DRIVER SIDE



Geometry: inches

A	<u>78.5</u>	F	<u>40</u>	K	<u>20.25</u>	P	<u>.3</u>	U	<u>28.2</u>
B	<u>73.5</u>	G	<u>28.25</u>	L	<u>28.5</u>	Q	<u>30.5</u>	V	<u>29.5</u>
C	<u>227.5</u>	H	<u>63.08846</u>	M	<u>68.5</u>	R	<u>18</u>	W	<u>63.0</u>
D	<u>47</u>	I	<u>10.5</u>	N	<u>68</u>	S	<u>12.75</u>	X	<u>77</u>
E	<u>140.5</u>	J	<u>25.85</u>	O	<u>44.5</u>	T	<u>77</u>		

Wheel Center Height Front	<u>14.75</u>	Wheel Well Clearance (Front)	<u>9.75</u>	Bottom Frame Height - Front	<u>17</u>
Wheel Center Height Rear	<u>14.75</u>	Wheel Well Clearance (Rear)	<u>9.75</u>	Bottom Frame Height - Rear	<u>25.5</u>

RANGE LIMIT: A=78 ±13 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G= > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; M+H/2=67 ±1.5 inches

<b>GVWR Ratings:</b>	<b>Mass: lb</b>	<b>Curb</b>	<b>Test Inertial</b>	<b>Gross Static</b>
Front <u>1674 3700</u>	M <sub>front</sub>	<u>2802</u>	<u>2718</u>	<u>2860</u>
Back <u>1796 3920</u>	M <sub>rear</sub>	<u>2126</u>	<u>2264</u>	<u>2347</u>
Total <u>6700</u>	M <sub>Total</sub>	<u>4988</u>	<u>5042</u>	<u>5207</u>

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

Mass Distribution:  
 lb LF: 1393 RF: 1385 LR: 1140 RR: 1124



**APPENIDX B. CRASH TEST NO. [REDACTED] (MASH TEST 3-11)**

**B1 VEHICLE PROPERTIES AND INFORMATION**

**Table B.1. Vehicle Properties for Test No. [REDACTED] 1.**

Date: [REDACTED] Test No.: [REDACTED] VIN No.: 1D3HB18T99S704322  
 Year: 2009 Make: Dodge Model: Ram 1500  
 Tire Size: 265/70R17 Tire Inflation Pressure: 35 psi  
 Tread Type: Highway Odometer: 171412

Note any damage to the vehicle prior to test: \_\_\_\_\_

• Denotes accelerometer location.

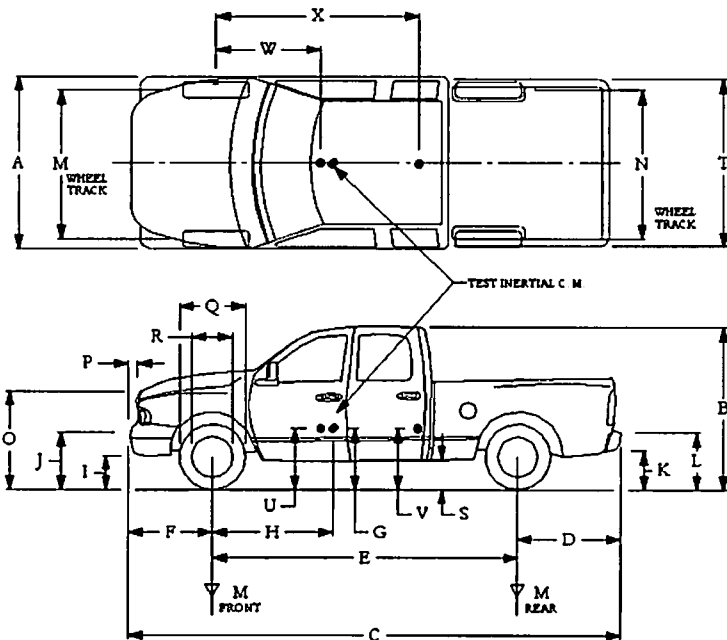
NOTES: NA

Engine Type: V-8  
 Engine CID: 4.7 Liter

Transmission Type:  
 Auto or \_\_\_\_\_ Manual  
 FWD  RWD  4WD

Optional Equipment:  
NA

Dummy Data:  
 Type: None  
 Mass: NA  
 Seat Position: NA



**Geometry: inches**

A	<u>78.50</u>	F	<u>40.00</u>	K	<u>20.25</u>	P	<u>3.00</u>	U	<u>28.50</u>
B	<u>73.50</u>	G	<u>28.25</u>	L	<u>29.50</u>	Q	<u>30.50</u>	V	<u>29.50</u>
C	<u>227.50</u>	H	<u>60.04</u>	M	<u>68.50</u>	R	<u>18.00</u>	W	<u>60.00</u>
D	<u>47.00</u>	I	<u>10.50</u>	N	<u>68.00</u>	S	<u>12.75</u>	X	<u>77.00</u>
E	<u>140.50</u>	J	<u>25.25</u>	O	<u>44.50</u>	T	<u>77.00</u>		
	Wheel Center Height Front	<u>14.75</u>		Wheel Well Clearance (Front)	<u>6.00</u>		Bottom Frame Height - Front	<u>17.00</u>	
	Wheel Center Height Rear	<u>14.75</u>		Wheel Well Clearance (Rear)	<u>9.25</u>		Bottom Frame Height - Rear	<u>25.50</u>	

RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; M•N/2=67 ±1.5 inches

GVWR Ratings:	Mass: lb	Curb	Test Inertial	Gross Static
Front	<u>3700</u>	$M_{front}$ <u>2963</u>	<u>2872</u>	<u>2872</u>
Back	<u>3900</u>	$M_{rear}$ <u>1984</u>	<u>2143</u>	<u>2143</u>
Total	<u>6700</u>	$M_{Total}$ <u>4947</u>	<u>5015</u>	<u>5015</u>

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

**Mass Distribution:**

lb LF: 1430 RF: 1442 LR: 1099 RR: 1044

**APPENDIX D. CRASH TEST NO. [REDACTED] (MASH TEST 5-11)**

**D.1 VEHICLE PROPERTIES AND INFORMATION**

**Table D.1. Vehicle Properties for Test No. [REDACTED].**

Date: [REDACTED] Test No.: [REDACTED] VIN No.: 1D3HB18739S779243

Year: 2009 Make: Dodge Model: Ram 1500

Tire Size: 265/70R17 Tire Inflation Pressure: 35 psi

Tread Type: Highway Odometer: 163126

Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

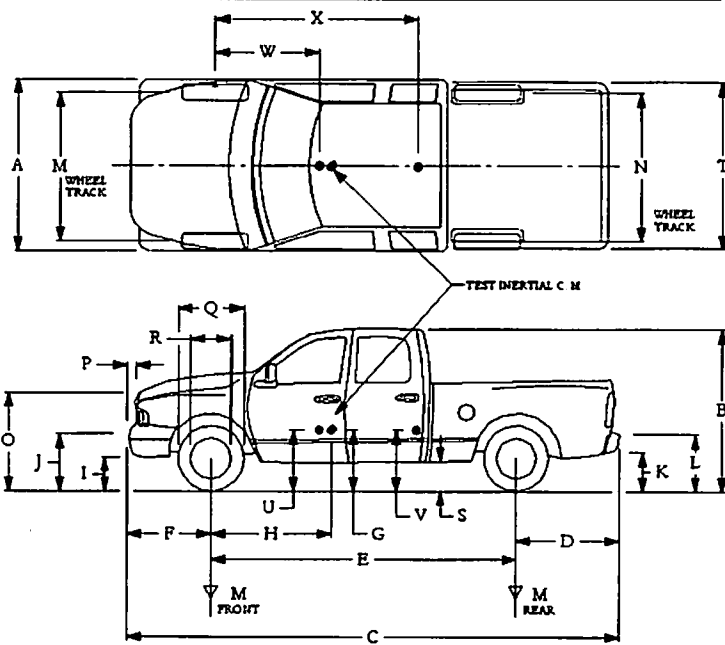
NOTES: NA

Engine Type: V-8  
 Engine CID: 4.7 liter

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:  
None

Dummy Data:  
 Type: 50<sup>th</sup> percentile male  
 Mass: 165 lb  
 Seat Position: Right front



**Geometry: inches**

A	78.50	F	40.00	K	20.25	P	3.00	U	28.50
B	73.50	G	28.12	L	29.50	Q	30.50	V	29.50
C	227.50	H	61.25	M	68.50	R	18.00	W	61.20
D	47.00	I	10.50	N	68.00	S	12.25	X	77.00
E	140.50	J	25.25	O	44.50	T	77.00		
	Wheel Center Height Front	14.75		Wheel Well Clearance (Front)	6.00		Bottom Frame Height - Front	17.00	
	Wheel Center Height Rear	14.75		Wheel Well Clearance (Rear)	9.25		Bottom Frame Height - Rear	25.50	

GVWR Ratings:	Mass: lb	Curb	Test Inertial	Gross Static
Front <u>3700</u>	$M_{front}$	<u>2889</u>	<u>2844</u>	<u>2929</u>
Back <u>3900</u>	$M_{rear}$	<u>2146</u>	<u>2198</u>	<u>2278</u>
Total <u>6700</u>	$M_{Total}$	<u>5035</u>	<u>5042</u>	<u>5207</u>

**Mass Distribution:**

lb	LF: <u>1452</u>	RF: <u>1392</u>	LR: <u>1110</u>	RR: <u>1088</u>
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**APPENIDX C. CRASH TEST NO. [REDACTED] (MASH TEST 3-36)**

**C1 VEHICLE PROPERTIES AND INFORMATION**

**Table C.1. Vehicle Properties for Test No. [REDACTED].**

Date: [REDACTED] Test No.: [REDACTED] VIN No.: 1D3HB18P49S759912  
 Year: 2009 Make: Dodge Model: Ram 1500  
 Tire Size: 265/70R17 Tire Inflation Pressure: 35 psi  
 Tread Type: Highway Odometer: 150600  
 Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

NOTES: NA

Engine Type: V-8  
 Engine CID: 4.7 liter

Transmission Type:  
 Auto or  Manual  
 FWD  RWD  4WD

Optional Equipment:  
None

Dummy Data:  
 Type: None  
 Mass: NA  
 Seat Position: NA

**Geometry: inches**

A	<u>78.50</u>	F	<u>40.00</u>	K	<u>20.25</u>	P	<u>3.00</u>	U	<u>28.50</u>
B	<u>73.50</u>	G	<u>28.38</u>	L	<u>29.50</u>	Q	<u>30.50</u>	V	<u>29.50</u>
C	<u>227.50</u>	H	<u>61.54</u>	M	<u>68.50</u>	R	<u>18.00</u>	W	<u>61.50</u>
D	<u>47.00</u>	I	<u>10.50</u>	N	<u>68.00</u>	S	<u>12.75</u>	X	<u>77.00</u>
E	<u>140.50</u>	J	<u>25.25</u>	O	<u>44.50</u>	T	<u>77.00</u>		
	Wheel Center Height Front	<u>14.75</u>		Wheel Well Clearance (Front)	<u>6.00</u>		Bottom Frame Height - Front	<u>17.00</u>	
	Wheel Center Height Rear	<u>14.75</u>		Wheel Well Clearance (Rear)	<u>9.25</u>		Bottom Frame Height - Rear	<u>25.50</u>	

RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; D=43 ±4 inches; M•N/2=67 ±1.5 inches

GVWR Ratings:	Mass: lb	Curb	Test Inertial	Gross Static
Front	<u>3700</u>	<u>M<sub>front</sub></u>	<u>2865</u>	<u>2832</u>
Back	<u>3900</u>	<u>M<sub>rear</sub></u>	<u>2168</u>	<u>2207</u>
Total	<u>3700</u>	<u>M<sub>Total</sub></u>	<u>5033</u>	<u>5039</u>

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

**Mass Distribution:**

lb LF: 1398 RF: 1434 LR: 1148 RR: 1059

