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PERFORMANCE EVALUATION OF MISSOURI DOT DUAL-POST, U-CHANNEL SIGN SUPPORT ACCORDING TO MASH 2016

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16. Abstract

The objective of this research was to evaluate the dual-post, U-channel sign support system according to the Test Level 3 (TL-3) safety performance evaluation criteria of the American Association of State Highway and Transportation Officials' (AASHTO) *Manual for Assessing Safety Hardware* (MASH). In test no. MOS-5, a 5,026-lb (2,280-kg) pickup truck impacted the dual-post, U-channel sign support at 62.7 mph (100.9 km/h) and an angle of 0 degrees. In test no. MOS-6, a 2,420-lb (1,098-kg) small car impacted the dual-post, U-channel sign support at 63.3 mph (101.9 km/h) and an angle of 0 degrees. In test no. MOS-7, a 2,435-lb (1,104-kg) small car impacted the dual-post, U-channel sign support at 20.0 mph (32.2 km/h) and an angle of 0 degrees. In all three tests, the impact was head-on to the vehicle, with the vehicle and system centerlines aligned. All three tests were determined to be successful according to MASH 2016 criteria. None of the systems showed potential for penetrating the occupant compartment. Minimal occupant compartment deformation occurred in all three tests. In each test, the system readily activated in a predictable manner and allowed the vehicle to continue travelling without any major obstruction of the windshield. Therefore, the dual-post, U-channel sign support system met all the TL-3 safety performance criteria of MASH 2016.

17. Key Words Highway Safety, Crash Test, Roadside Appurtenances, Compliance Test, MASH 2016, U-Channel Sign Supports, Dual Support, Test Level 3, TL-3		**18. Distribution Statement** No restrictions. This document is available through the National Technical Information Service. 5285 Port Royal Road Springfield, VA 22161	
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DISCLAIMER STATEMENT

This material is based upon work supported by the Federal Highway Administration, U.S. Department of Transportation and the Missouri Department of Transportation under TPF-5(193) Supplement #129. The contents of this report reflect the views and opinions of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the University of Nebraska-Lincoln, the Missouri Department of Transportation, nor the Federal Highway Administration, U.S. Department of Transportation. This report does not constitute a standard, specification, or regulation. Trade or manufacturers' names, which may appear in this report, are cited only because they are considered essential to the objectives of the report. The United States (U.S.) government and the State of Nebraska do not endorse products or manufacturers.

UNCERTAINTY OF MEASUREMENT STATEMENT

The Midwest Roadside Safety Facility (MwRSF) has determined the uncertainty of measurements for several parameters involved in standard full-scale crash testing and non-standard testing of roadside safety features. Information regarding the uncertainty of measurements for critical parameters is available upon request by the sponsor and the Federal Highway Administration.

INDEPENDENT APPROVING AUTHORITY

The Independent Approving Authority (IAA) for the data contained herein was Dr. Joshua Steelman, Associate Professor in the Department of Civil and Environmental Engineering

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1 INTRODUCTION

1.1 Background

U-channel posts, as shown in Figure 1, are one of three post mounting options that the Missouri Department of Transportation (MoDOT) utilizes for temporary traffic control devices. The other two options are perforated square steel tubes and wood posts. According to MoDOT's standard plans, these posts are to be utilized with rigid sign panels, which are mounted between 5 ft and 7 ft (1.5 and 2.1 m) above the ground. For the U-channel post option, MoDOT's standard plans state that only one splice is allowed per post and that four $^{5}/_{16}$-in. (8-mm) diameter galvanized ASTM A449 bolts, nuts, and washers are to be used in the splice connection. Two posts are required if the sign is greater than 4 ft (1.2 m) in width unless it is a diamond-shaped sign. Further, the posts should be free from any bracing and should not extend above the sign panel, except as needed for warning light attachments. MoDOT desired to test the existing system as used in the field.

Limited testing of temporary, ground-mounted sign supports has been conducted according to the National Cooperative Highway Research Program (NCHRP) Report No. 350 [1] and the *Manual for Assessing Safety Hardware* (MASH) [2, 3] safety performance criteria. In test no. 474660-1-2, a single U-channel post met the MASH performance evaluation criteria when impacted with a 2270P pickup truck; in the same test, the single perforated square steel tube post failed MASH test designation no. 3-62 due to exceeding the windshield deformation threshold of 3 in. (76 mm) [4].

Figure 1. Ground-Mounted, Dual-Post, U-channel Sign System

1.2 Objective

The objective of this research included an evaluation of the safety performance of a temporary, ground-mounted, dual-post, U-channel sign support system. The system was evaluated according to the Test Level 3 (TL-3) criteria of MASH 2016 [3].

1.3 Scope

The research objective was achieved through the completion of several tasks. Three full-scale crash tests were conducted on the ground-mounted, dual-post, U-channel sign support system according to MASH 2016 test designation nos. 3-60, 3-61, and 3-62. Next, the full-scale vehicle crash test results were analyzed, evaluated, and documented. Conclusions and recommendations were then made pertaining to the safety performance of the ground-mounted, dual-post, U-channel sign support system.

2 DESIGN DETAILS

The sign support test installation consisted of a dual-post, U-channel sign support system, as shown in Figures 2 through 11. Photographs of the test installation are shown in Figures 12 through 15. Material specifications, mill certifications, and certificates of conformity for the system materials are shown in Appendix A.

The same system configuration was used in all three tests. Each post utilized a two-part assembly with a 3.0 lb/ft (4.5 kg/m) U-channel sign support and 3.0 lb/ft (4.5 kg/m) U-channel embedment stub attached by means of a lap splice. The lap slice consisted of four $^{5}/_{16}$-in. diameter by 1¾-in. long (8-mm x 44-mm) bolts and nuts with a $^{5}/_{16}$-in. (8-mm) diameter plain washer under the nut and bolt head, as shown in Figures 5 and 6. The total length of the post assembly was 170 in. (4,318 mm). The posts were spaced 30 in. (762 mm) apart on center, and the stubs were embedded 36 in. (914 mm) into the ground.

This sign support system was configured with two sign panels. The larger 48-in. x 48-in. (1,219-mm x 1,219-mm) diamond-shaped sign was centered between and supported by both posts. Its orientation was 45 degrees from horizontal with its bottom corner 84 in. (2,134 mm) above the ground, as shown in Figure 5. The smaller 24-in. x 24-in. (610-mm x 610-mm) sign was centered and supported by the left post. It was oriented horizontally with its bottom edge 60 in. (1,524 mm) above the ground, as shown in Figure 5. The signs were connected to the U-channels with $^{5}/_{16}$-in. diameter by 2½-in. long (8-mm x 64-mm) bolts and nuts with a $^{5}/_{16}$-in. (8-mm) diameter plain washer under the nut and bolt head, as shown in Figures 5 and 6.

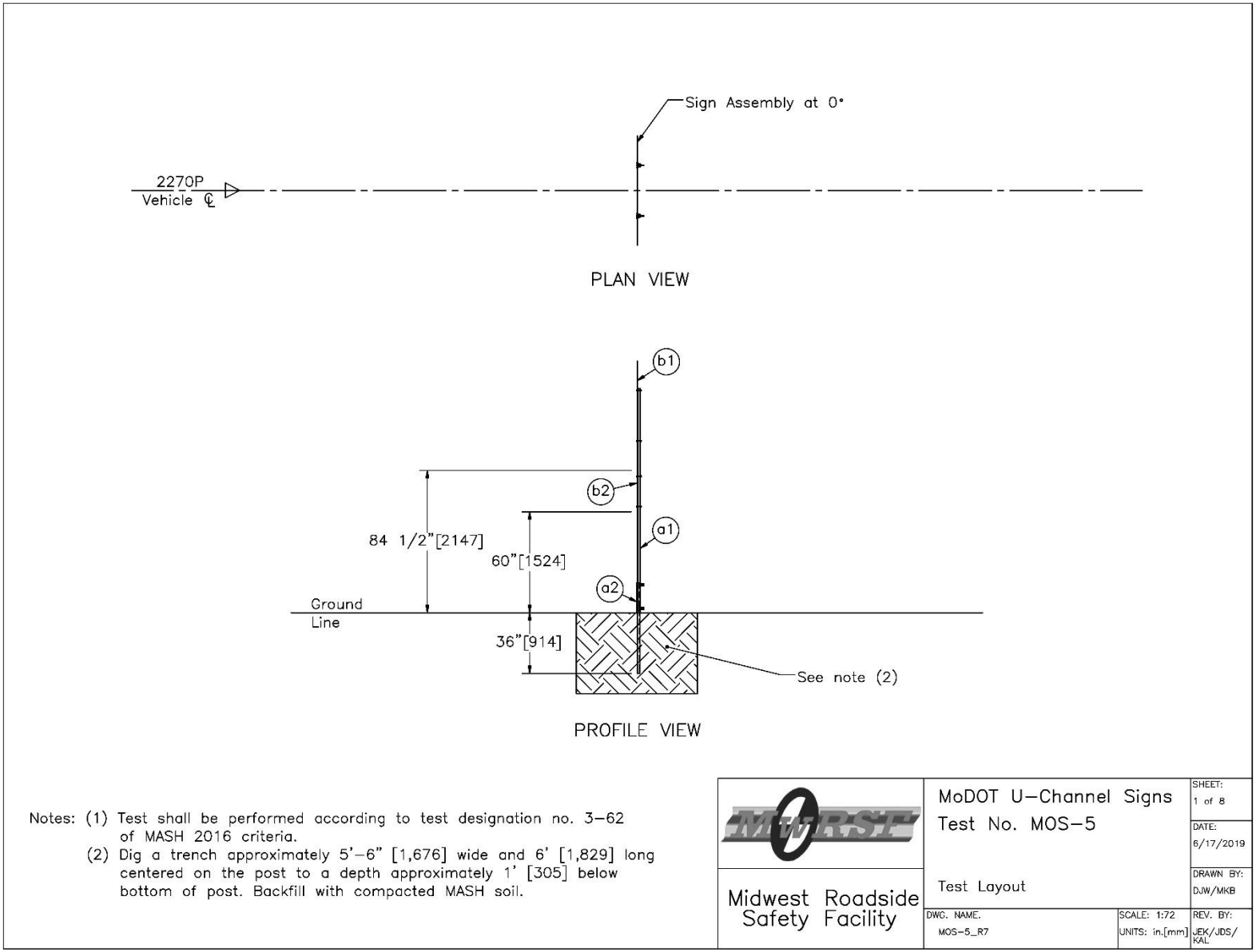


Figure 2. Test Installation Layout, Test No. MOS-5

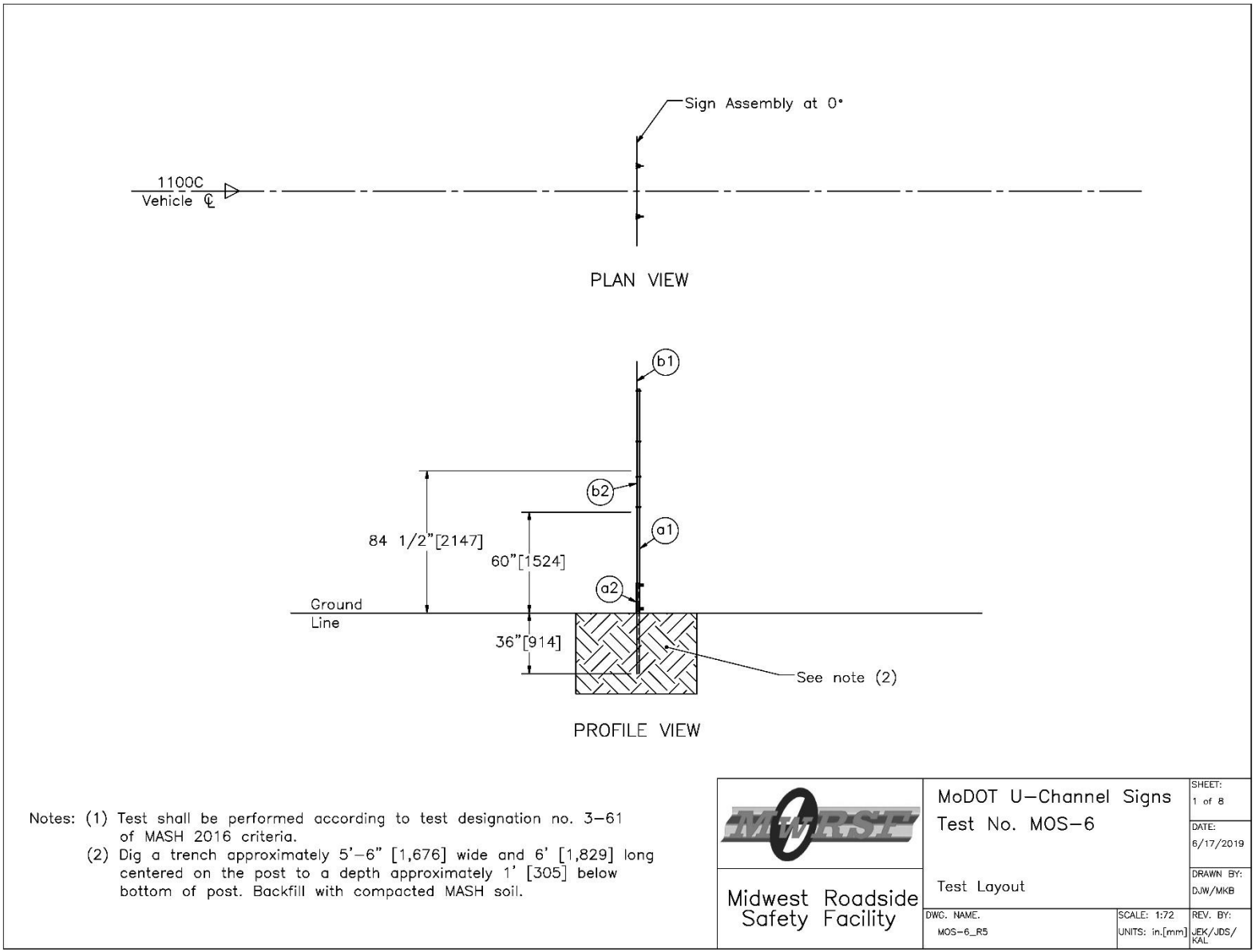


Figure 3. Test Installation Layout, Test No. MOS-6

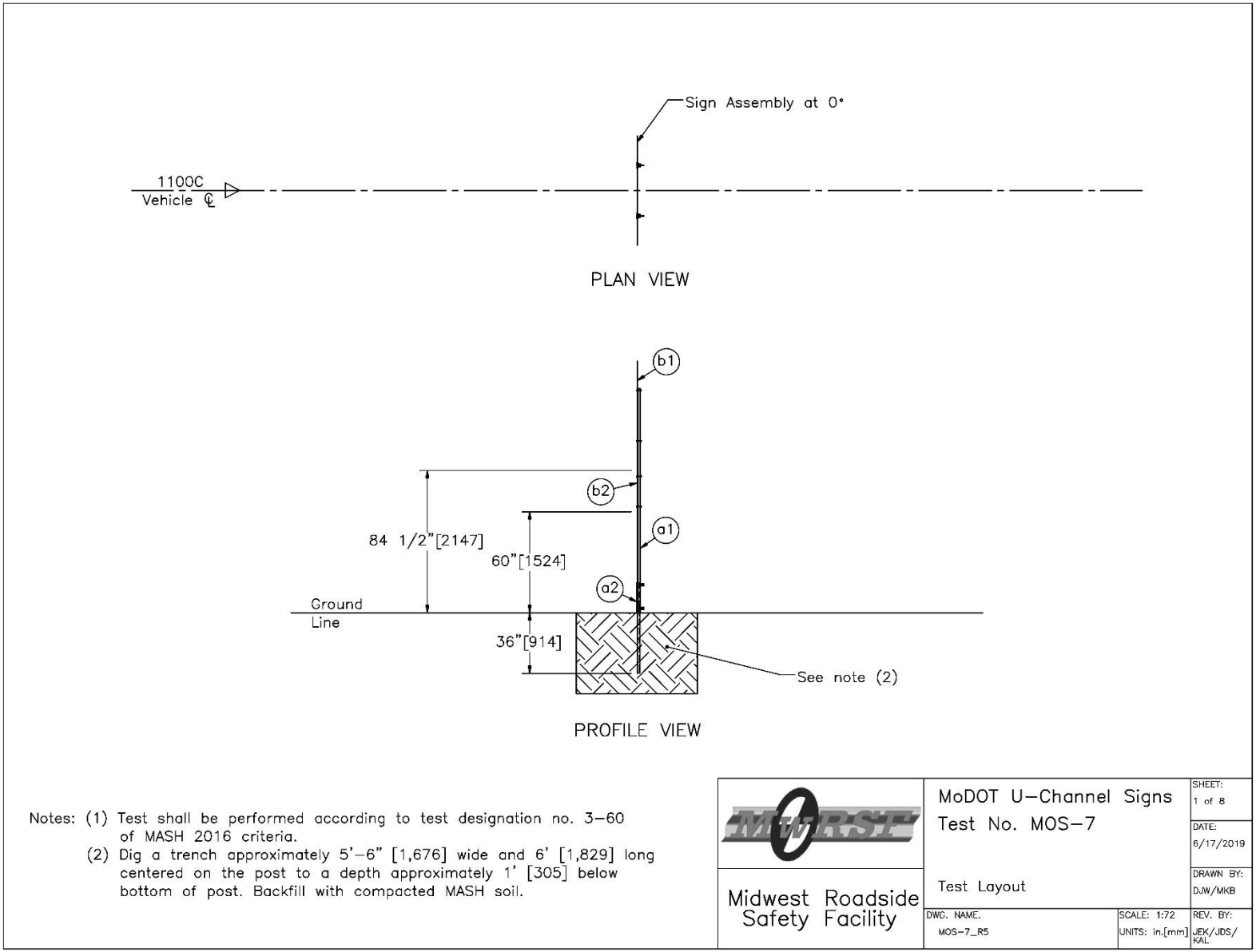


Figure 4. Test Installation Layout, Test No. MOS-7

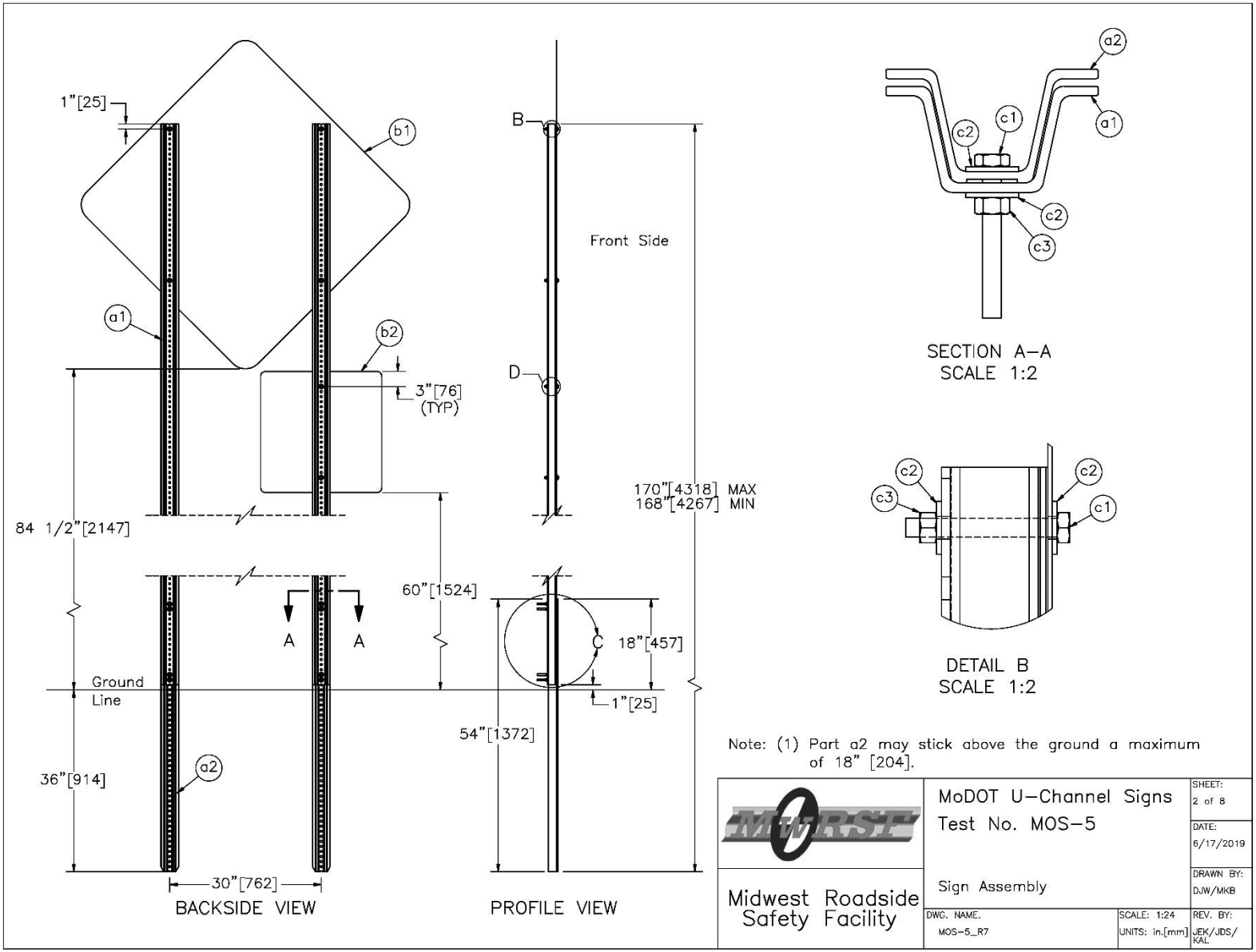


Figure 5. Sign Assembly Overview, Test Nos. MOS-5 through MOS-7

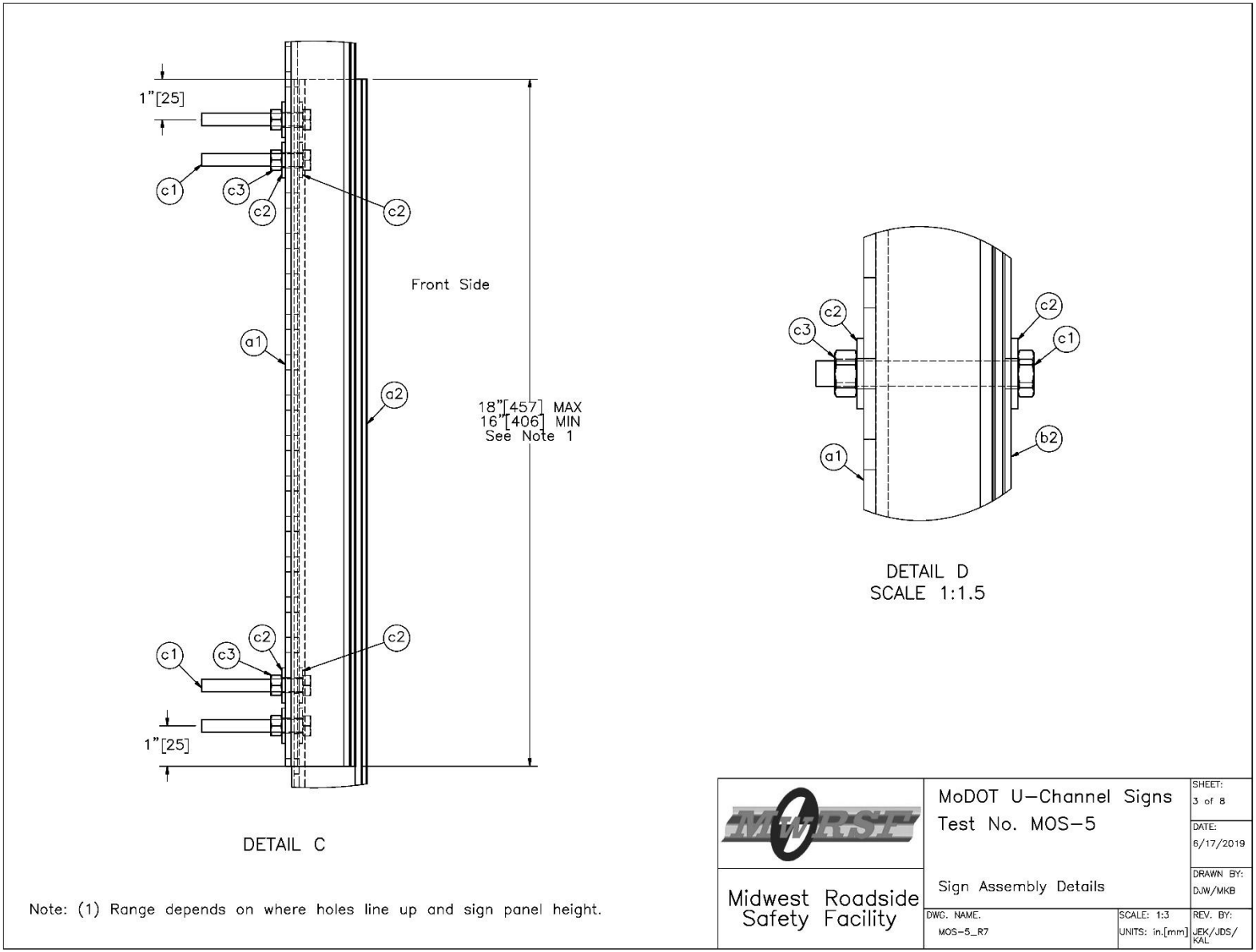


Figure 6. Sign Assembly Details, Test Nos. MOS-5 through MOS-7

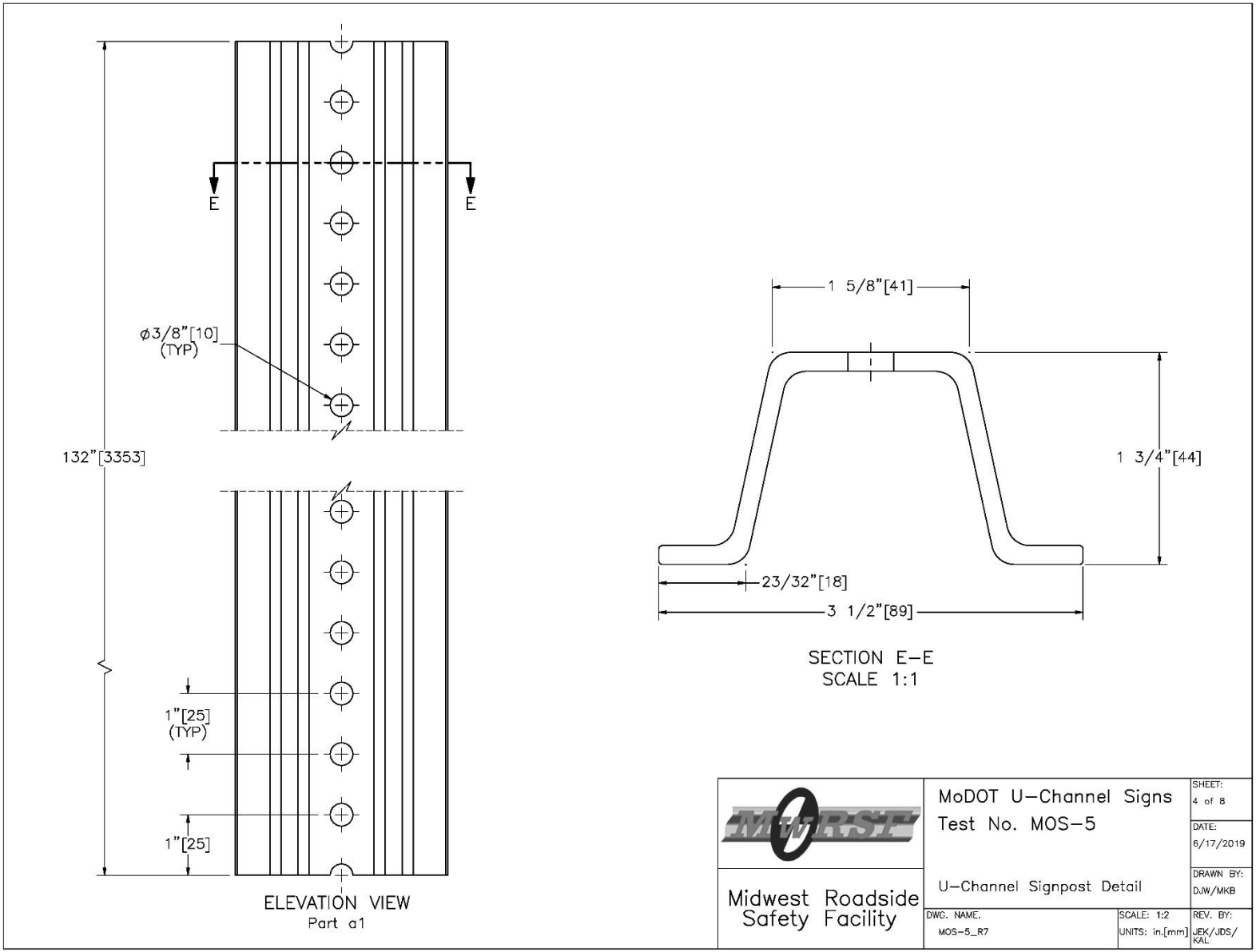


Figure 7. Post Details, Test Nos. MOS-5 through MOS-7

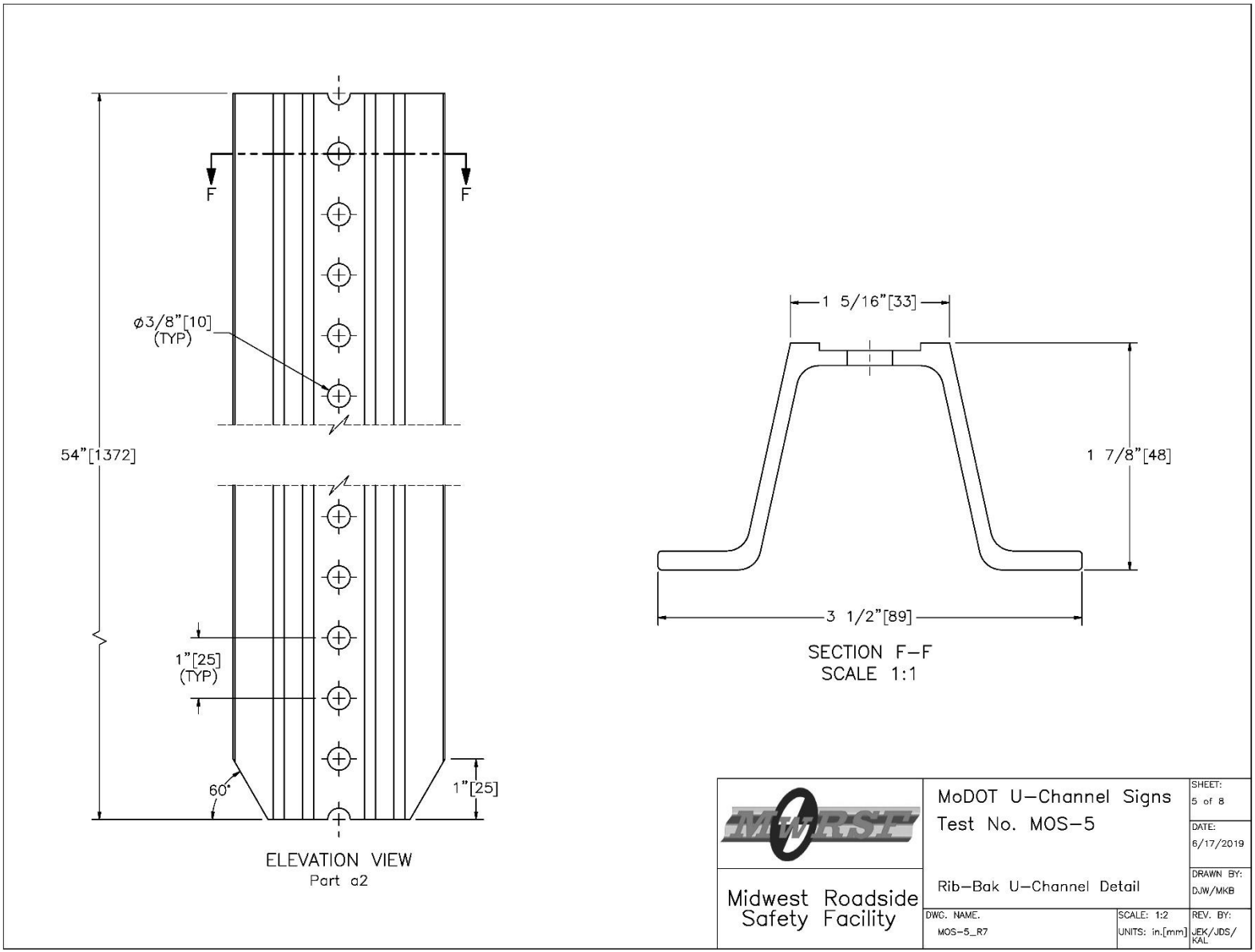


Figure 8. Post Details, Test Nos. MOS-5 through MOS-7

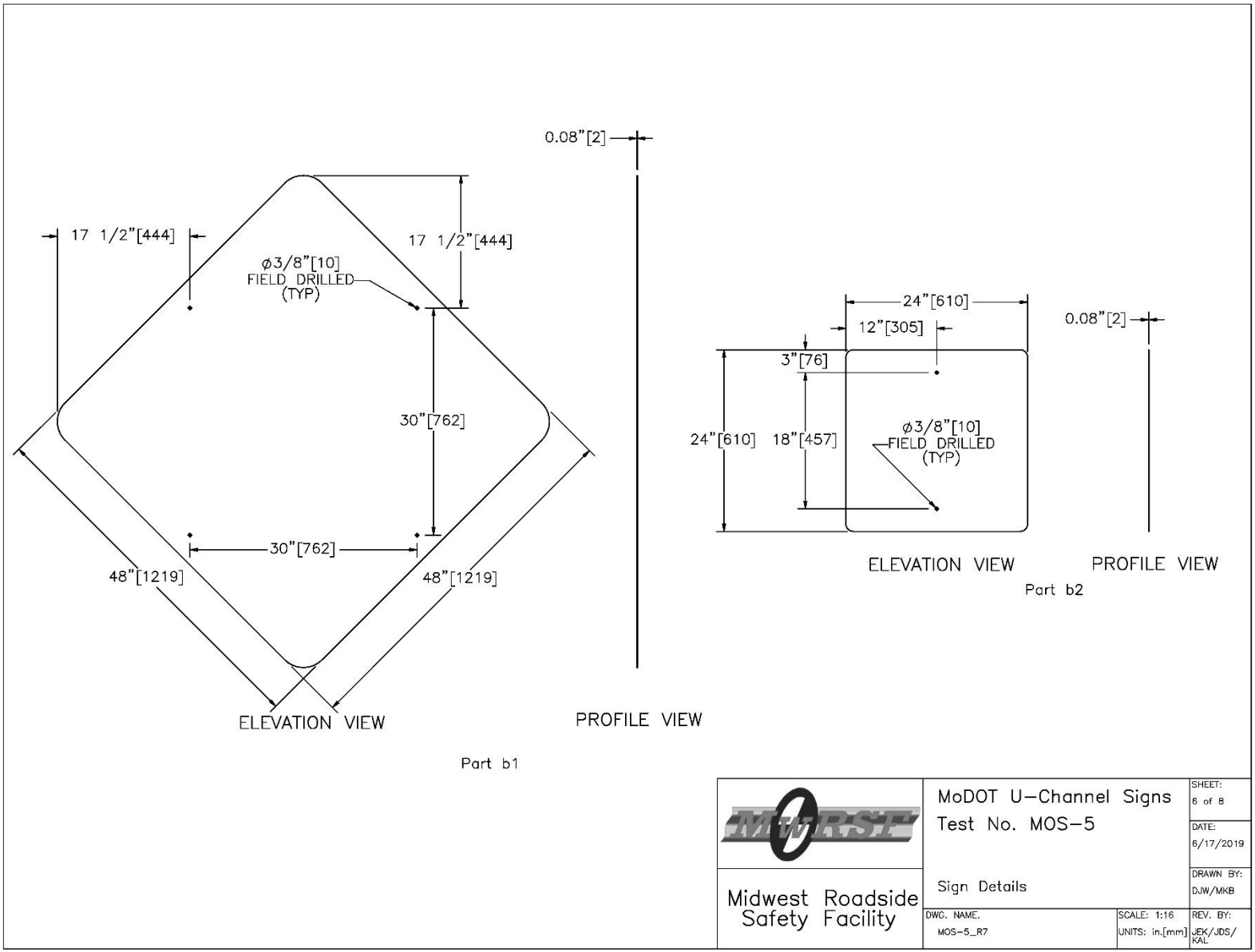


Figure 9. Sign Details, Test Nos. MOS-5 through MOS-7

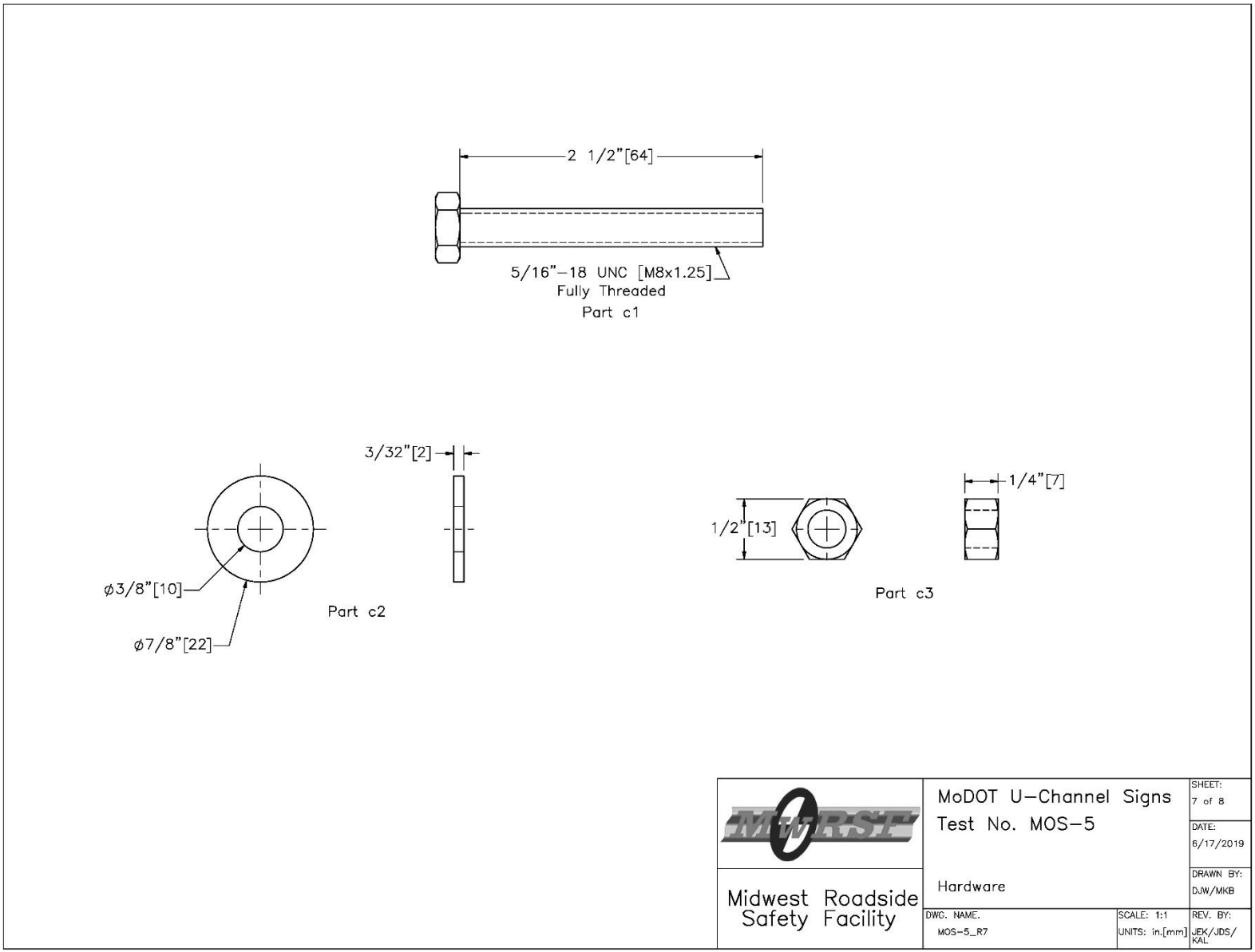


Figure 10. Hardware, Test Nos. MOS-5 through MOS-7

Item No.	QTY.	Description	Material Specification	Treatment Specification	Hardware Guide
a1	2	3.0 lb/ft [4.5 kg/m] U–Channel Sign Post, 132" [3,353] Long	ASTM A499 Gr. 60 Min. Yield = 60 ksi [414 Mpa]	ASTM A123	–
a2	2	3.0 lb/ft [4.5 kg/m] Rib–Bak U–Channel Base Post, 54" [1,372] Long	ASTM A499 Gr. 60 Min. Yield = 80 ksi [552 Mpa]	ASTM A123	–
b1	1	48"x48"x0.08" [1219x1219x2] Sign with Reflective Sheeting	Aluminum Alloy 5052 or Similar	–	–
b2	1	24"x24"x0.08" [610x610x2] Sign with Reflective Sheeting	Aluminum Alloy 5052 or Similar	–	–
c1	14	5/16"–18 UNC [M8x1.25], 2 1/2" [70] Long Fully Threaded Hex Bolt	SAE J429 Gr. 5 or equivalent	Fe/ZN 3AN per ASTM F1941	FBX08b
c2	28	5/16" [8] Dia. Plain USS Washer	ASTM F844	ASTM A123 or A153 or B695 Class 55	FWC08a
c3	14	5/16"–18 UNC [M8x1.25] Heavy Hex Nut	SAE J995 Gr. 5 or equivalent	Fe/Zn 3AN per ASTM F1941	FNX08b

Midwest Roadside Safety Facility

MoDOT U–Channel Signs
Test No. MOS–5
Bill of Materials

SHEET: 8 of 8
DATE: 6/17/2019
DRAWN BY: DJW/MKB
REV. BY: JEK/JDS/KAL
DWG. NAME. MOS–5_R7
SCALE: None
UNITS: in.[mm]

Figure 11. Bill of Materials, Test Nos. MOS-5 through MOS-7

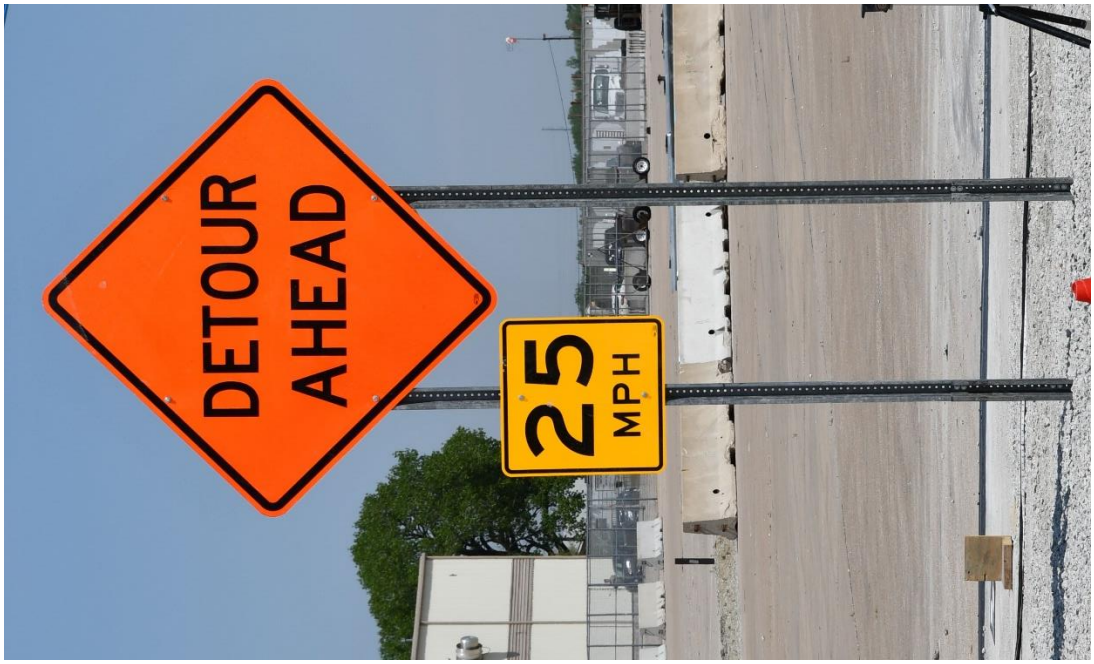


Figure 12. Test Installation Photographs, Test Nos. MOS-5 through MOS-7

Figure 13. Test Installation Photographs, Test Nos. MOS-5 through MOS-7

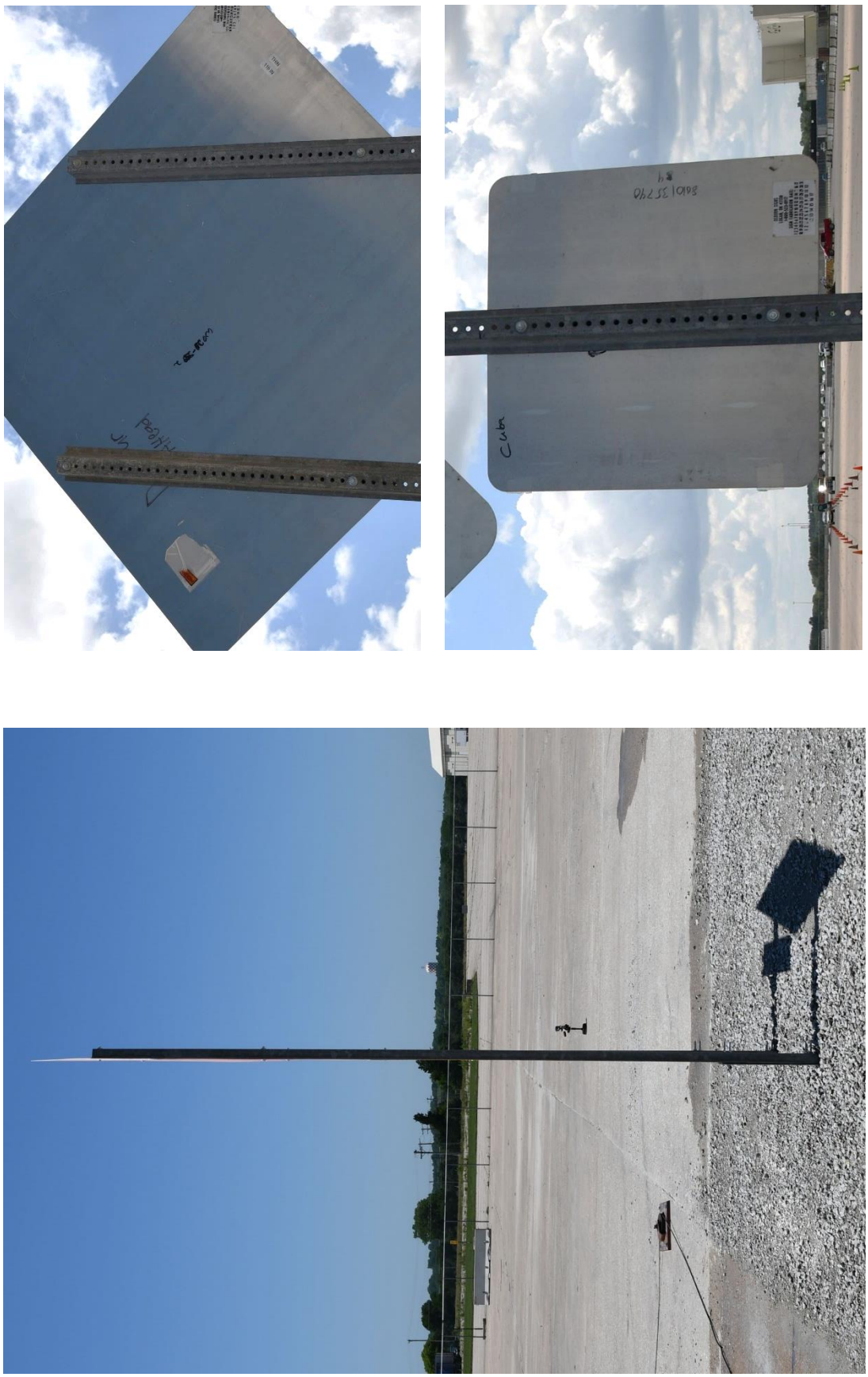


Figure 14. Test Installation Photographs, Test Nos. MOS-5 through MOS-7

Figure 15. Test Installation Photographs, U-Channel Post and Stub Splice, Test Nos. MOS-5 through MOS-7

3 TEST REQUIREMENTS AND EVALUATION CRITERIA

3.1 Test Requirements

Support structures, such as U-channel sign supports, must satisfy impact safety standards to be declared eligible for federal reimbursement by the Federal Highway Administration for use on the National Highway System. For new hardware, these safety standards consist of the guidelines and procedures published in MASH 2016. According to TL-3 of MASH 2016, support structures must be subjected to three full-scale vehicle crash tests, as summarized in Table 1.

Table 1. MASH 2016 TL-3 Crash Test Conditions for Support Structures

Test Article	Test Designation No.	Test Vehicle	Vehicle Weight, lb (kg)	Impact Conditions		Evaluation Criteria [1]
				Speed, mph (km/h)	Impact Point	
Support Structures	3-60	1100C	2,425 (1,100)	19 (30)	CIA	B,D,F,H,I,N
	3-61	1100C	2,425 (1,100)	62 (100)	CIA	B,D,F,H,I,N
	3-62	2270P	5,000 (2,270)	62 (100)	CIA	B,D,F,H,I,N

[1] Evaluation criteria explained in Table 2.
CIA = Critical Impact Angle

Test designation nos. 3-60, 3-61, and 3-62 were conducted for the dual-post, U-channel sign support system. In each test, the system was contacted by the test vehicle at a 0-degree angle, or head-on to the vehicle, with the vehicle centerline aligned with the centerline of the system. MASH notes that the CIA should be selected to represent the highest risk for the system to fail any of the recommended evaluation criteria. Since these sign supports will not typically be installed 90 degrees from the normal direction of travel, a critical impact angle between 0 and 25 degrees is recommended. Impacting the sign systems at a 0-degree angle was believed to be the most critical in terms of maximizing the potential contact area of the sign panels with the windshield and roof.

3.2 Evaluation Criteria

Evaluation criteria for full-scale vehicle crash testing are based on three appraisal areas: (1) structural adequacy; (2) occupant risk; and (3) vehicle trajectory after collision. Criteria for structural adequacy are intended to evaluate the ability of the sign supports to readily activate in a predictable manner by breaking away, fracturing, or yielding. Occupant risk evaluates the degree of hazard to occupants in the impacting vehicle. Post-impact vehicle trajectory is a measure of the potential of the vehicle to result in a secondary collision with other vehicles and/or fixed objects, thereby increasing the risk of injury to the occupants of the impacting vehicle and/or other vehicles. These evaluation criteria are summarized in Table 2 and defined in greater detail in MASH 2016. The full-scale vehicle crash tests were conducted and reported in accordance with the procedures provided in MASH 2016.

In addition to the standard occupant risk measures, the Post-Impact Head Deceleration (PHD), the Theoretical Head Impact Velocity (THIV), and the Acceleration Severity Index (ASI) were determined and reported. Additional discussion on PHD, THIV and ASI is provided in MASH 2016.

Table 2. MASH 2016 Evaluation Criteria for Support Structures

<table>
<tr><td>Structural Adequacy</td><td>B.</td><td colspan="3">The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.</td></tr>
<tr><td rowspan="5">Occupant Risk</td><td>D.</td><td colspan="3">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. Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH 2016.</td></tr>
<tr><td>F.</td><td colspan="3">The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</td></tr>
<tr><td rowspan="3">H.</td><td colspan="3">Occupant Impact Velocity (OIV) (see Appendix A, Section A5.2.2 of MASH 2016 for calculation procedure) should satisfy the following limits:</td></tr>
<tr><td colspan="3">Occupant Impact Velocity Limits</td></tr>
<tr><td>Component</td><td>Preferred</td><td>Maximum</td></tr>
<tr><td rowspan="3">I.</td><td>Longitudinal</td><td>10 ft/s
(3.0 m/s)</td><td>16 ft/s
(4.9 m/s)</td></tr>
<tr><td colspan="3">The Occupant Ridedown Acceleration (ORA) (see Appendix A, Section A5.2.2 of MASH 2016 for calculation procedure) should satisfy the following limits:</td></tr>
<tr><td colspan="3">Occupant Ridedown Acceleration Limits</td></tr>
<tr><td>Component</td><td>Preferred</td><td>Maximum</td></tr>
<tr><td>Longitudinal and Lateral</td><td>15.0 g’s</td><td>20.49 g’s</td></tr>
<tr><td>Post-Impact Vehicular Response</td><td>N.</td><td colspan="3">Vehicle trajectory behind the test article is acceptable.</td></tr>
</table>

3.3 Soil Strength Requirements

In accordance with Chapter 3 and Appendix B of MASH 2016, foundation soil strength must be verified before any full-scale crash testing can occur. During the installation of a soil dependent system, W6x16 posts are installed near the impact region utilizing the same installation procedures as the system itself. Prior to full-scale testing, a dynamic impact test must be conducted to verify a minimum dynamic soil resistance of 7.5 kips (33.4 kN) at post deflections between 5 and 20 in. (127 and 508 mm) measured at a height of 25 in. (635 mm). If dynamic testing near the

system is not desired, MASH 2016 permits a static test to be conducted instead and compared against the results of a previously established baseline test. In this situation, the soil must provide a resistance of at least 90% of the static baseline test at deflections of 5, 10, and 15 in. (127, 254, and 381 mm). Further details can be found in Appendix B of MASH 2016.

4 TEST CONDITIONS

4.1 Test Facility

The Outdoor Test Site is located at the Lincoln Air Park on the northwest side of the Lincoln Municipal Airport and is approximately 5 miles (8.0 km) northwest of the University of Nebraska-Lincoln.

4.2 Vehicle Tow and Guidance System

A reverse-cable tow system with a 1:2 mechanical advantage was used to propel the test vehicle. The distance traveled and the speed of the tow vehicle were one-half that of the test vehicle. The test vehicle was released from the tow cable before impact with the sign support system. A digital speedometer on the tow vehicle increased the accuracy of the test vehicle impact speed.

A vehicle guidance system developed by Hinch [5] was used to steer the test vehicle. A guide flag, attached to the left-front wheel and the guide cable, was sheared off before impact with the sign support system. The ⅜-in. (9.5-mm) diameter guide cable was tensioned to approximately 3,500 lb (15.6 kN) and supported both laterally and vertically every 100 ft (30.5 m) by hinged stanchions. The hinged stanchions stood upright while holding up the guide cable, but as the vehicle was towed down the line, the guide flag struck and knocked each stanchion to the ground.

4.3 Test Vehicles

For test no. MOS-5, a 2011 Dodge Ram 1500 crew cab pickup truck was used as the test vehicle. The curb, test inertial, and gross static vehicle weights were 5,302 lb (2,405 kg), 5,026 lb (2,280 kg), and 5,191 lb (2,355 kg), respectively. The test vehicle is shown in Figures 16 and 17, and vehicle dimensions are shown in Figure 18. Note that pre-test photographs of the vehicle's undercarriage are not available.

For test no. MOS-6, a 2009 Kia Rio small car was used as the test vehicle. The curb, test inertial, and gross static vehicle weights were 2,510 lb (1,139 kg), 2,420 lb (1,098 kg), and 2,584 lb (1,172 kg), respectively. The test vehicle is shown in Figures 19 and 20 and vehicle dimensions are shown in Figure 21.

For test no. MOS-7, a 2009 Kia Rio small car was used as the test vehicle. The curb, test inertial, and gross static vehicle weights were 2,499 lb (1,134 kg), 2,435 lb (1,104 kg), and 2,593 lb (1,176 kg), respectively. The test vehicle is shown in Figures 22 and 23, and vehicle dimensions are shown in Figure 24.

MASH 2016 requires test vehicles used in crash testing to be no more than six model years old. Two 2009 models were used for test nos. MOS-6 and MOS-7 because the vehicle geometry of newer models did not comply with recommended vehicle dimension ranges specified in Table 4.1 of MASH 2016. The use of older test vehicles due to recent small car vehicle properties falling outside of MASH 2016 recommendations was allowed by FHWA and AASHTO in MASH implementation guidance dated May of 2018 [6].

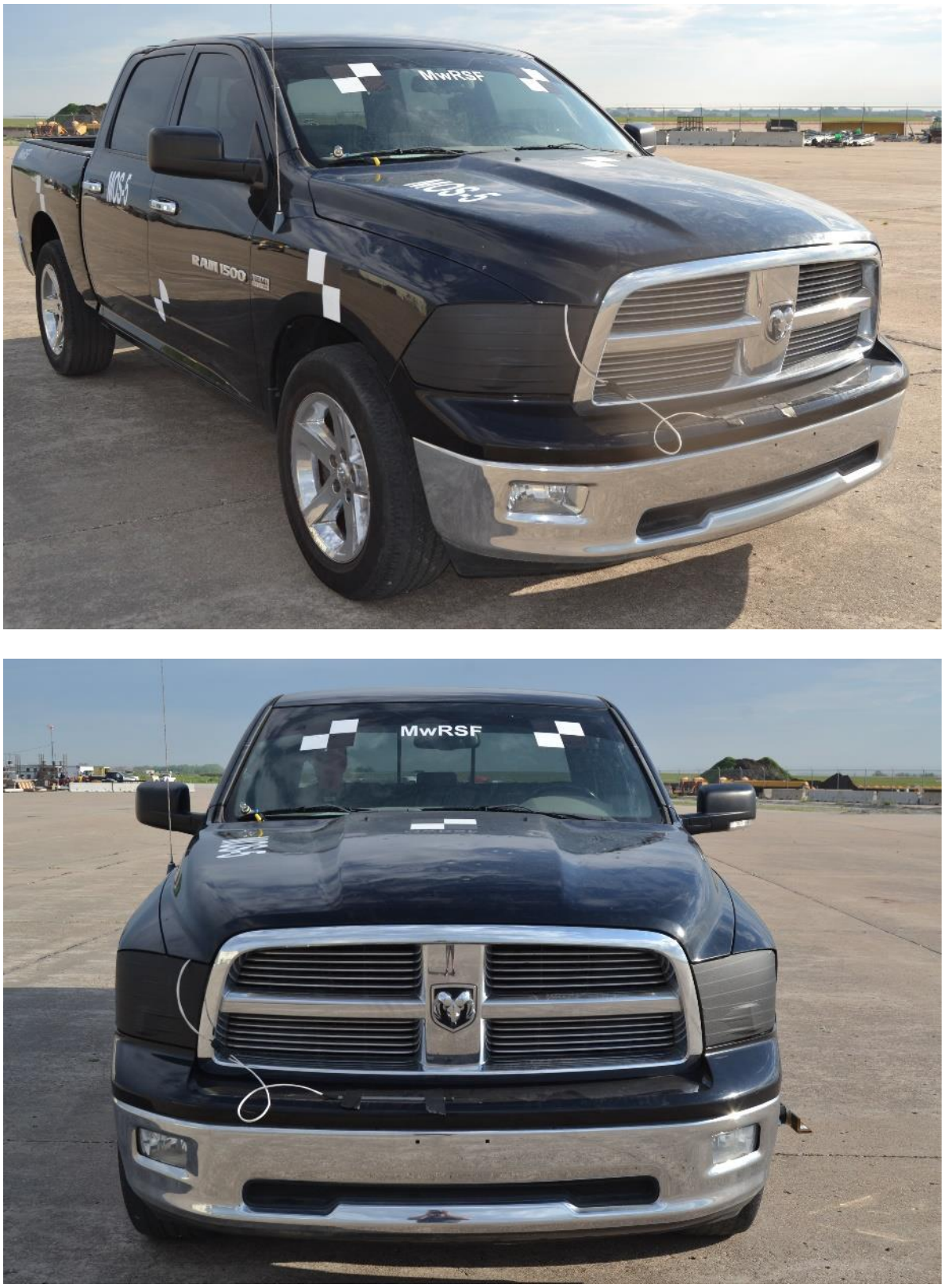


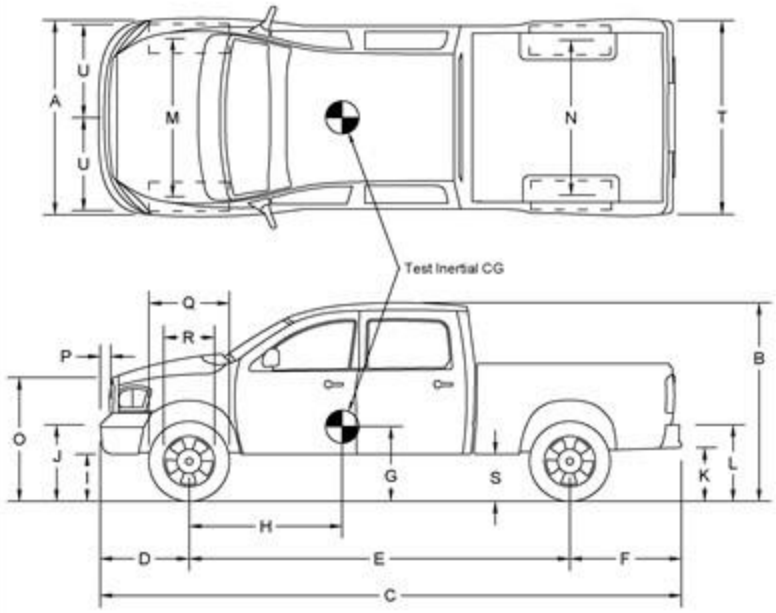
Figure 16. Test Vehicle, Test No. MOS-5

Figure 17. Vehicle's Interior Floorboards, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN No: 1D7RB1CT2BS657795

Year: 2011 Make: Dodge Model: Ram 1500

Tire Size: P275/60R20 Tire Inflation Pressure: 35 Psi Odometer: 211919



Vehicle Geometry - in. (mm)
Target Ranges listed below

A:	77 1/8 (1959)	B:	75 1/2 (1918)
	78±2 (1950±50)		
C:	229 1/4 (5823)	D:	40 (1016)
	237±13 (6020±325)		39±3 (1000±75)
E:	140 1/4 (3562)	F:	49 (1245)
	148±12 (3760±300)		
G:	29 5/16 (745)	H:	60 1/16 (1526)
	min 28 (710)		63±4 (1575±100)
I:	13 1/4 (337)	J:	27 1/2 (699)
K:	21 1/2 (546)	L:	30 1/2 (775)
M:	68 1/8 (1730)	N:	68 (1727)
	67±1.5 (1700±38)		67±1.5 (1700±38)
O:	45 1/4 (1149)	P:	5 (127)
	43±4 (1100±75)		
Q:	31 1/2 (800)	R:	21 1/2 (546)
S:	14 1/2 (368)	T:	77 (1956)

U (impact width): 38 9/16 (980)

Mass Distribution lb (kg)

Gross Static LF 1457 (661) RF 1518 (689)

LR 1106 (502) RR 1110 (503)

Wheel Center Height (Front): 15 3/4 (400)

Wheel Center Height (Rear): 15 3/4 (400)

Wheel Well Clearance (Front): 4 3/4 (121)

Wheel Well Clearance (Rear): 7 1/8 (181)

Bottom Frame Height (Front): 13 5/8 (346)

Bottom Frame Height (Rear): 12 1/4 (311)

Weights lb (kg)	Curb	Test Inertial	Gross Static
W-front	2944 (1335)	2873 (1303)	2975 (1349)
W-rear	2358 (1070)	2153 (977)	2216 (1005)
W-total	5302 (2405)	5026 (2280)	5191 (2355)
		5000±110 (2270±50)	5165±110 (2343±50)

Engine Type: Gasoline

Engine Size: 5.7l v8

GVWR Ratings lb

Front 3700

Rear 3900

Total 6800

Surrogate Occupant Data

Type: Hybrid II

Mass: 165 lb

Seat Position: Passenger

Transmission Type: Automatic

Drive Type: RWD

Cab Style: CrewCab

Bed Length: 67"

Note any damage prior to test: Small hail dents is surface of hood. Dent in surface of roof.

Figure 18. Vehicle Dimensions, Test No. MOS-5

Figure 19. Test Vehicle, Test No. MOS-6

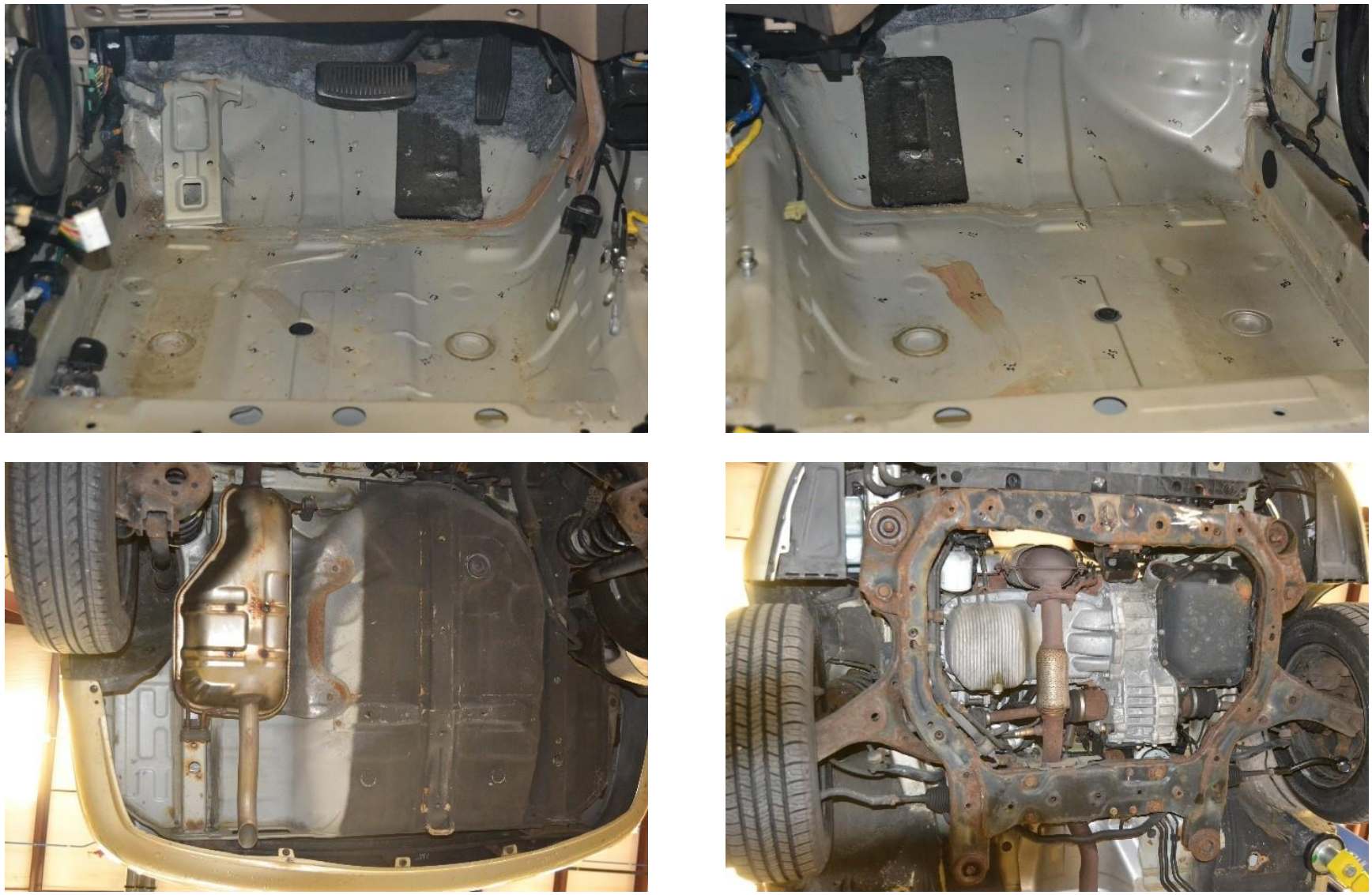
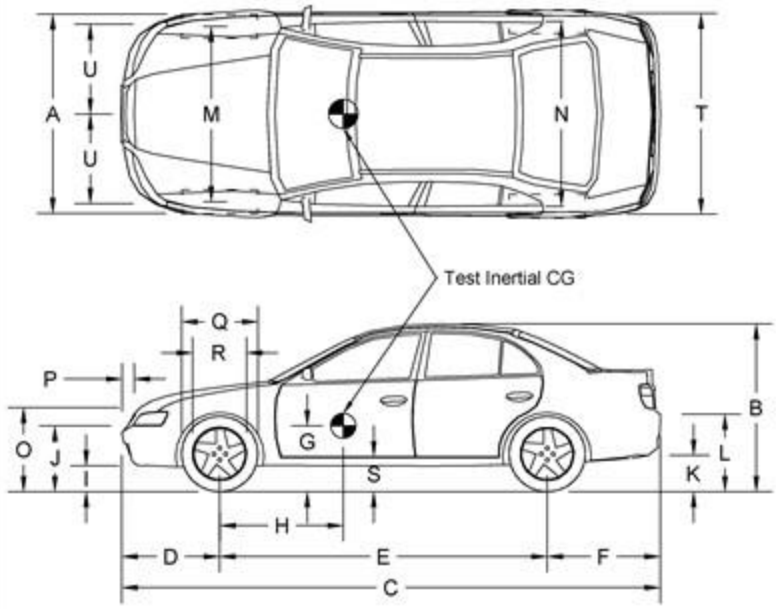


Figure 20. Test Vehicle's Interior Floorboards and Undercarriage, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN No: KNADE223296512940

Year: 2009 Make: Kia Model: Rio

Tire Size: 185/65R14 Tire Inflation Pressure: 32 Psi Odometer: 138093



Vehicle Geometry - in. (mm)
Target Ranges listed below

A:	66 1/4 (1683)	B:	57 1/2 (1461)
	65±3 (1650±75)		
C:	166 5/8 (4232)	D:	35 1/4 (895)
	169±8 (4300±200)		35±4 (900±100)
E:	98 1/2 (2502)	F:	36 1/2 (927)
	98±5 (2500±125)		
G:	22 3/4 (578)	H:	36 1/8 (918)
			39±4 (990±100)
I:	16 (406)	J:	20 (508)
K:	15 1/2 (394)	L:	21 (533)
M:	57 3/4 (1467)	N:	57 1/2 (1461)
	56±2 (1425±50)		56±2 (1425±50)
O:	27 3/4 (705)	P:	4 1/8 (105)
	24±4 (600±100)		
Q:	23 1/4 (591)	R:	15 3/8 (391)
S:	9 (229)	T:	65 3/4 (1670)
U (impact width):			61 7/8 (1572)

Mass Distribution lb (kg)

Gross Static	LF	835 (379)	RF	781 (354)	
	LR	442 (200)	RR	526 (239)	

Weights lb (kg)	Curb	Test Inertial	Gross Static
W-front	1578 (716)	1532 (695)	1616 (733)
W-rear	932 (423)	888 (403)	968 (439)
W-total	2510 (1139)	2420 (1098)	2584 (1172)
		2420±55 (1100±25)	2585±55 (1175±50)

Top of radiator core support:	27 (686)
Wheel Center Height (Front):	10 3/4 (273)
Wheel Center Height (Rear):	11 1/8 (283)
Wheel Well Clearance (Front):	25 1/4 (641)
Wheel Well Clearance (Rear):	24 7/8 (632)
Bottom Frame Height (Front):	6 3/4 (171)
Bottom Frame Height (Rear):	9 1/4 (235)
Engine Type:	Gasoline
Engine Size:	1.4L 4 cyl
Transmission Type:	Automatic
Drive Type:	FWD

GVWR Ratings lb

Front	1918
Rear	1874
Total	3638

Surrogate Occupant Data

Type:	Hybrid II
Mass:	164 lb
Seat Position:	Right/Passenger

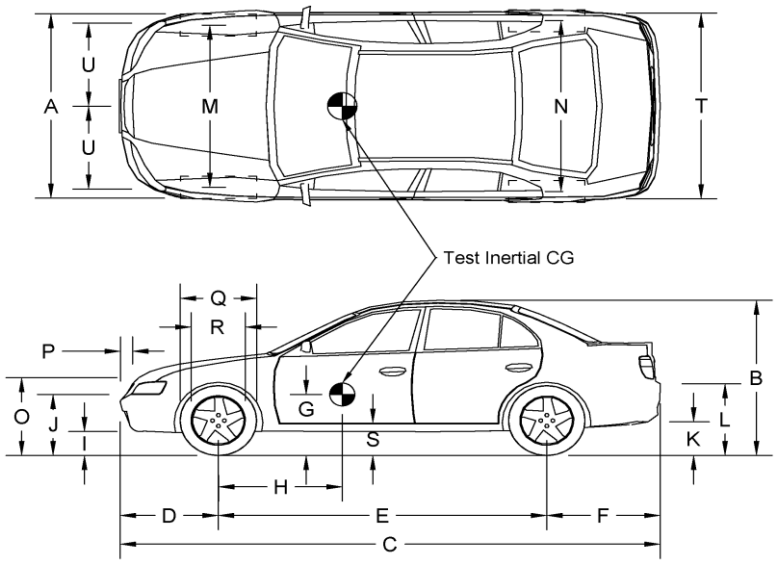
Note any damage prior to test: None

Figure 21. Vehicle Dimensions, Test No. MOS-6

Figure 22. Test Vehicle, Test No. MOS-7

Figure 23. Vehicle's Interior Floorboards and Undercarriage, Test No. MOS-7

Date:	6/28/2019	**Test Name:**	MOS-7	**VIN No:**	KNADE223896580563
Year:	2009	**Make:**	Kia	**Model:**	Rio
Tire Size:	185/65 R14	**Tire Inflation Pressure:**	32 psi	**Odometer:**	269054



Vehicle Geometry - in. (mm)
Target Ranges listed below

A:	66 3/8 (1686) 65±3 (1650±75)	**B:**	58 1/4 (1480)
C:	167 (4242) 169±8 (4300±200)	**D:**	34 1/2 (876) 35±4 (900±100)
E:	98 1/2 (2502) 98±5 (2500±125)	**F:**	31 3/4 (806)
G:	22 13/16 (579)	**H:**	35 15/16 (913) 39±4 (990±100)
I:	15 1/2 (394)	**J:**	21 (533)
K:	16 (406)	**L:**	22 1/2 (572)
M:	57 3/8 (1457) 56±2 (1425±50)	**N:**	57 3/8 (1457) 56±2 (1425±50)
O:	27 1/2 (699) 24±4 (600±100)	**P:**	1 1/4 (32)
Q:	22 3/4 (578)	**R:**	15 3/8 (391)
S:	12 (305)	**T:**	65 1/8 (1654)
U (impact width):	30 5/8 (778)		

Mass Distribution - lb (kg)

Gross Static	**LF**	820 (372)	**RF**	803 (364)
	LR	475 (215)	**RR**	495 (225)

Weights lb (kg)	**Curb**	**Test Inertial**	**Gross Static**
W-front	1606 (728)	1547 (702)	1623 (736)
W-rear	893 (405)	888 (403)	970 (440)
W-total	2499 (1134)	2435 (1104) 2420±55 (1100±25)	2593 (1176) 2585±55 (1175±50)

Top of radiator core support:	28 (711)
Wheel Center Height (Front):	10 3/4 (273)
Wheel Center Height (Rear):	11 1/8 (283)
Wheel Well Clearance (Front):	25 1/2 (648)
Wheel Well Clearance (Rear):	25 5/8 (651)
Bottom Frame Height (Front):	7 1/8 (181)
Bottom Frame Height (Rear):	11 (279)
Engine Type:	Gasoline
Engine Size:	1.6L 4 Cyl
Transmission Type:	Automatic
Drive Type:	FWD

GVWR Ratings lb

Front	1918
Rear	1874
Total	3638

Surrogate Occupant Data

Type:	Hybrid II
Mass:	158 lb
Seat Position:	Right/Passenger

Note any damage prior to test: None

Figure 24. Vehicle Dimensions, Test No. MOS-7

The longitudinal component of the center of gravity (c.g.) for all vehicles was determined using the measured axle weights. The Suspension Method [7] was used to determine the vertical component of the c.g. for the 2270P pickup truck. This method is based on the principle that the c.g. of any freely suspended body is in the vertical plane through the point of suspension. The vehicle was suspended successively in three positions, and the respective planes containing the c.g. were established. The intersection of these planes pinpointed the final c.g. location for the test inertial condition. The vertical component of the c.g. for the 1100C vehicles was determined utilizing a procedure published by SAE [8]. The final c.g. locations are shown in Figures 25 through 27. Data used to calculate the location of the c.g. and ballast information are shown in Appendix B.

Square, black-and-white checkered targets were placed on the vehicles, as shown in Figures 25 through 27, to serve as reference points in the high-speed digital video and aid in video analysis. Round, checkered targets were placed at the c.g. on the left-side door, the right-side door, and the roof of the vehicle.

The front wheels of the test vehicles were aligned to vehicle standards except the toe-in value was adjusted to zero such that the vehicles would track properly along the guide cable. A 5B flash bulb was mounted under the vehicle's right-side windshield wiper for test nos. MOS-5 and MOS-6 and the left-side windshield wiper for test no. MOS-7, and was fired by a pressure tape switch mounted at the right quarter point of the front bumper. The flash bulb was fired upon initial impact with the test article to create a visual indicator of the precise time of impact on the high-speed digital videos. A radio-controlled brake system was installed in each test vehicle so the vehicle could be brought safely to a stop after the test.

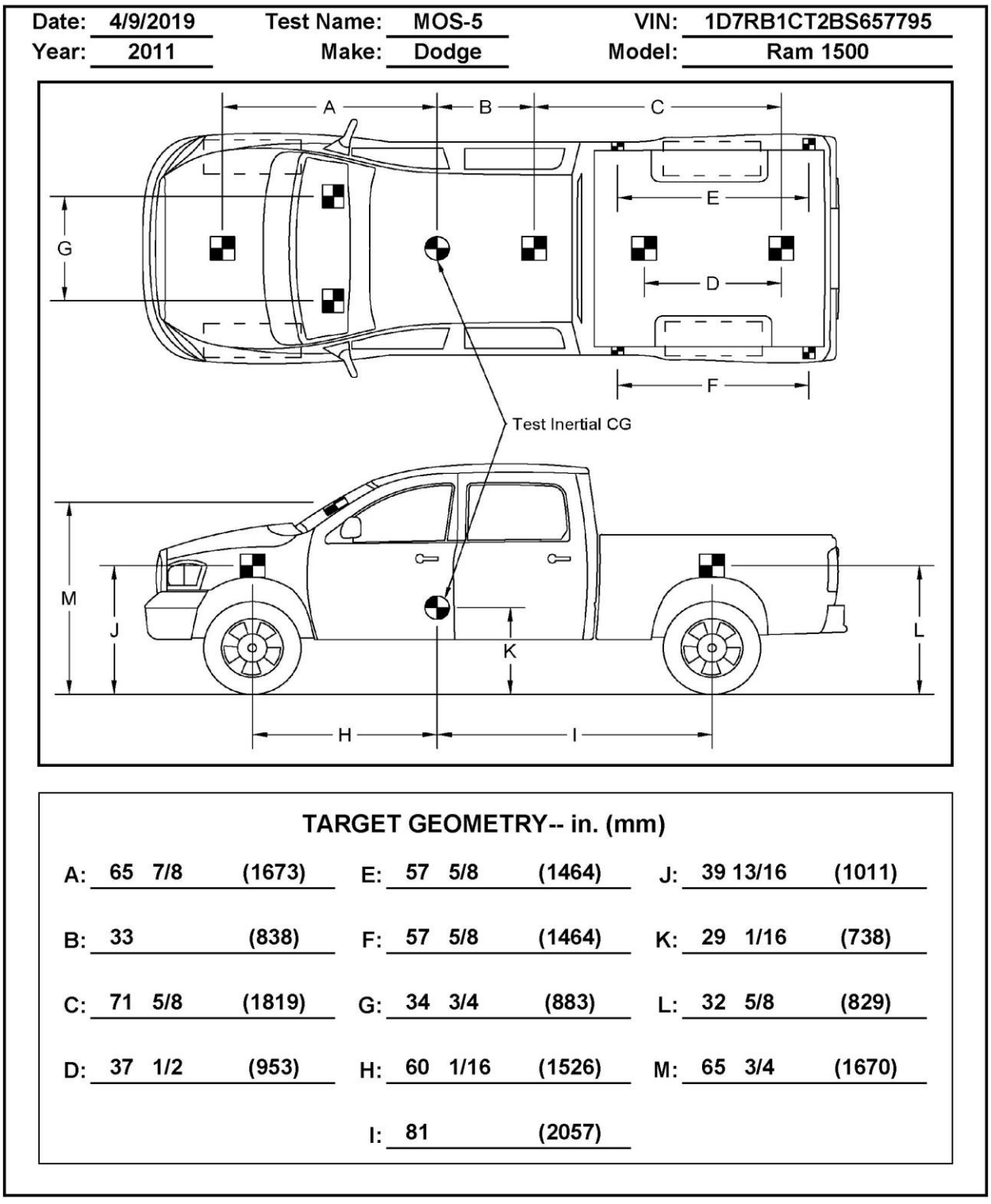


Figure 25. Target Geometry, Test No. MOS-5

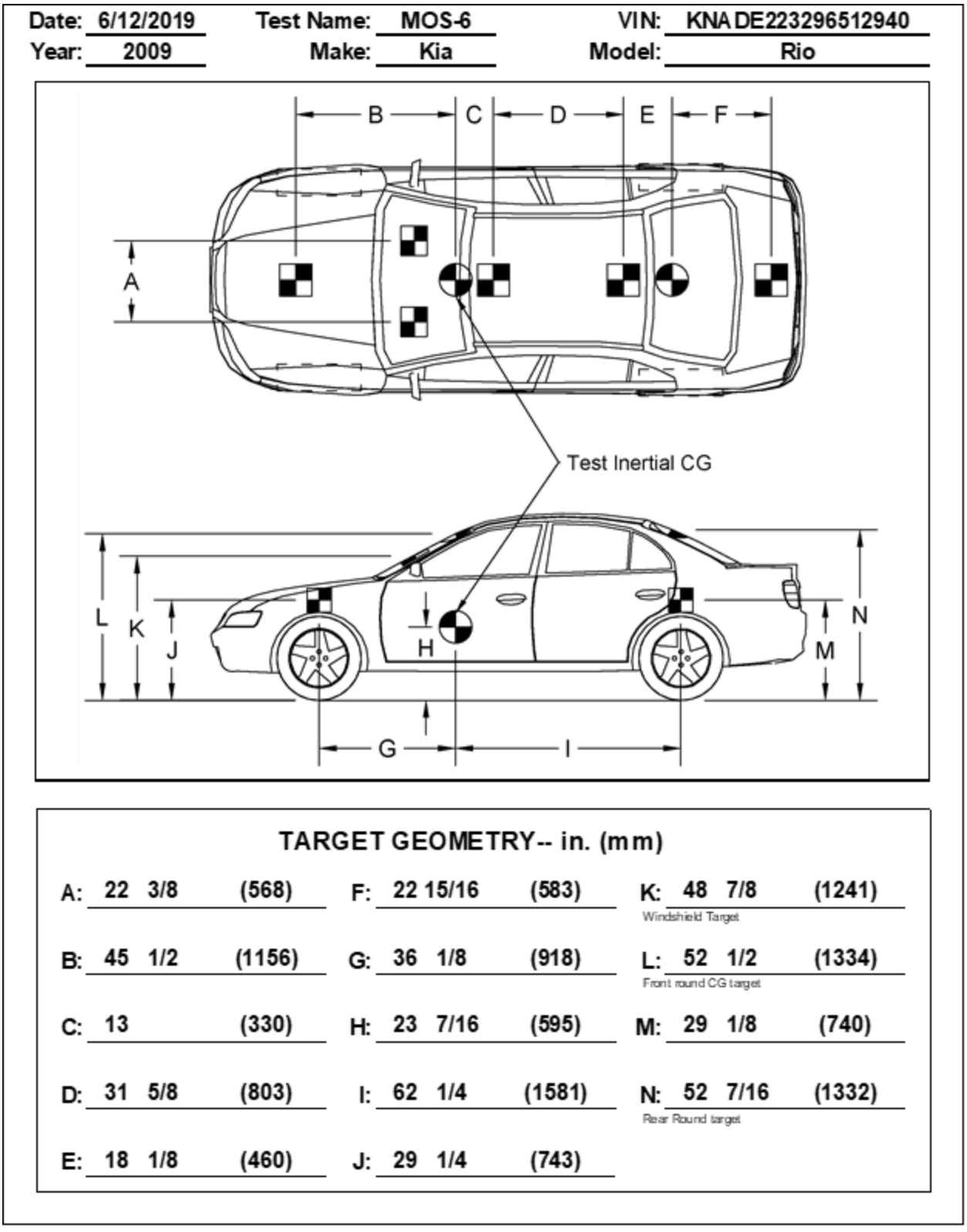
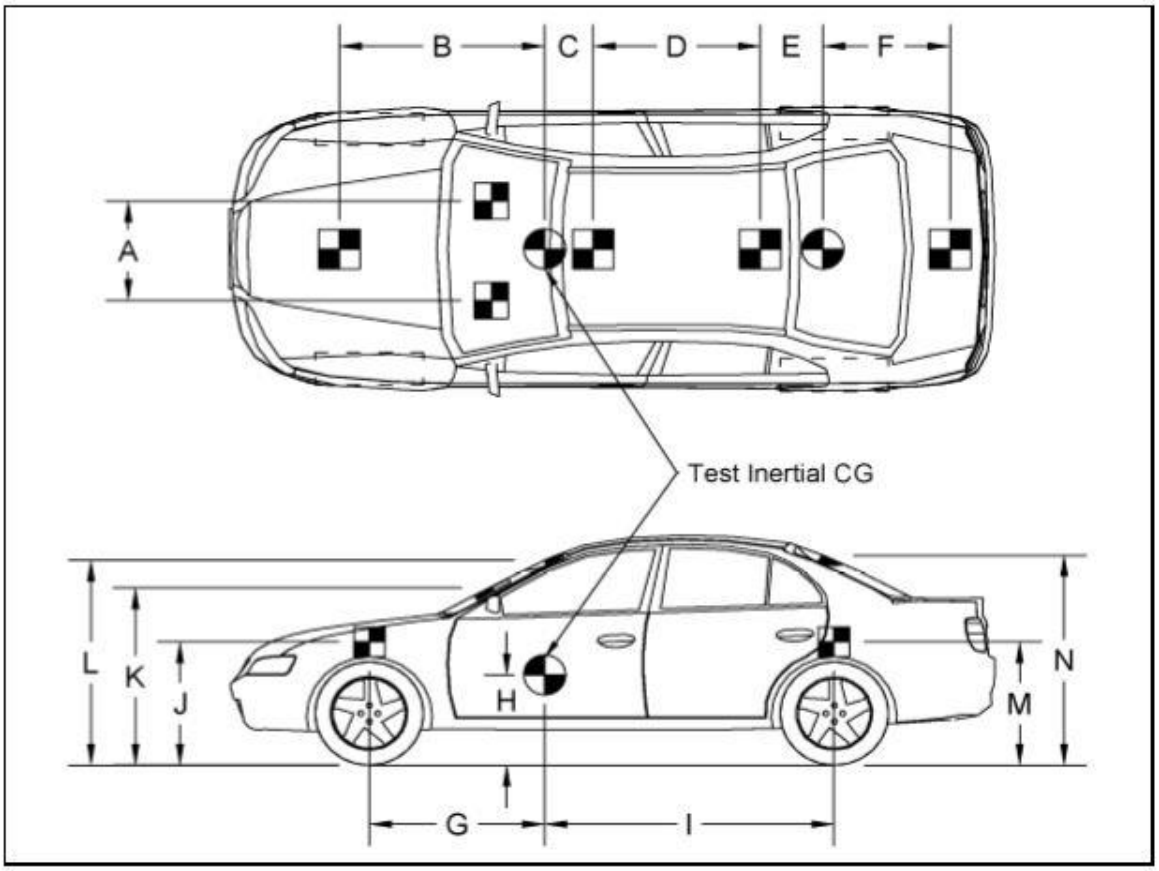


Figure 26. Target Geometry, Test No. MOS-6

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio



TARGET GEOMETRY-- in. (mm)

A:	23 7/8	(606)	F:	22 1/8	(562)	K:	48 1/4	(1226)
						Windshield Target		
B:	43 1/2	(1105)	G:	35 15/16	(913)	L:	52 1/2	(1334)
						Front round CG target		
C:	11 7/8	(302)	H:	22 13/16	(579)	M:	29 1/4	(743)
D:	34 7/8	(886)	I:	62 3/4	(1594)	N:	52 1/2	(1334)
						Rear Round target		
E:	50 1/2	(1283)	J:	29	(737)			

Figure 27. Target Geometry, Test No. MOS-7

4.4 Simulated Occupant

For test nos. MOS-5, MOS-6, and MOS-7, a Hybrid II 50th-Percentile, Adult Male Dummy, equipped with clothing and footwear, was placed in the right-front seat of the test vehicle with the seat belt fastened. The dummy had final weights of 165 lb (75 kg), 164 lb (74 kg), and 158 lb (72 kg) for test nos. MOS-5, MOS-6, and MOS-7, respectively. As recommended by MASH 2016, the dummy was not included in calculating the c.g. locations.

4.5 Data Acquisition Systems

4.5.1 Accelerometers

Two environmental shock and vibration sensor/recorder systems were used to measure the accelerations in the longitudinal, lateral, and vertical directions. Both accelerometer systems were mounted near the c.g. of the test vehicles. The electronic accelerometer data obtained in dynamic testing was filtered using the SAE Class 60 and the SAE Class 180 Butterworth filter conforming to the SAE J211/1 specifications [9].

The two systems, the SLICE-1 and SLICE-2 units, were modular data acquisition systems manufactured by Diversified Technical Systems, Inc. (DTS) of Seal Beach, California. The SLICE-1 unit was designated as the primary system in test nos. MOS-6 and MOS-7. In test no. MOS-5, the SLICE-2 unit was designated as the primary system. The acceleration sensors were mounted inside the bodies of custom-built, SLICE 6DX event data recorders and recorded data at 10,000 Hz to the onboard microprocessor. Each SLICE 6DX was configured with 7 GB of non-volatile flash memory, a range of ±500 g's, a sample rate of 10,000 Hz, and a 1,650 Hz (CFC 1000) anti-aliasing filter. The "SLICEWare" computer software program and a customized Microsoft Excel worksheet were used to analyze and plot the accelerometer data.

4.5.2 Rate Transducers

Two identical angular rate sensor systems mounted inside the bodies of the SLICE-1 and SLICE-2 event data recorders were used to measure the rates of rotation of the test vehicle. Each SLICE MICRO Triax ARS had a range of 1,500 degrees/sec in each of the three directions (roll, pitch, and yaw) and recorded data at 10,000 Hz to the onboard microprocessors. The raw data measurements were then downloaded, converted to the proper Euler angles for analysis, and plotted. The "SLICEWare" computer software program and a customized Microsoft Excel worksheet were used to analyze and plot the angular rate sensor data.

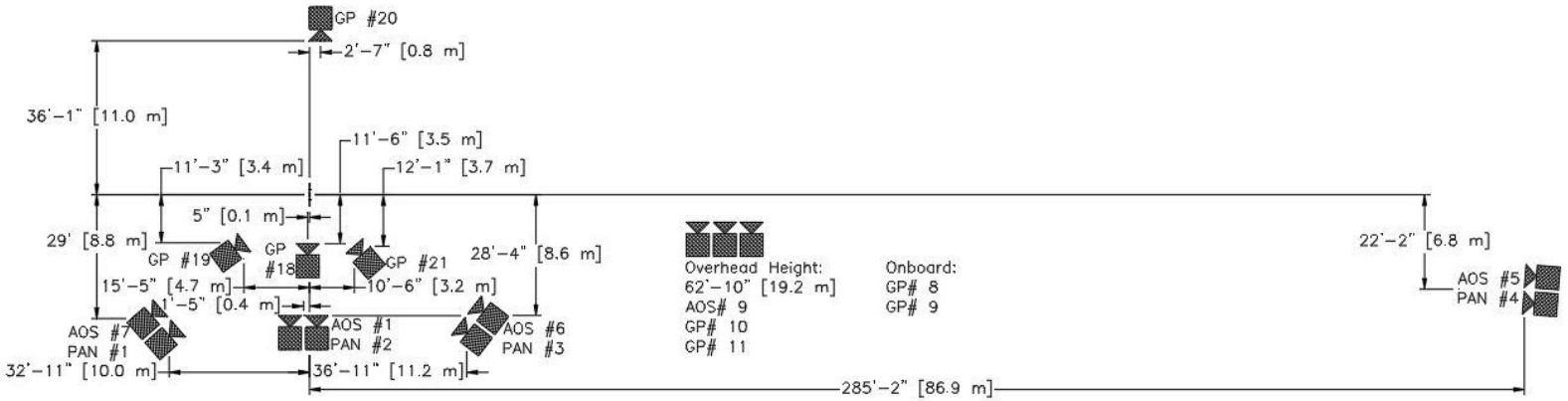
4.5.3 Retroreflective Optic Speed Trap

The retroreflective optic speed trap was used to determine the speed of the test vehicles before impact. Five retroreflective targets, spaced at approximately 18-in. (457-mm) intervals, were applied to the side of each vehicle. When the emitted beam of light was reflected by the targets and returned to the Emitter/Receiver, a signal was sent to the data acquisition computer, recording at 10,000 Hz, as well as the external LED box activating the LED flashes. The speed was then calculated using the spacing between the retroreflective targets and the time between the signals. LED lights and high-speed digital video analysis are used as a backup if vehicle speeds cannot be determined from the electronic data.

4.5.4 Digital Photography

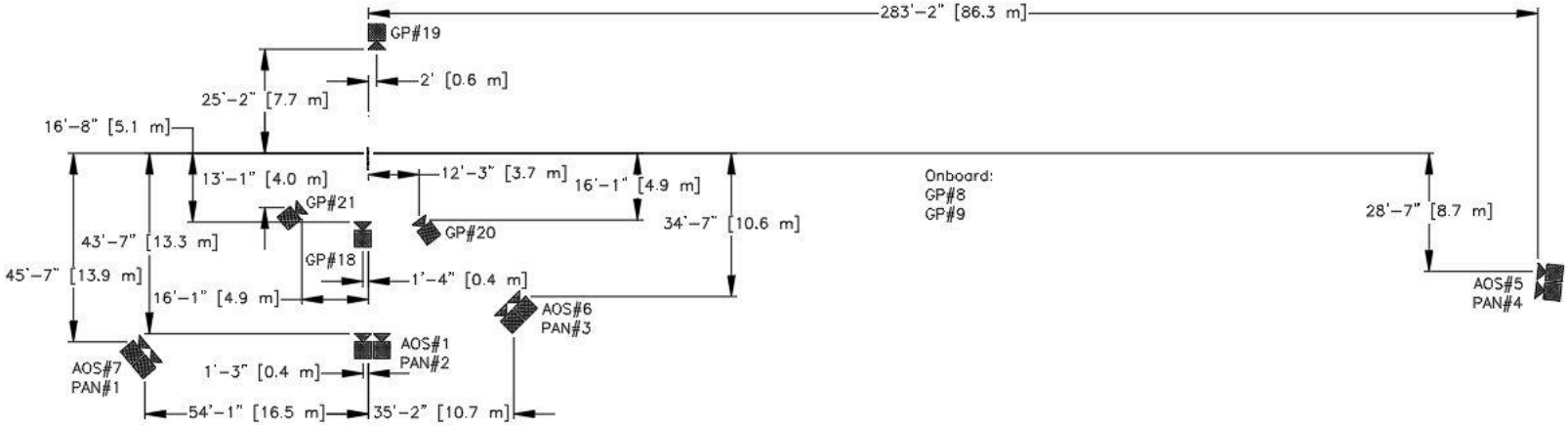
Five AOS high-speed digital video cameras, eight GoPro digital video cameras, and four Panasonic digital video cameras were utilized to film test no. MOS-5. Four AOS high-speed digital video cameras, six GoPro digital video cameras, and four Panasonic digital video cameras were utilized to film test nos. MOS-6 and MOS-7. Camera details, camera operating speeds, lens information, and a schematic of the camera locations relative to the systems are shown in Figures 28 through 30 for test nos. MOS-5, MOS-6, and MOS-7, respectively.

The high-speed videos were analyzed using TEMA Motion and Redlake MotionScope software programs. Actual camera speed and camera divergence factors were considered in the analysis of the high-speed videos. A digital still camera was also used to document pre- and post-test conditions for all tests.



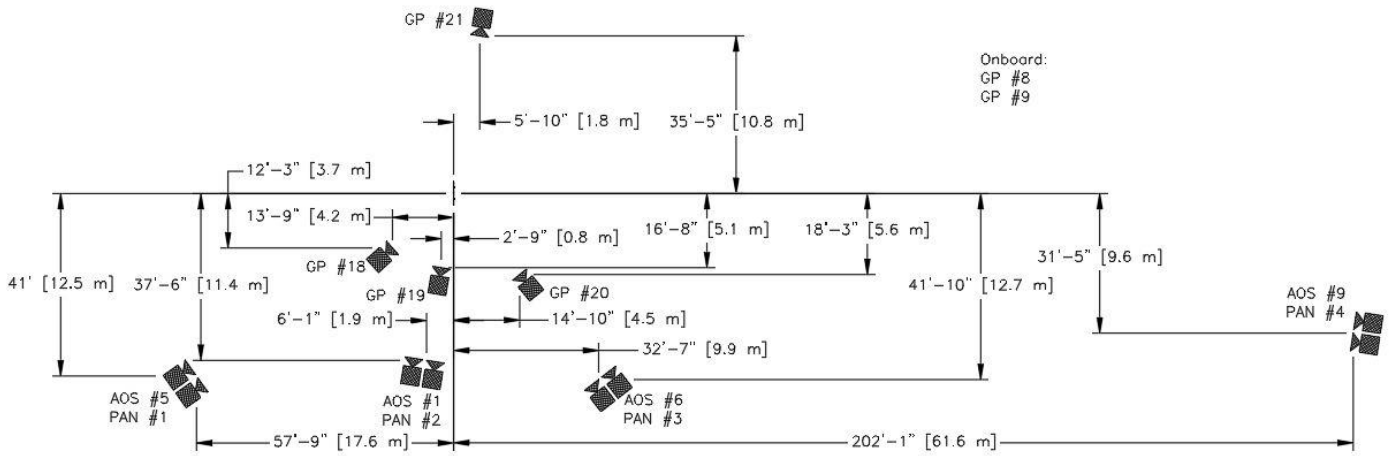
No.	Type	Operating Speed (frames/sec)	Lens	Lens Setting
AOS-1	AOS Vitcam CTM	500	KOWA 16 mm Fixed	-
AOS-5	AOS X-PRI Gigabit	500	100 mm Fixed	-
AOS-6	AOS X-PRI Gigabit	500	Fujinon 35 mm Fixed	-
AOS-7	AOS X-PRI Gigabit	500	KOWA 25 mm Fixed	-
AOS-9	AOS TRI-VIT	500	KOWA 12 mm Fixed	-
GP-8	GoPro Hero 4	120		
GP-9	GoPro Hero 4	120		
GP-10	GoPro Hero 4	120		
GP-11	GoPro Hero 4	240		
GP-18	GoPro Hero 6	240		
GP-19	GoPro Hero 6	240		
GP-20	GoPro Hero 6	240		
GP-21	GoPro Hero 6	240		
PAN-1	Panasonic HC-V770	120		
PAN-2	Panasonic HC-V770	120		
PAN-3	Panasonic HC-V770	120		
PAN-4	Panasonic HC-V770	120		

Figure 28. Camera Locations, Speeds, and Lens Settings, Test No. MOS-5



No.	Type	Operating Speed (frames/sec)	Lens	Lens Setting
AOS-1	AOS Vitcam CTM	500	KOWA 25 mm	-
AOS-5	AOS X-PRI	500	100 mm	-
AOS-6	AOS X-PRI	500	Fujinon 35 mm	-
AOS-7	AOS X-PRI	500	Fujinon 50 mm	-
GP-8	GoPro Hero 4	120		
GP-9	GoPro Hero 4	120		
GP-18	GoPro Hero 6	240		
GP-19	GoPro Hero 6	240		
GP-20	GoPro Hero 6	240		
GP-21	GoPro Hero 6	240		
PAN-1	Panasonic HC-V770	120		
PAN-2	Panasonic HC-V770	120		
PAN-3	Panasonic HC-V770	120		
PAN-4	Panasonic HC-V770	120		

Figure 29. Camera Locations, Speeds, and Lens Settings, Test No. MOS-6



No.	Type	Operating Speed (frames/sec)	Lens	Lens Setting
AOS-1	AOS Vitcam CTM	500	KOWA 16 mm	-
AOS-5	AOS X-PRI	500	Sigma 28-70 DG #2	-
AOS-6	AOS X-PRI	500	Sigma 28-70 DG #1	-
AOS-9	AOS TRI-VIT 2236	500	100 mm	-
GP-8	GoPro Hero 4	120		
GP-9	GoPro Hero 4	120		
GP-18	GoPro Hero 6	240		
GP-19	GoPro Hero 6	240		
GP-20	GoPro Hero 6	240		
GP-21	GoPro Hero 6	240		
PAN-1	Panasonic HC-V770	120		
PAN-2	Panasonic HC-V770	120		
PAN-3	Panasonic HC-V770	120		
PAN-4	Panasonic HC-V770	120		

Figure 30. Camera Locations, Speeds, and Lens Settings, Test No. MOS-7

5 FULL-SCALE CRASH TEST NO. MOS-5

5.1 Static Soil Test

Before full-scale crash test no. MOS-5 was conducted, the strength of the foundation soil was evaluated with a static test, as described in MASH 2016. The static test results, as shown in Appendix C, demonstrated a soil resistance above the baseline test limits. Thus, the soil provided adequate strength, and full-scale crash testing could be conducted on the sign support system.

5.2 Weather Conditions

Test no. MOS-5 was conducted on May 15, 2019 at approximately 11:45 a.m. The weather conditions as per the National Oceanic and Atmospheric Administration (station 14939/LNK) were reported and are shown in Table 3.

Table 3. Weather Conditions, Test No. MOS-5

Temperature	82°F
Humidity	40%
Wind Speed	11 mph
Wind Direction	110° from True North
Sky Conditions	Sunny
Visibility	10 Statute Miles
Pavement Surface	Dry
Previous 3-Day Precipitation	0.14 in.
Previous 7-Day Precipitation	1.09 in.

5.3 Test Description

Initial vehicle impact was to occur with the vehicle centerline aligned with the centerline of the system, as shown in Figure 31. The 5,026-lb (2,280-kg) pickup truck impacted the U-channel sign system oriented at 0 degrees, or head-on to the vehicle, at a speed of 62.7 mph (100.9 km/h). The vehicle came to rest 250 ft – 3 in. (76.3 m) longitudinally downstream and 8 ft – 6 in. (2.6 m) laterally to the right of the centerline after brakes were applied. A detailed description of the sequential impact events is contained in Table 4. Sequential photographs are shown in Figures 32 and 33. Documentary photographs of the crash test are shown in Figures 34 through 36. The vehicle trajectory and final position are shown in Figure 37.

Table 4. Sequential Description of Impact Events, Test No. MOS-5

TIME (sec)	EVENT
0.000	Vehicle's front bumper contacted left and right posts.
0.002	Vehicle's hood contacted left and right posts. Both posts deflected downstream.
0.004	Right post fractured just above the embedded stub.
0.006	Left post fractured just above the embedded stub.
0.008	Lower sign deformed due to post flexure.
0.012	Vehicle's front bumper deformed.
0.016	Upper sign deformed due to post movements.
0.030	Detached portion of system became airborne when it lost contact with vehicle.
0.094	Upper sign contacted vehicle's roof.
0.102	Vehicle's roof deformed.
0.156	System lost contact with vehicle.
0.752	Vehicle yawed left/counterclockwise.
2.446	Detached portion of system contacted ground.

Figure 31. Impact Location, Test No. MOS-5


0.000 sec


0.000 sec


0.050 sec


0.050 sec


0.100 sec


0.100 sec


0.200 sec


0.200 sec


0.300 sec


0.300 sec


0.400 sec


0.400 sec

Figure 32. Sequential Photographs, Test No. MOS-5


0.000 sec

0.000 sec


0.050 sec


0.050 sec


0.100 sec


0.100 sec

0.200 sec


0.200 sec

0.300 sec


0.300 sec


0.400 sec


0.400 sec

Figure 33. Additional Sequential Photographs, Test No. MOS-5

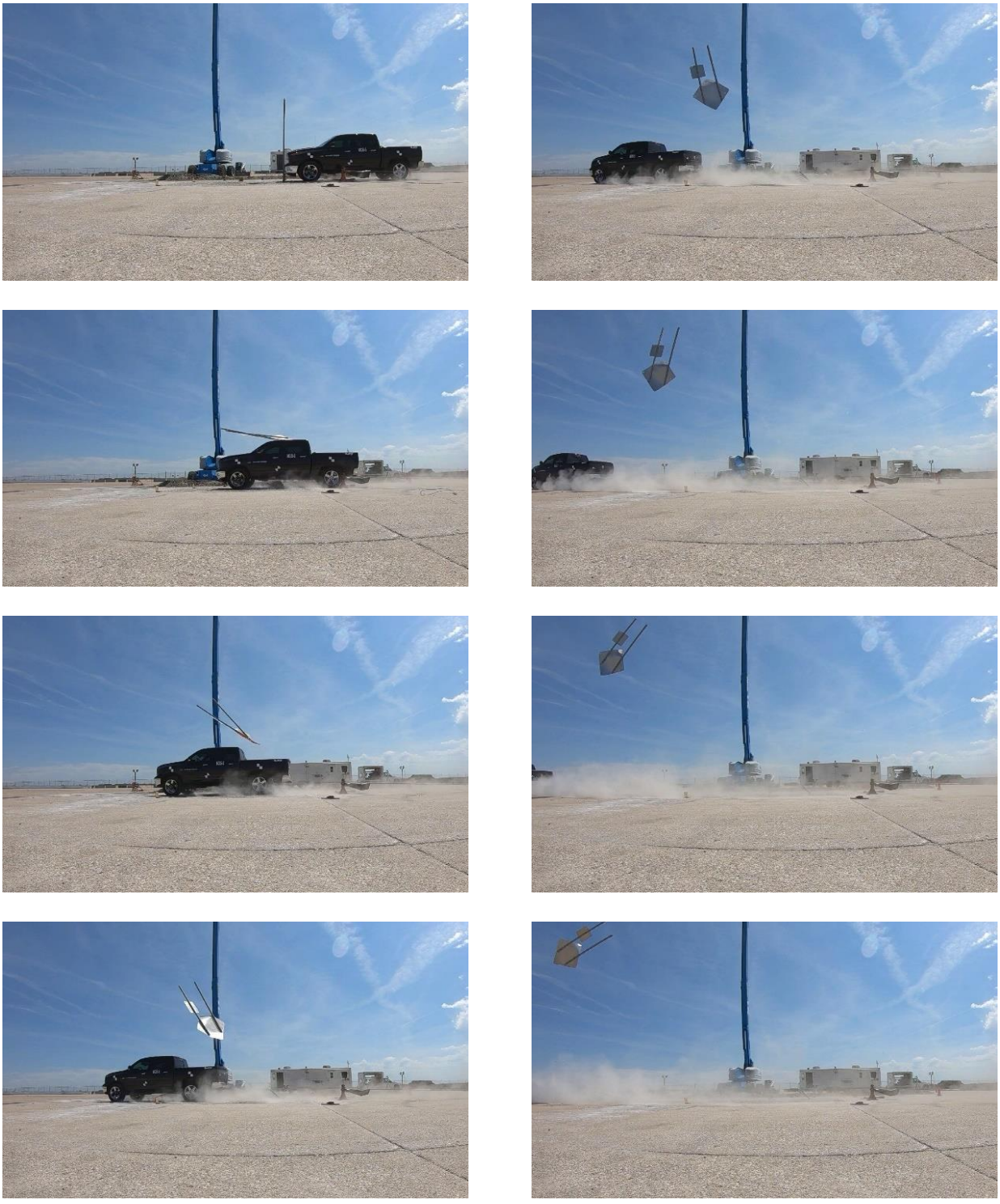


Figure 34. Documentary Photographs, Test No. MOS-5

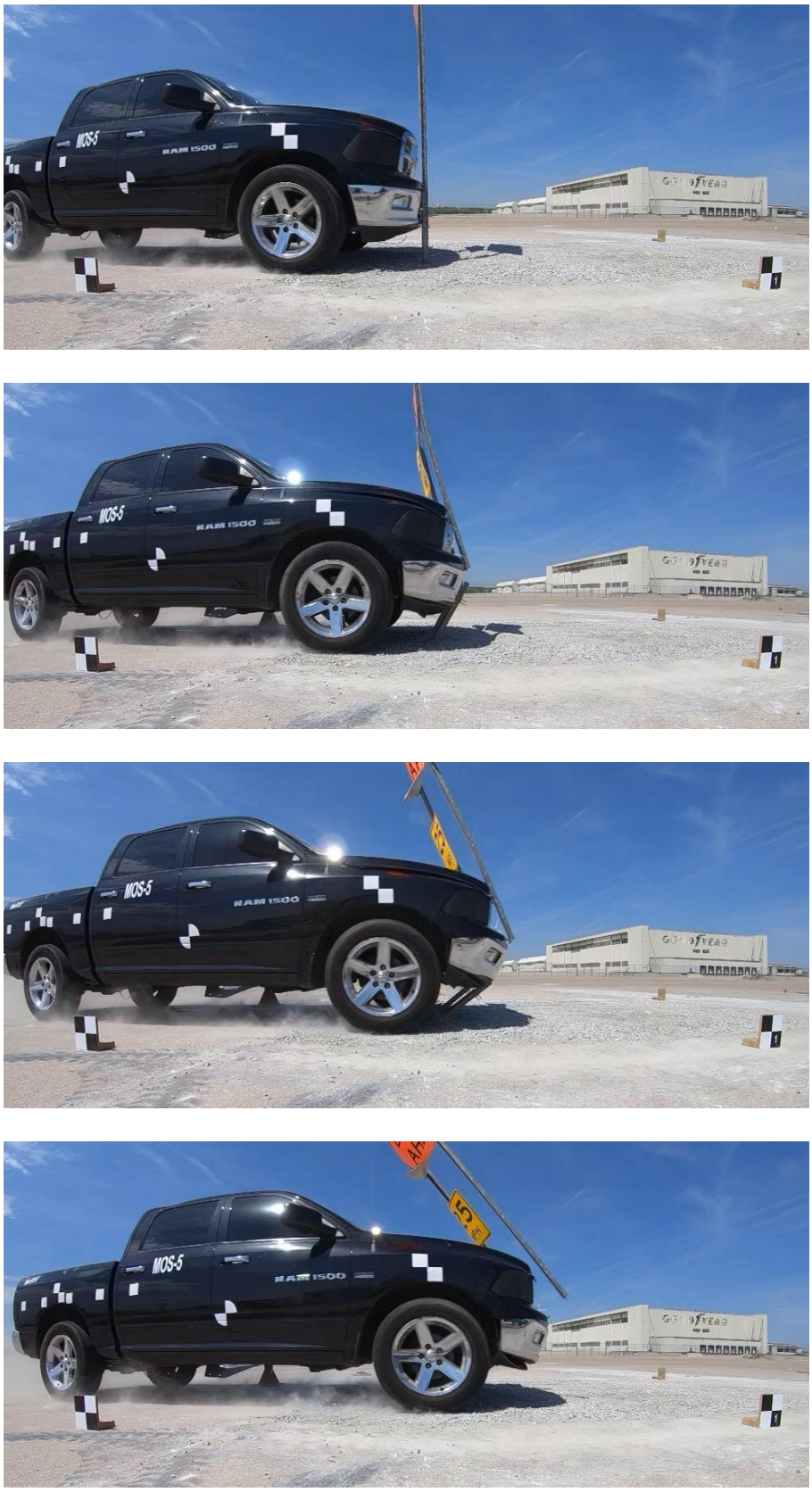


Figure 35. Documentary Photographs, Test No. MOS-5

Figure 36. Documentary Photographs, Test No. MOS-5

Figure 37. Vehicle Final Position and Trajectory Marks, Test No. MOS-5

5.4 System Damage

Damage to the system was severe, as shown in Figures 38 through 42. System damage consisted of contact marks, fracture and deformation of the posts, and bending of the upper sign panel.

The left and right edges of the upper sign panel bent in the downstream direction such that the left edge was 13 in. (330 mm) out of plane and the right edge was 7½ in. (191 mm) out of plane. The right post sheared 26½ in. (673 mm) above the ground line, and the left post sheared 27¾ in. (705 mm) above the ground line. The upper portion of both posts remained attached to the sign panels and the posts were minimally damaged.

Both embedded stubs bent at the ground line in the downstream direction, and the bending deformed the U-channel stub cross sections to a width of 4¾ in. (121 mm). Cracking along the centerline of both U-channel stubs was visible beginning at the ground line and extending up 3¾ in. (95 mm), stopping below the bolted connection to the post. The height of the remaining stub in its deformed state was greater than 4 in. (102 mm) above the ground line. Removing the stubs from the ground revealed that the left post had fractured below the ground line. Both stubs had additional centerline cracking along the embedded portion of the stub, extending approximately 6 in. below the ground line. The bolted connections between the embedded stubs and the U-channel posts remained intact. On the right post, 11-in. (279 mm) long contact marks started at the sheared top and extended down. Contact marks on the left edge of the left post started 21¾ in. (552 mm) from the sheared top and extended down. Additional contact marks on the right edge of the left post started 22¾ in. (578 mm) from the sheared top and extended down.

Figure 38. System Damage, Test No. MOS-5

Figure 39. System Damage, Sign Panels, Test No. MOS-5

Figure 40. System Damage, U-Channel Posts, Test No. MOS-5

Figure 41. System Damage, U-Channel Posts, Test No. MOS-5

Figure 42. System Damage, Embedded Stubs, Test No. MOS-5

5.5 Vehicle Damage

The damage to the vehicle was minimal, as shown in Figures 43 and 44. The maximum occupant compartment intrusions are listed in Table 5 along with the intrusion limits established in MASH 2016 for various areas of the occupant compartment. Complete occupant compartment and vehicle deformations and the corresponding locations are provided in Appendix D. MASH 2016 defines intrusion or deformation as the occupant compartment being deformed and reduced in size with no observed penetration. There were no penetrations into the occupant compartment and none of the established MASH 2016 deformation limits were violated. Outward deformations, which are denoted as negative numbers in Appendix D are not considered crush toward the occupant and are not evaluated by MASH 2016 criteria.

The majority of damage was concentrated on the front of the vehicle where the impact occurred. The grille was cracked on both sides of the vehicle and was fractured on the left side. The front bumper was dented and bent downward. The hood of the vehicle was slightly ajar. Scrapes were observed along the undercarriage. The lower control arms and muffler were slightly dented. The roof was slightly dented. No damage was observed to the sides of the vehicle, and the windshield and windows remained intact.

Figure 43. Vehicle Damage, Test No. MOS-5

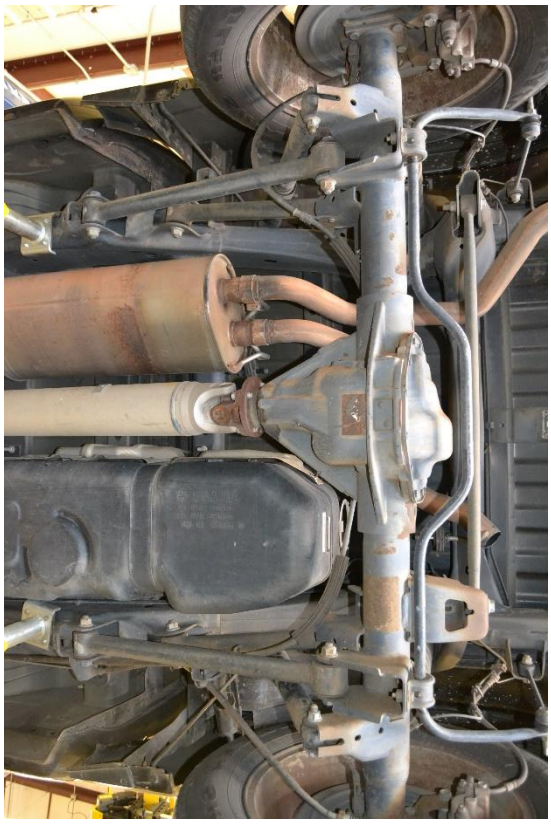


Figure 44. Vehicle Undercarriage Damage, Test No. MOS-5

Table 5. Maximum Occupant Compartment Intrusion by Location, Test No. MOS-5

LOCATION	MAXIMUM INTRUSION in. (mm)	MASH 2016 ALLOWABLE INTRUSION in. (mm)
Wheel Well & Toe Pan	0.2 (5)	≤ 9 (229)
Floor Pan & Transmission Tunnel	0.2 (5)	≤ 12 (305)
A-Pillar	0.2 (5)	≤ 5 (127)
A-Pillar (Lateral)	0.0 (0)	≤ 3 (76)
B-Pillar	0.2 (5)	≤ 5 (127)
B-Pillar (Lateral)	0.0 (0)	≤ 3 (76)
Side Front Panel (in Front of A-Pillar)	0.0 (0)	≤ 12 (305)
Side Door (Above Seat)	0.0 (0)	≤ 9 (229)
Side Door (Below Seat)	0.0 (0)	≤ 12 (305)
Roof	0.1 (3)	≤ 4 (102)
Windshield	0.0 (0)	≤ 3 (76)
Side Window	Intact	No shattering resulting from contact with structural member of test article
Dash	0.2 (5)	N/A

N/A – No MASH 2016 criteria exist for this location

5.6 Occupant Risk

The calculated occupant impact velocities (OIVs) and maximum 0.010-sec average occupant ridedown accelerations (ORAs) in both the longitudinal and lateral directions, as determined from the accelerometer data, are shown in Table 6. The impulse on the vehicle was relatively small and of short duration. As a result, *x* and *y* in the flail-space model were less than 2 ft and 1 ft, respectively, during the period when the vehicle was in contact with the system. As specified in Section A5.2.2 of MASH 2016 in such cases, it is recommended that OIV be set equal to the vehicle's change in velocity during contact with the test article, or parts thereof. If parts of the test article remain in contact with the vehicle after impact, the vehicle's change in velocity should be computed at the time the vehicle clears the footing or foundation of the test article. For test no. MOS-5, OIV was reported as the vehicle's change in velocity at 0.5 sec after impact, at which point the vehicle had cleared the test article foundation and was no longer in contact with any portion of the test article. The OIVs were within suggested limits, as provided in MASH 2016, and ORA values were not applicable. The calculated ASI values are also shown in Table 6. THIV and PHD values were not applicable. The recorded data from the accelerometers and the rate transducers are shown graphically in Appendix E.

Table 6. Summary of OIV, ORA, THIV, PHD, and ASI Values, Test No. MOS-5

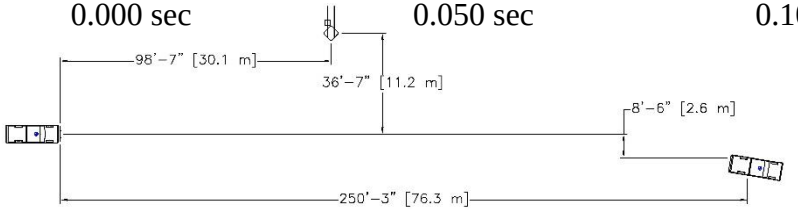
Evaluation Criteria		Transducer		MASH 2016 Limits
		SLICE-1	SLICE-2 (primary)	
OIV ft/s (m/s)	Longitudinal	-2.17 (-0.66)	-2.15 (-0.65)	±16 (4.9)
	Lateral	-1.03 (-0.31)	-1.11 (-0.34)	not required
ORA g's	Longitudinal	N/A	N/A	±20.49
	Lateral	N/A	N/A	±20.49
MAX. ANGULAR DISPL. deg.	Roll	1.5	-1.4	±75
	Pitch	0.8	0.8	±75
	Yaw	-1.0	-1.1	not required
THIV ft/s (m/s)		N/A	N/A	not required
PHD g's		N/A	N/A	not required
ASI		0.12	0.11	not required

Note: The vehicle cleared the test article foundation at 0.400 sec after impact for test no. MOS-5, which was used to determine vehicle change in velocity, denoted as OIV.

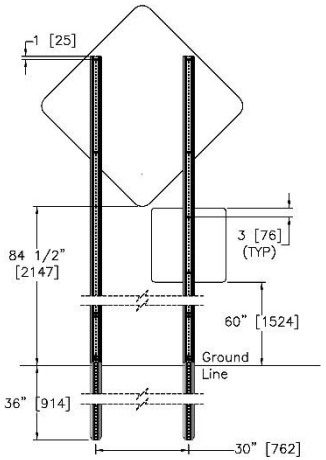
N/A = Not Applicable

5.7 Discussion

The analysis of the test results for test no. MOS-5 showed that the system readily activated in a predictable manner via post fracture and allowed the 2270P vehicle to continue travelling without any major obstruction of the windshield. A summary of the test results and sequential photographs are shown in Figure 45. Detached elements, fragments, or other debris from the test article did not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or work-zone personnel. Deformations of, or intrusions into, the occupant compartment that could have caused serious injury did not occur. Vehicle roll, pitch, and yaw angular displacements, as shown in Appendix E, were deemed acceptable because they did not adversely influence occupant risk nor cause rollover. After impact, the vehicle traversed the foundation and continued forward until it stopped downstream from the system. Therefore, test no. MOS-5 was determined to be acceptable according to the MASH 2016 safety performance criteria for test designation no. 3-62.



- Test Agency ..... MwRSF
- Test Number MOS-5
- Date 5/15/2019
- MASH 2016 Test Designation No. 3-62
- Test Article ..... Dual-Post, U-Channel Sign Support
- Key Component – Upper Sign
  - Size ..... 48 in. x 48 in. (1,219 mm x 1,219 mm)
  - Thickness ..... 0.08 in. (2 mm)
  - Height to Bottom of Sign ..... 7 ft (2.1 m)
- Key Component – Lower Sign
  - Size ..... 24 in. x 24 in. (610 mm x 610 mm)
  - Thickness ..... 0.08 in. (2 mm)
  - Height to Bottom of Sign ..... 5 ft (1.5 m)
- Key Component – U-Channel Posts
  - Weight ..... 3.0 lb/ft (4.5 kg/m)
  - Length ..... 132 in (3,353 mm)
- Key Component – U-Channel Stub
  - Weight ..... 3.0 lb/ft (4.5 kg/m)
  - Length ..... 54 in. (1,372 mm)
- Soil Type ..... Well-Graded Gravel
- Vehicle Make /Model ..... 2011 Dodge Ram Crew Cab
  - Curb ..... 5,302 lb (2,405 kg)
  - Test Inertial ..... 5,026 lb (2,280 kg)
  - Gross Static ..... 5,191 lb (2,355 kg)
- Impact Conditions
  - Speed ..... 62.7 mph (100.9 km/h)
  - Angle ..... 0 degrees
  - Impact Location ..... Centerline of front bumper
- Kinetic Energy ..... 661.4 kip-ft (896.7 kJ) ≥ 594 kip-ft (806 kJ) limit from MASH 2016
- Exit Box Criterion ..... N/A
- Vehicle Stability ..... Satisfactory
- Vehicle Stopping Distance ..... 250 ft – 3 in. (76.3 m) longitudinally
  8 ft – 6 in. (2.6 m) laterally to the right



- Vehicle Damage ..... Minimal
  - VDS [10] 12-FC-1
  - CDC [11] 12-FCEN-1
  - Maximum Interior Deformation ..... 0.2 in. (5 mm)
- Test Article Damage ..... Severe
- Transducer Data

Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-1	SLICE-2 (primary)	
OIV ft/s (m/s)	Longitudinal	-2.17 (-0.66)	-2.15 (-0.65)	±16 (4.9)
	Lateral	-1.03 (-0.31)	-1.11 (-0.34)	not required
ORA g's	Longitudinal	N/A	N/A	±20.49
	Lateral	N/A	N/A	±20.49
MAX ANGULAR DISP. deg.	Roll	1.5	-1.4	±75
	Pitch	0.8	0.8	±75
	Yaw	-1.0	-1.1	not required
THIV – ft/s (m/s)		N/A	N/A	not required
PHD – g's		N/A	N/A	not required
ASI		0.12	0.11	not required

N/A – Not applicable

Figure 45. Summary of Test Results and Sequential Photographs, Test No. MOS-5

6 FULL-SCALE CRASH TEST NO. MOS-6

6.1 Static Soil Test

Before full-scale crash test no. MOS-6 was conducted, the strength of the foundation soil was evaluated with a static test, as described in MASH 2016. The static test results, as shown in Appendix C, demonstrated a soil resistance above the baseline test limits. Thus, the soil provided adequate strength, and full-scale crash testing could be conducted on the sign support system.

6.2 Weather Conditions

Test no. MOS-6 was conducted on June 12, 2019 at approximately 1:30 p.m. The weather conditions as per the National Oceanic and Atmospheric Administration (station 14939/LNK) were reported and are shown in Table 7.

Table 7. Weather Conditions, Test No. MOS-6

Temperature	73°F
Humidity	32%
Wind Speed	21 mph
Wind Direction	360° from True North
Sky Conditions	Sunny
Visibility	10.0 Statute Miles
Pavement Surface	Dry
Previous 3-Day Precipitation	0.35 in.
Previous 7-Day Precipitation	0.35 in.

6.3 Test Description

Initial vehicle impact was to occur with the vehicle centerline aligned with the centerline of the system, as shown in Figure 46. The 2,420-lb (1,098-kg) small car impacted the U-channel sign system oriented at 0 degrees, or head-on to the vehicle, at a speed of 63.3 mph (101.9 km/h). The vehicle came to rest 274 ft – 7 in. (83.7 m) longitudinally downstream and 18 ft (5.5 m) laterally to the right of the centerline after brakes were applied. A detailed description of the sequential impact events is contained in Table 8. Sequential photographs are shown in Figures 47 and 48. Documentary photographs of the crash test are shown in Figures 49 through 51. The vehicle trajectory and final position are shown in Figure 52.

Table 8. Sequential Description of Impact Events, Test No. MOS-6

TIME (sec)	EVENT
0.000	Vehicle's front bumper contacted left and right posts.
0.002	Vehicle's front bumper deformed. Lower half of system deflected downstream.
0.004	Vehicle's hood contacted left and right posts.
0.006	Vehicle's hood deformed. Upper half of system deflected downstream. Left post fractured. Soil heave formed on the downstream side of both posts.
0.008	Vehicle's hood flexed. Right post fractured. Both embedded stubs bent downstream.
0.024	Vehicle pitched upward.
0.032	Vehicle yawed counterclockwise.
0.042	Detached portion of system became airborne.
0.064	Both sign post stubs contacted vehicle's undercarriage.
0.146	Upper sign contacted vehicle's left C-pillar.
0.148	Upper sign contacted vehicle's trunk lid.
0.150	Vehicle's trunk lid deformed.
0.158	Vehicle rolled clockwise.
0.188	System lost contact with vehicle.
0.198	Vehicle pitched downward.
0.292	Vehicle rolled counterclockwise.
0.574	Vehicle pitched upward.
0.914	Vehicle pitched downward.
1.016	Detached portion of system contacted ground.

Figure 46. Impact Location, Test No. MOS-6

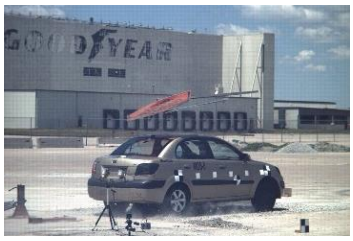

0.000 sec

0.000 sec

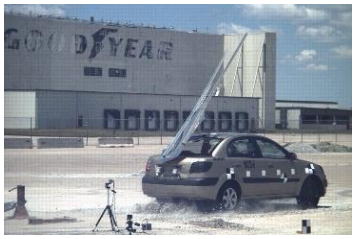

0.050 sec

0.050 sec


0.100 sec


0.100 sec


0.150 sec


0.150 sec


0.200 sec


0.200 sec


0.250 sec


0.250 sec

Figure 47. Sequential Photographs, Test No. MOS-6


0.000 sec


0.000 sec


0.050 sec


0.050 sec


0.100 sec


0.100 sec

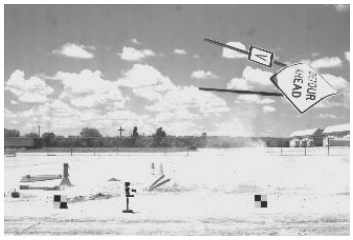
0.200 sec


0.200 sec

0.300 sec


0.300 sec

0.400 sec



0.400 sec

Figure 48. Additional Sequential Photographs, Test No. MOS-6

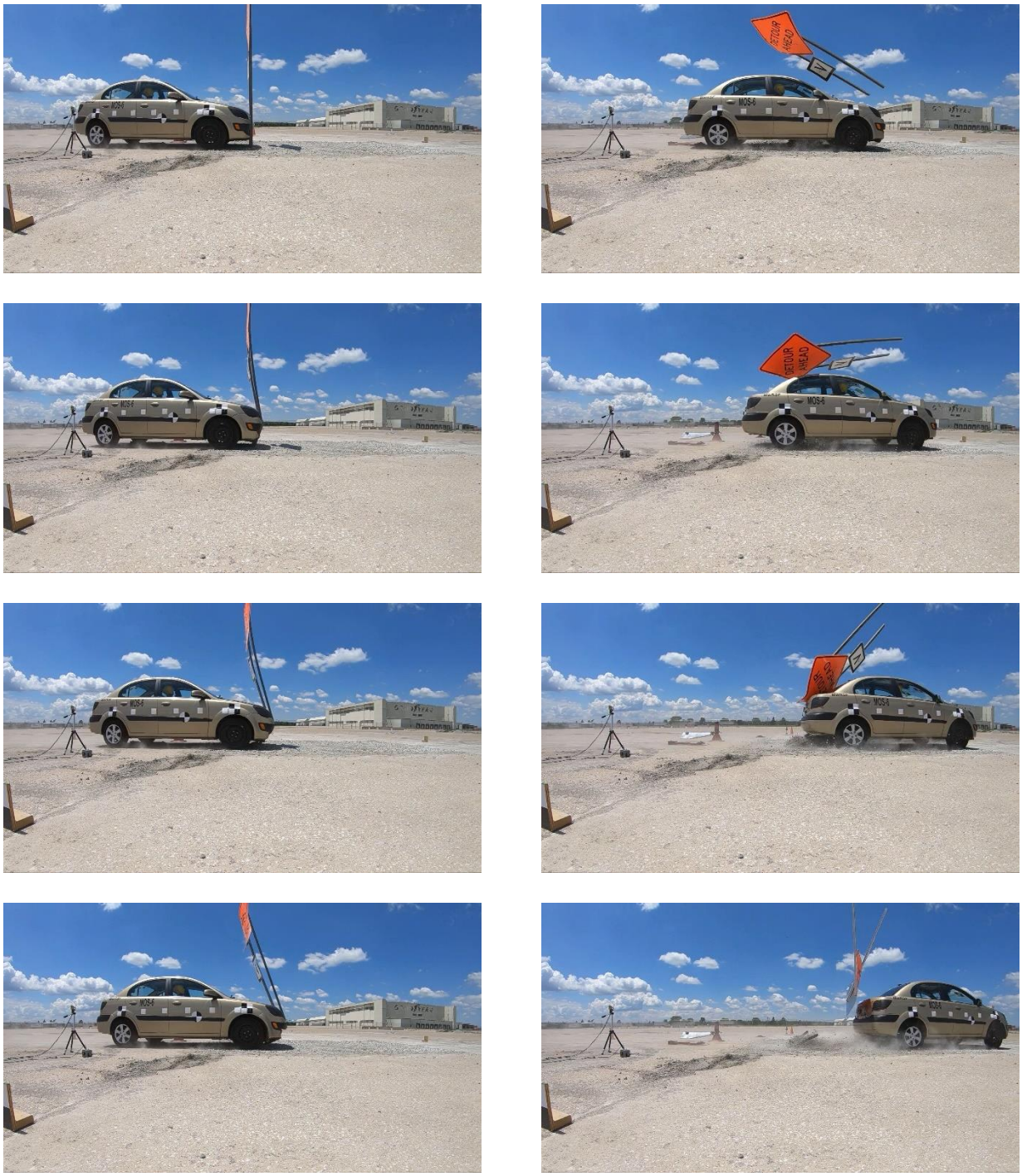


Figure 49. Documentary Photographs, Test No. MOS-6

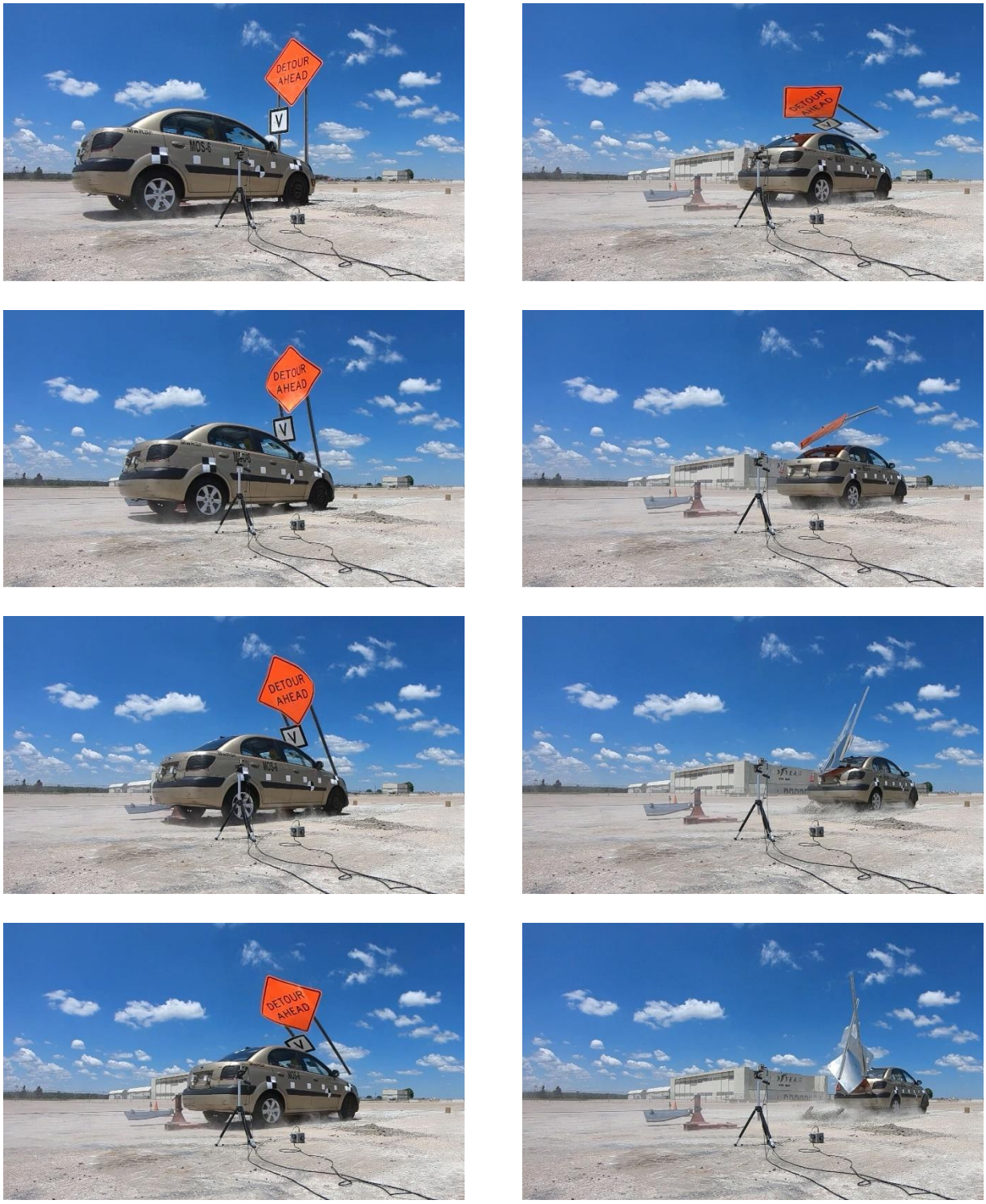


Figure 50. Documentary Photographs, Test No. MOS-6

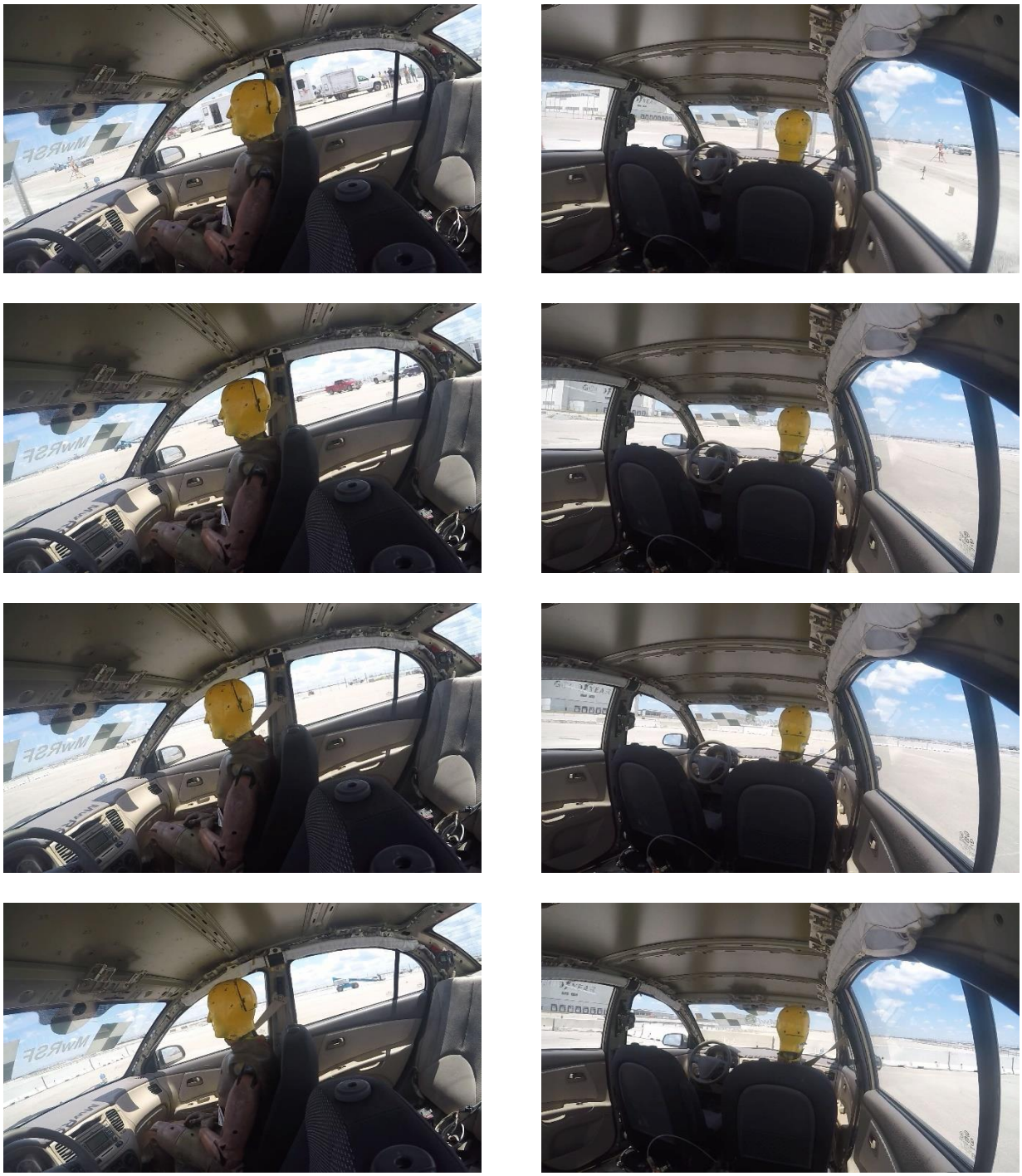


Figure 51. Documentary Photographs, Test No. MOS-6

Figure 52. Vehicle Final Position and Trajectory Marks, Test No. MOS-6

6.4 System Damage

Damage to the system was severe, as shown Figures 53 through 57. System damage consisted of contact marks, deformation, and fracture of the sign posts as well as deformation and cracking of the upper sign panel.

The left post sheared 23 in. (584 mm) above the ground line while the right post sheared 25½ in. (648 mm) above the ground line. The portion of the system above the shear plane became airborne, contacted the roof of the test vehicle, and landed upstream from the original system position. The sign panels remained attached to the posts. All four corners of the upper sign were bent slightly out of plane and a crack extended inward approximately 4 in. (102 mm) from the upper-right edge of the panel.

Both embedded stubs bent at the ground line in the downstream direction and the bending deformed the U-channel stub cross sections, increasing the section width to 5⅞ in. (149 mm) at the left stub and 5 in. (127 mm) at the right stub. Cracking along the centerline of both U-channel stubs was visible beginning at the ground line, extending 3½ in. (89 mm) up the left stub and 5½ in. (140 mm) up the right stub. In both stubs, the cracking stopped below the bolted connection to the post. The height of the remaining stub in its deformed state was greater than 4 in. (102 mm) above the ground line. Removing the stubs from the ground revealed that both stubs had additional centerline cracking along the embedded portion of the stub. The bolted connections between the embedded stubs and the U-channel posts remained intact, however, the left post had a centerline crack beginning at the bottom of the post and extending up approximately 4 in. (102 mm). The left post had contact marks on the front face starting 9 in. (229 mm) from the ground and measuring 13 in. (330 mm) long. The right post was had contact marks starting 12 in. (305 mm) above the ground that measured 12 in. (305 mm) in length.

Figure 53. System Damage, Test No. MOS-6

Figure 54. System Damage, Sign Panels, Test No. MOS-6

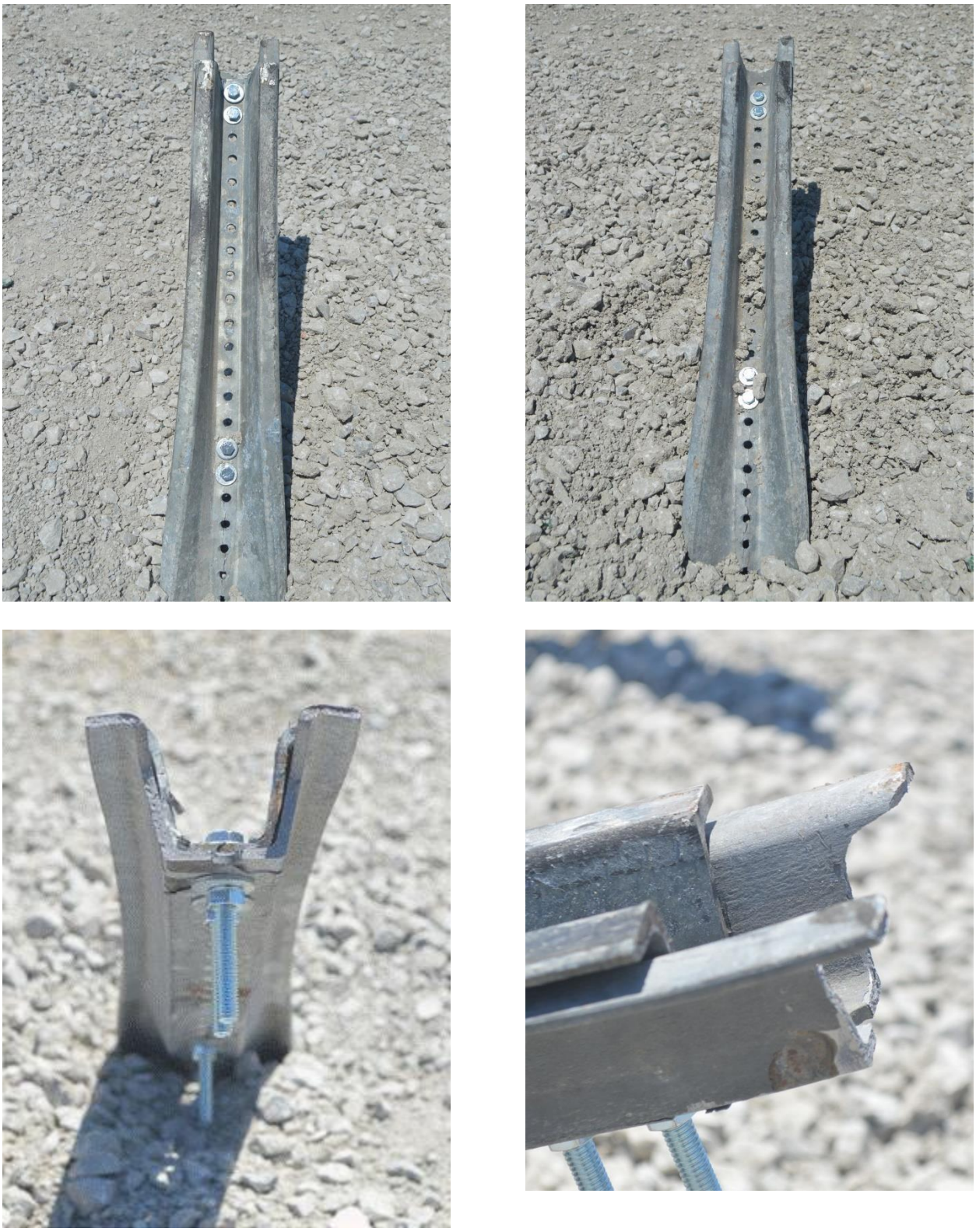


Figure 55. System Damage, U-Channel Posts, Test No. MOS-6

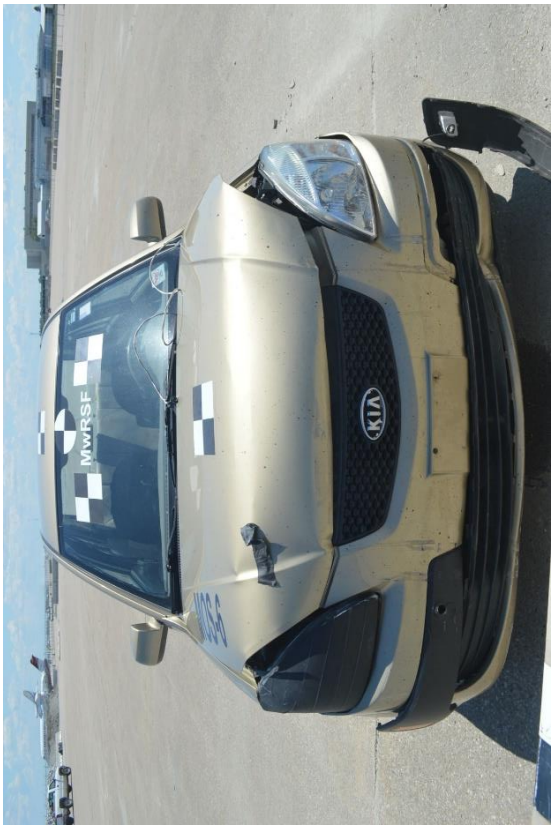
Figure 56. System Damage, U-Channel Posts, Test No. MOS-6

Figure 57. System Damage, Embedded Stubs, Test No. MOS-6

6.5 Vehicle Damage

The damage to the vehicle was minimal, as shown in Figure 58. The maximum occupant compartment intrusions are listed in Table 9 along with the intrusion limits established in MASH 2016 for various areas of the occupant compartment. Complete occupant compartment and vehicle deformations and the corresponding locations are provided in Appendix D. MASH 2016 defines intrusion or deformation as the occupant compartment being deformed and reduced in size with no observed penetration. There were no penetrations into the occupant compartment and none of the established MASH 2016 deformation limits were violated. Outward deformations, which are denoted as negative numbers in Appendix D are not considered crush toward the occupant and are not evaluated by MASH 2016 criteria.

The majority of the damage was concentrated on the front of the vehicle where the impact occurred. The grille and hood were crushed inward. The left-side running light disengaged from the vehicle. The bumper insert disengaged from the top mounts. The right fender deformed outward at the middle. The left side of the trunk was crushed downward into the trunk compartment. The right frame horn was dented inward toward the engine compartment. The floor pan and gas tank experienced minor scraping. The windshield and side windows remained intact.



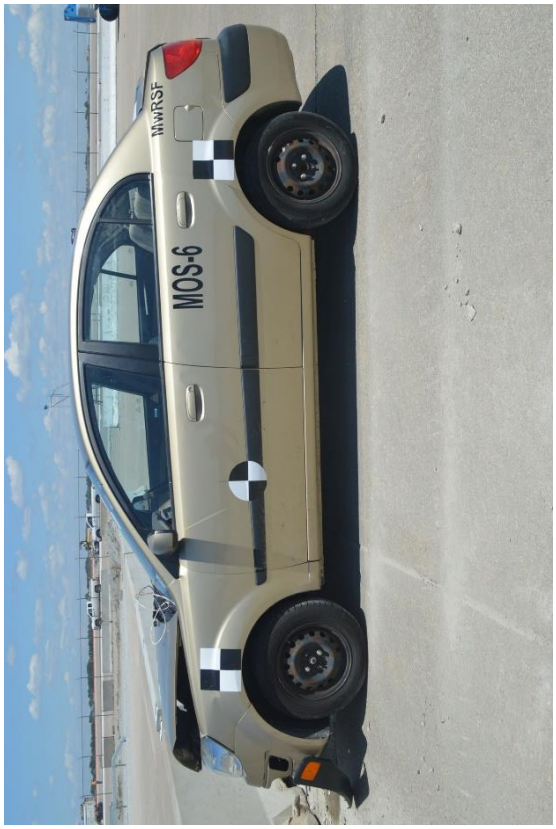


Figure 58. Vehicle Damage, Test No. MOS-6

Figure 59. Vehicle Damage, Test No. MOS-6

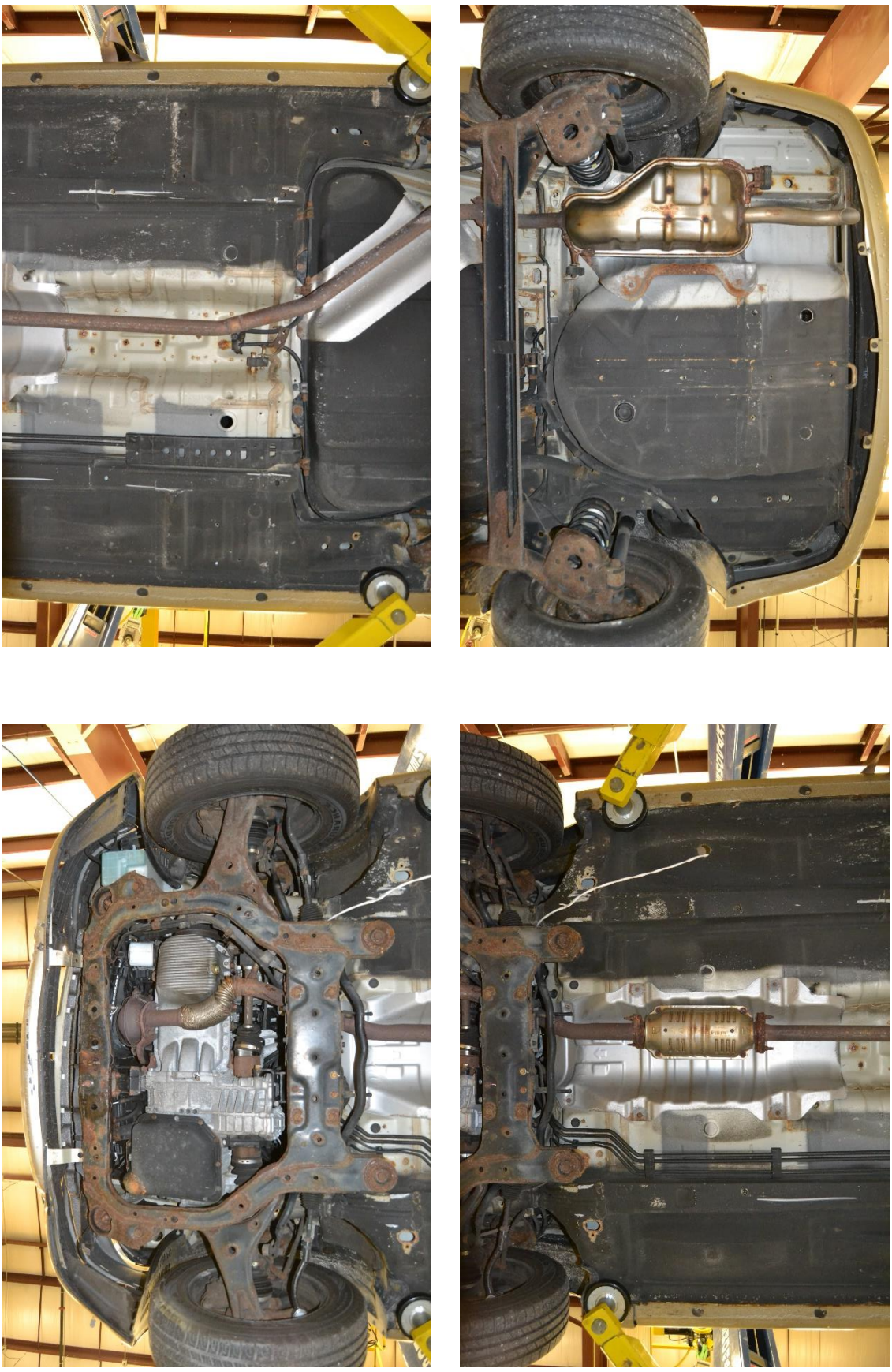


Figure 60. Vehicle Undercarriage Damage, Test No. MOS-6

Table 9. Maximum Occupant Compartment Intrusion by Location, Test No. MOS-6

LOCATION	MAXIMUM INTRUSION in. (mm)	MASH 2016 ALLOWABLE INTRUSION in. (mm)
Wheel Well & Toe Pan	0.7 (18)	≤ 9 (229)
Floor Pan & Transmission Tunnel	0.5 (13)	≤ 12 (305)
A-Pillar	0.9 (23)	≤ 5 (127)
A-Pillar (Lateral)	0.0 (0)	≤ 3 (76)
B-Pillar	0.3 (8)	≤ 5 (127)
B-Pillar (Lateral)	0.1 (3)	≤ 3 (76)
Side Front Panel (in Front of A-Pillar)	0.1 (3)	≤ 12 (305)
Side Door (Above Seat)	0.0 (0)	≤ 9 (229)
Side Door (Below Seat)	0.0 (0)	≤ 12 (305)
Roof	0.4 (10)	≤ 4 (102)
Windshield	0.0 (0)	≤ 3 (76)
Side Window	Intact	No shattering resulting from contact with structural member of test article
Dash	0.9 (23)	N/A

N/A – No MASH 2016 criteria exist for this location

6.6 Occupant Risk

The calculated occupant impact velocities (OIVs) and maximum 0.010-sec average occupant ridedown accelerations (ORAs) in both the longitudinal and lateral directions, as determined from the accelerometer data, are shown in Table 10. The impulse on the vehicle was relatively small and of short duration. As a result, *x* and *y* in the flail-space model were less than 2 ft and 1 ft, respectively, during the period when the vehicle was in contact with the system. As specified in Section A5.2.2 of MASH 2016 in such cases, it is recommended that OIV be set equal to the vehicle's change in velocity during contact with the test article, or parts thereof. If parts of the test article remain in contact with the vehicle after impact, the vehicle's change in velocity should be computed at the time the vehicle clears the footing or foundation of the test article. For test no. MOS-6, OIV was reported as the vehicle's change in velocity at 0.3 sec after impact, at which point the vehicle had cleared the test article foundation and was no longer in contact with any portion of the test article. The OIVs were within suggested limits, as provided in MASH 2016, and ORA values were not applicable. The calculated ASI values are also shown in Table 10. THIV and PHD values were not applicable. The recorded data from the accelerometers and the rate transducers are shown graphically in Appendix F.

Table 10. Summary of OIV, ORA, THIV, PHD, and ASI Values, Test No. MOS-6

Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-1 (primary)	SLICE-2	
OIV ft/s (m/s)	Longitudinal	-3.93 (-1.97)	-3.95 (-1.20)	±16 (4.9)
	Lateral	-0.19 (-0.06)	-0.41 (-0.12)	not required
ORA g's	Longitudinal	N/A	N/A	±20.49
	Lateral	N/A	N/A	±20.49
MAX. ANGULAR DISPL. deg.	Roll	1.1	1.1	±75
	Pitch	1.8	1.9	±75
	Yaw	-0.5	-0.7	not required
THIV ft/s (m/s)		N/A	N/A	not required
PHD g's		N/A	N/A	not required
ASI		0.16	0.15	not required

Note: The vehicle cleared the test article foundation at 0.300 sec after impact for test no. MOS-6, which was used to determine vehicle change in velocity, denoted as OIV

N/A = Not Applicable

6.7 Discussion

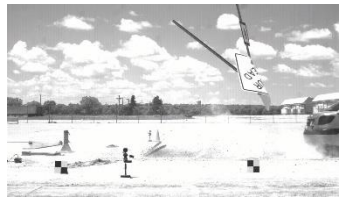
The analysis of the test results for test no. MOS-6 showed that the system readily activated in a predictable manner via post fracture and allowed the 1100C vehicle to continue travelling without any major obstruction of the windshield. A summary of the test results and sequential photographs is shown in Figure 61. Detached elements, fragments, or other debris from the test article did not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or work-zone personnel. Deformations of, or intrusions into, the occupant compartment that could have caused serious injury did not occur. Vehicle roll, pitch, and yaw angular displacements, as shown in Appendix E, were deemed acceptable because they did not adversely influence occupant risk nor cause rollover. After impact, the vehicle traversed the foundation and continued forward until it stopped downstream from the system. Therefore, test no. MOS-6 was determined to be acceptable according to the MASH 2016 safety performance criteria for test designation no. 3-61.

0.000 sec

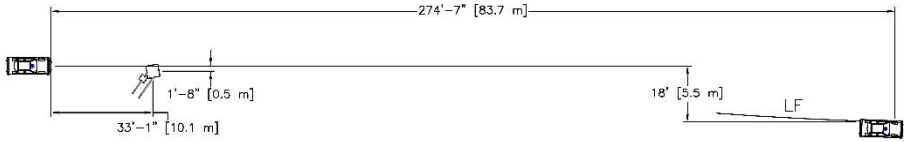
0.050 sec

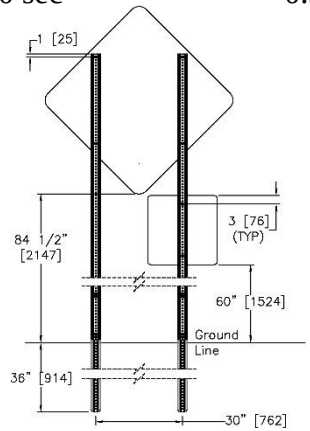
0.100 sec

0.150 sec



0.300 sec





- Test Agency ..... MwRSF
- Test Number MOS-6
- Date 6/12/2019
- MASH 2016 Test Designation No. 3-61
- Test Article ..... Dual Post, U-Channel Sign Support
- Key Component – Upper Sign
  - Size ..... 48 in. x 48 in. (1,219 mm x 1,219 mm)
  - Thickness ..... 0.08 in. (2 mm)
  - Height to Bottom of Sign ..... 7 ft (2.1 m)
- Key Component – Lower Sign
  - Size ..... 24 in. x 24 in. (610 mm x 610 mm)
  - Thickness ..... 0.08 in. (2 mm)
  - Height to Bottom of Sign ..... 5 ft (1.5 m)
- Key Component – U-Channel Posts
  - Weight ..... 3.0 lb/ft (4.5 kg/m)
  - Length ..... 132 in (3,353 mm)
- Key Component – U-Channel Stub
  - Weight ..... 3.0 lb/ft (4.5 kg/m)
  - Length ..... 54 in. (1,372 mm)
- Soil Type ..... Well-Graded Gravel
- Vehicle Make /Model ..... 2009 Kia Rio
  - Curb ..... 2,510 lb (1,139 kg)
  - Test Inertial ..... 2,420 lb (1,098 kg)
  - Gross Static ..... 2,584 lb (1,172 kg)
- Impact Conditions
  - Speed ..... 63.3 mph (101.9 km/h)
  - Angle ..... 0 degrees
  - Impact Location ..... Centerline of front bumper
- Kinetic Energy ..... 324.2 kip-ft (439.6 kJ) ≥ 288 kip-ft (390 kJ) limit from MASH 2016
- Exit Box Criterion ..... N/A
- Vehicle Stability ..... Satisfactory
- Vehicle Stopping Distance ..... 274 ft – 7 in. (83.7 m) longitudinally
  18 ft (5.5 m) laterally to the right
- Vehicle Damage ..... Moderate
  - VDS [10] 12-FC-2
  - CDC [11] 12-FCEN-1
  - Maximum Interior Deformation ..... 0.9 in. (23 mm)
- Test Article Damage ..... Severe
- Transducer Data

Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-1 (primary)	SLICE-2	
OIV ft/s (m/s)	Longitudinal	-3.93 (-1.97)	-3.95 (-1.20)	±16 (4.9)
	Lateral	-0.19 (-0.06)	-0.41 (-0.12)	not required
ORA g's	Longitudinal	N/A	N/A	±20.49
	Lateral	N/A	N/A	±20.49
MAX ANGULAR DISP. deg.	Roll	1.1	1.1	±75
	Pitch	1.8	1.9	±75
	Yaw	-0.5	-0.7	not required
THIV – ft/s (m/s)		N/A	N/A	not required
PHD – g's		N/A	N/A	not required
ASI		0.16	0.15	not required

N/A – Not applicable

Figure 61. Summary of Test Results and Sequential Photographs, Test No. MOS-6

7 FULL-SCALE CRASH TEST NO. MOS-7

7.1 Static Soil Test

Before full-scale crash test no. MOS-7 was conducted, the strength of the foundation soil was evaluated with a static test, as described in MASH 2016. The static test results, as shown in Appendix C, demonstrated a soil resistance above the baseline test limits. Thus, the soil provided adequate strength, and full-scale crash testing could be conducted on the sign support system.

7.2 Weather Conditions

Test no. MOS-7 was conducted on June 28, 2019 at approximately 2:00 p.m. The weather conditions as per the National Oceanic and Atmospheric Administration (station 14939/LNK) were reported and are shown in Table 11.

Table 11. Weather Conditions, Test No. MOS-7

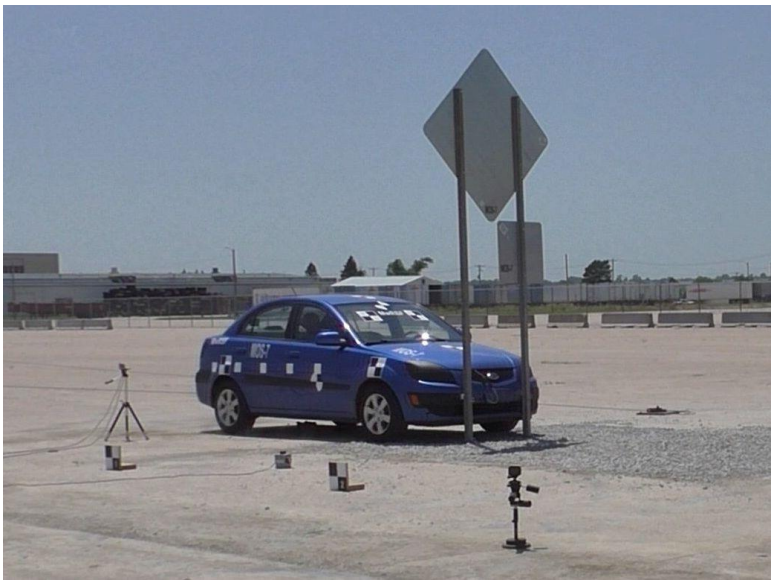
Temperature	93°F
Humidity	54%
Wind Speed	8 mph
Wind Direction	230° from True North
Sky Conditions	Sunny
Visibility	10.0 Statute Miles
Pavement Surface	Dry
Previous 3-Day Precipitation	0.40 in.
Previous 7-Day Precipitation	1.88 in.

7.3 Test Description

Initial vehicle impact was to occur with the vehicle centerline aligned with the centerline of the system, as shown in Figure 62. The 2,435-lb (1,104-kg) small car impacted the U-channel sign system oriented at 0 degrees, or head-on to the vehicle, at a speed of 20.0 mph (32.2 km/h). The vehicle came to rest 44 ft – 7 in. (13.6 m) longitudinally downstream and 5 ft – 7 in. (1.7 m) laterally to the right of the centerline after brakes were applied. A detailed description of the sequential impact events is contained in Table 12. Sequential photographs are shown in Figures 63 and 64. Documentary photographs of the crash test are shown in Figures 65 through 67. The vehicle trajectory and final position are shown in Figure 68.

Table 12. Sequential Description of Impact Events, Test No. MOS-7

TIME (sec)	EVENT
0.000	Vehicle's front bumper contacted left and right posts.
0.006	Vehicle's front bumper deformed.
0.008	Left and right posts bent downstream.
0.012	Lower sign deformed due to post flexure.
0.014	Upper sign deformed due to post movements.
0.016	Both posts deflected downstream.
0.062	Vehicle's hood deformed.
0.176	Vehicle's right-front tire became airborne.
0.182	Vehicle's left-front tire became airborne.
0.328	Vehicle pitched upward.
0.356	Vehicle pitched downward.
0.358	Top of sign contacted ground as vehicle began to traverse over system.
0.462	Vehicle's right-front tire regained contact with ground.
0.470	Vehicle's undercarriage contacted the system. Vehicle's left-front tire regained contact with ground.
0.540	Bottom corner of the upper sign bent.
2.474	System lost contact with vehicle.



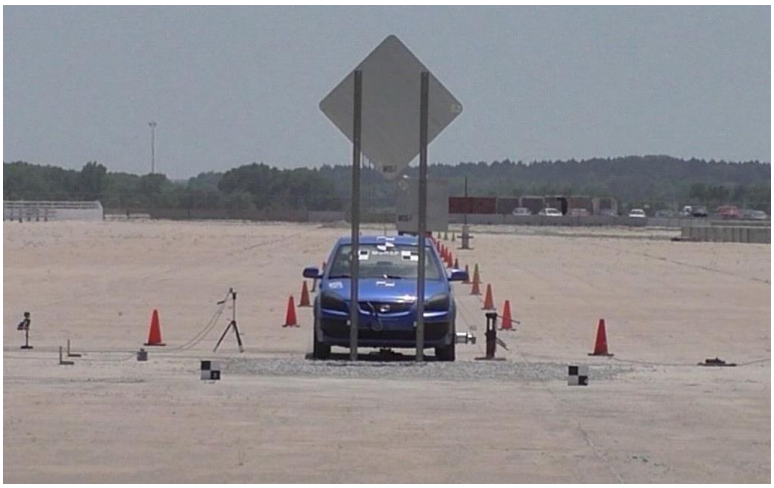


Figure 62. Impact Location, Test No. MOS-7


0.000 sec


0.000 sec


0.100 sec


0.100 sec


0.250 sec


0.250 sec


0.600 sec


0.600 sec


1.600 sec


1.600 sec


2.450 sec


2.450 sec

Figure 63. Sequential Photographs, Test No. MOS-7


0.000 sec


0.000 sec


0.150 sec


0.150 sec


0.300 sec


0.300 sec


0.500 sec


0.500 sec


1.000 sec


1.000 sec


1.500 sec


1.500 sec

Figure 64. Additional Sequential Photographs, Test No. MOS-7

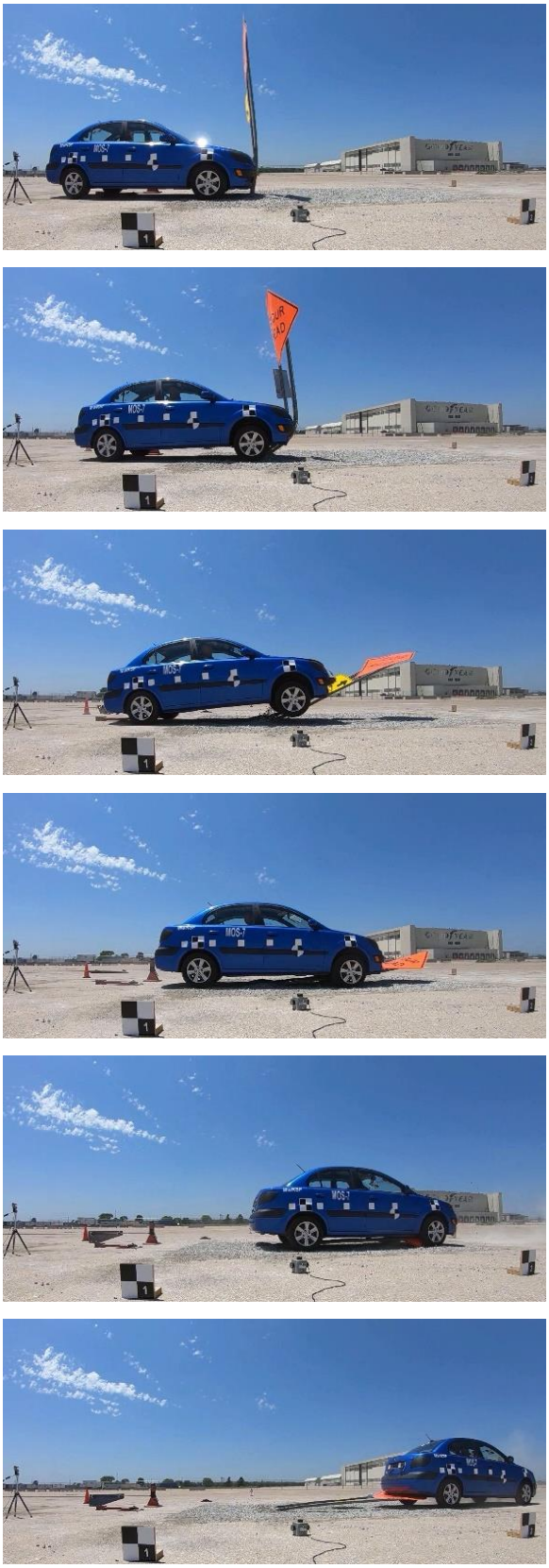


Figure 65. Documentary Photographs, Test No. MOS-7

Figure 66. Documentary Photographs, Test No. MOS-7

Figure 67. Documentary Photographs, Test No. MOS-7

Figure 68. Vehicle Final Position and Trajectory Marks, Test No. MOS-7

7.4 System Damage

Damage to the system was severe, as shown in Figures 69 through 72. System damage consisted of contact marks on the posts, bending of the posts, and bending of the upper sign panel.

The left and right posts bent downstream at the ground line and the bolted connections to the embedded stubs remained intact. The sign panels remained attached to the posts, and the bottom edge of the upper sign panel was bent. The system in its deformed state was greater than 4 in. (102 mm) above the ground line. Removing the embedded stubs from the ground revealed cracking along the centerline of the U-channel that extended several inches below the ground line. In addition, both embedded stubs were bent.

On the left post, a 21½-in. (546-mm) long contact mark on the left flange and a 39-½ in. (1,003-mm) long contact mark on the right flange started 10 in. (254 mm) and 7½ in. (191 mm) from the ground line, respectively. Four contact marks were found on the right post. The left flange had 37½-in. (953-mm) and 24-in. (610-mmm) long contact marks that started 10½ in. (267 mm) and 53 in. (1,346 mm) from the ground line, respectively. The right flange had a 24-in. (610-mm) long contact mark that started 9 in. (229 mm) from the ground line and a 26½-in. (673-mm) long contact mark that started 66 in. (1,676 mm) from the ground line. Over the lower portion of the system, both posts exhibited lateral deformation toward the centerline of the system and deformation of the left U-channel flange.

Figure 69. System Damage, Test No. MOS-7

Figure 70. System Damage, Sign Panels, Test No. MOS-7

Figure 71. System Damage, U-Channel Posts, Test No. MOS-7

Figure 72. System Damage, Embedded Stubs, Test No. MOS-7

7.5 Vehicle Damage

The damage to the vehicle was minimal, as shown in Figure 73. The maximum occupant compartment intrusions are listed in Table 13 along with the intrusion limits established in MASH 2016 for various areas of the occupant compartment. Complete occupant compartment and vehicle deformations and the corresponding locations are provided in Appendix D. MASH 2016 defines intrusion or deformation as the occupant compartment being deformed and reduced in size with no observed penetration. There were no penetrations into the occupant compartment and none of the established MASH 2016 deformation limits were violated. Outward deformations, which are denoted as negative numbers in Appendix D are not considered crush toward the occupant and are not evaluated by MASH 2016 criteria.

The majority of the damage was concentrated on the front of the vehicle where the impact occurred, and on the undercarriage of the vehicle where the system contacted the vehicle. The bumper was scraped and cracked at the two points where the bumper impacted the posts of the system. Scraping occurred along a majority of the undercarriage of the vehicle. The windshield, windows, and remainder of the vehicle remained undamaged.

Figure 73. Vehicle Damage, Test No. MOS-7

Figure 74. Vehicle Damage, Test No. MOS-7

Figure 75. Vehicle Undercarriage Damage, Test No. MOS-7

Table 13. Maximum Occupant Compartment Intrusion by Location, Test No. MOS-7

LOCATION	MAXIMUM INTRUSION in. (mm)	MASH 2016 ALLOWABLE INTRUSION in. (mm)
Wheel Well & Toe Pan	0.1 (3)	≤ 9 (229)
Floor Pan & Transmission Tunnel	0.1 (3)	≤ 12 (305)
A-Pillar	0.9 (23)	≤ 5 (127)
A-Pillar (Lateral)	0.3 (8)	≤ 3 (76)
B-Pillar	0.2 (5)	≤ 5 (127)
B-Pillar (Lateral)	0.2 (5)	≤ 3 (76)
Side Front Panel (in Front of A-Pillar)	0.3 (8)	≤ 12 (305)
Side Door (Above Seat)	0.2 (5)	≤ 9 (229)
Side Door (Below Seat)	0.2 (5)	≤ 12 (305)
Roof	0.2 (5)	≤ 4 (102)
Windshield	0.0 (0)	≤ 3 (76)
Side Window	Intact	No shattering resulting from contact with structural member of test article
Dash	0.4 (10)	N/A

N/A – No MASH 2016 criteria exist for this location

7.6 Occupant Risk

The calculated occupant impact velocities (OIVs) and maximum 0.010-sec average occupant ridedown accelerations (ORAs) in both the longitudinal and lateral directions, as determined from the accelerometer data, are shown in Table 14. The OIVs and ORAs were within suggested limits, as provided in MASH 2016. The calculated THIV, PHD, and ASI values are also shown in Table 14. The recorded data from the accelerometers and the rate transducers are shown graphically in Appendix G.

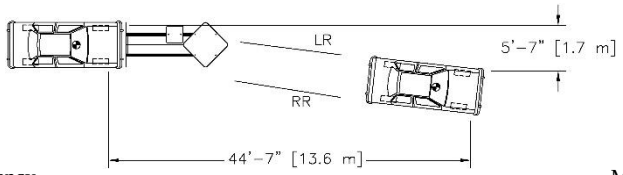
Table 14. Summary of OIV, ORA, THIV, PHD, and ASI Values, Test No. MOS-7

Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-1 (primary)	SLICE-2	
OIV ft/s (m/s)	Longitudinal	-15.03 (-4.58)	-14.90 (-4.54)	±16 (4.9)
	Lateral	-0.07 (-0.02)	0.08 (0.02)	not required
ORA g's	Longitudinal	-1.91	-1.79	±20.49
	Lateral	1.71	1.79	±20.49
MAX. ANGULAR DISPL. deg.	Roll	-0.9	-0.8	±75
	Pitch	5.4	5.6	±75
	Yaw	0.4	-0.2	not required
THIV ft/s (m/s)		15.03 (4.58)	14.90 (4.54)	not required
PHD g's		1.91	1.79	not required
ASI		0.33	0.31	not required

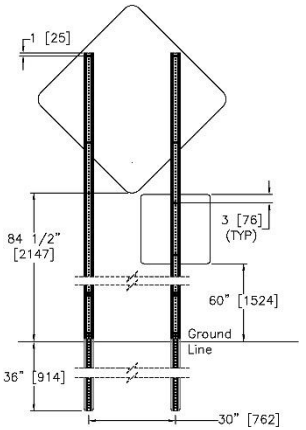
7.7 Discussion

The analysis of the test results for test no. MOS-7 showed that the system readily activated in a predictable manner by deforming to the ground and allowed the 1100C vehicle to continue travelling without any major obstruction of the windshield. A summary of the test results and sequential photographs is shown in Figure 76. Detached elements, fragments, or other debris from the test article did not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or work-zone personnel. Deformations of, or intrusions into, the occupant compartment that could have caused serious injury did not occur. Vehicle roll, pitch, and yaw angular displacements, as shown in Appendix G, were deemed acceptable because they did not adversely influence occupant risk nor cause rollover. After impact, the vehicle traversed the foundation and continued forward until it stopped downstream of the system. Therefore, test no. MOS-7 was determined to be acceptable according to the MASH 2016 safety performance criteria for test designation no. 3-60.

0.000 sec 0.050 sec 0.200 sec 0.500 sec 2.500 sec



- Test Agency ..... MwRSF
- Test Number MOS-7
- Date 6/28/2019
- MASH 2016 Test Designation No. 3-60
- Test Article ..... Dual-Post, U-Channel Sign Support
- Key Component – Upper Sign
  - Size ..... 48 in. x 48 in. (1,219 mm x 1,219 mm)
  - Thickness ..... 0.08 in. (2 mm)
  - Height to Bottom of Sign ..... 7 ft (2.1 m)
- Key Component – Lower Sign
  - Size ..... 24 in. x 24 in. (610 mm x 610 mm)
  - Thickness ..... 0.08 in. (2 mm)
  - Height to Bottom of Sign ..... 5 ft (1.5 m)
- Key Component – U-Channel Posts
  - Weight ..... 3.0 lb/ft (4.5 kg/m)
  - Length ..... 132 in (3,353 mm)
- Key Component – U-Channel Stub
  - Weight ..... 3.0 lb/ft (4.5 kg/m)
  - Length ..... 54 in. (1,372 mm)
- Soil Type ..... Well-Graded Gravel
- Vehicle Make /Model ..... 2009 Kia Rio
  - Curb ..... 2,499 lb (1,134 kg)
  - Test Inertial ..... 2,435 lb (1,104 kg)
  - Gross Static ..... 2,593 lb (1,176 kg)
- Impact Conditions
  - Speed ..... 20.0 mph (32.2 km/h)
  - Angle ..... 0 degrees
  - Impact Location ..... Centerline of front bumper
- Kinetic Energy ..... 32.6 kip-ft (44.2 kJ) ≤ 34 kip-ft (41 kJ) limit from MASH 2016
- Exit Box Criterion ..... N/A
- Vehicle Stability ..... Satisfactory
- Vehicle Stopping Distance ..... 44 ft – 7 in. (13.6 m) longitudinally
  5 ft – 7 in (1.7 m) laterally to the right



- Vehicle Damage ..... Minimal
  - VDS [10] 12-FC-1
  - CDC [11] 12-FCEN-1
  - Maximum Interior Deformation ..... 0.9 in. (23 mm)
- Test Article Damage ..... Severe
- Transducer Data

Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-1 (primary)	SLICE-2	
OIV ft/s (m/s)	Longitudinal	-15.03 (-4.58)	-14.90 (-4.54)	±16 (4.9)
	Lateral	-0.07 (-0.02)	0.08 (0.02)	not required
ORA g's	Longitudinal	-1.91	-1.79	±20.49
	Lateral	1.71	1.79	±20.49
MAX ANGULAR DISP. deg.	Roll	-0.9	-0.8	±75
	Pitch	5.4	5.6	±75
	Yaw	0.4	-0.2	not required
THIV – ft/s (m/s)		15.03 (4.58)	14.90 (4.54)	not required
PHD – g's		1.91	1.79	not required
ASI		0.33	0.31	not required

Figure 76. Summary of Test Results and Sequential Photographs, Test No. MOS-7

8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The objective of this project was to evaluate the dual-post, U-channel sign support system in accordance with MASH 2016 TL-3 criteria. The test article utilized for full-scale crash testing consisted of two signs attached to two U-channel posts. The posts were embedded in the ground using a spliced U-channel configuration. Each crash test was to occur with the centerline of the vehicle aligned with the centerline of the system. A summary of the test evaluation is shown in Table 15.

In test no. MOS-5, the 5,026-lb (2,280-kg) pickup truck impacted the U-channel sign support system oriented at 0 degrees, or head-on to the vehicle, at a speed of 62.7 mph (100.9 km/h), resulting in a kinetic energy of 661.4 kip-ft (896.7 kJ). After impact, the system readily activated in a predictable manner via post fracture and allowed the vehicle to continue travelling without any major obstruction of the windshield. All vehicle decelerations, ORAs, and OIVs fell within the recommended safety limits established in MASH 2016. Therefore, test no. MOS-5 was successful according to the safety performance criteria of MASH 2016 test designation no. 3-62.

In test no. MOS-6, the 2,420-lb (1,098-kg) small car impacted the U-channel sign support system oriented at 0 degrees, or head-on to the vehicle, at a speed of 63.3 mph (101.9 km/h), resulting in a kinetic energy of 324.2 kip-ft (439.6 kJ). After impact, the system readily activated in a predictable manner via post fracture and allowed the vehicle to continue travelling without any major obstruction of the windshield. All vehicle decelerations, ORAs, and OIVs fell within the recommended safety limits established in MASH 2016. Therefore, test no. MOS-6 was successful according to the safety performance criteria of MASH 2016 test designation no. 3-61.

In test no. MOS-7, the 2,435-lb (1,104-kg) small car impacted the U-channel sign support system oriented at 0 degrees, or head-on to the vehicle, at a speed of 20.0 mph (32.2 km/h), resulting in an impact severity of 32.6 kip-ft. (44.1 kJ) After impact, the system readily activated in a predictable manner by deforming to the ground and allowed the vehicle to continue travelling without any major obstruction of the windshield or penetration of the occupant compartment. All vehicle decelerations, ORAs, and OIVs fell within the recommended safety limits established in MASH 2016. Therefore, test no. MOS-7 was successful according to the safety performance criteria of MASH 2016 test designation no. 3-60.

Table 15. Summary of Safety Performance Evaluation

Evaluation Factors	Evaluation Criteria	Test No. MOS-5	Test No. MOS-6	Test No. MOS-7
Structural Adequacy	B. The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.	S	S	S
Occupant Risk	D. 1. 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.	S	S	S
	2. Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH 2016.	S	S	S
	F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	S	S	S
	H. Occupant Impact Velocity (OIV) (see Appendix A, Section A5.2.2 of MASH 2016 for calculation procedure) should satisfy the following limits:	S	S	S
	Occupant Impact Velocity Limits			
	Component: Longitudinal — Preferred: 10 ft/s (3.0 m/s) — Maximum: 16 ft/s (4.9 m/s)			
	I. The Occupant Ridedown Acceleration (ORA) (see Appendix A, Section A5.2.2 of MASH 2016 for calculation procedure) should satisfy the following limits:	S	S	S
	Occupant Ridedown Acceleration Limits			
	Component: Longitudinal and Lateral — Preferred: 15.0 g's — Maximum: 20.49 g's			
Post-Impact Vehicular Response	N. Vehicle trajectory behind the test article is acceptable.	S	S	S
MASH 2016 Test Designation No.		3-62	3-61	3-60
Final Evaluation (Pass or Fail)		Pass	Pass	Pass

S – Satisfactory U – Unsatisfactory NA - Not Applicable

9 MASH EVALUATION

The evaluation of Missouri DOT's dual-post, U-channel sign support system was conducted with four connection bolts. Two sign panels were attached to the U-channel masts. The bottom panel height was placed at 5 ft (1.5 m) from the ground line. The MoDOT dual-post, U-channel sign support system was subjected to three full-scale crash tests in accordance with MASH 2016 TL-3 evaluation criteria.

In test no. MOS-5, the 2270P pickup truck impacted the U-channel sign support system oriented at 0 degrees, or head-on to the vehicle, at a speed of 62.7 mph (100.9 km/h), resulting in a kinetic energy of 661.4 kip-ft (896.7 kJ). After impact, the system fractured as intended and the vehicle continued onward without major windshield damage. All occupant risk criteria were satisfied, and the test successfully met the safety performance criteria of MASH 2016 test designation no. 3-62.

In test no. MOS-6, the 1100C small car impacted the U-channel sign support system oriented at 0 degrees, or head-on to the vehicle, at a speed of 63.3 mph (101.9 km/h), resulting in a kinetic energy of 324.2 kip-ft (439.6 kJ). After impact, the system fractured as intended and the vehicle continued onward without major windshield damage. All occupant risk criteria were satisfied, and the test successfully met the safety performance criteria of MASH 2016 test designation no. 3-61.

In test no. MOS-7, the 1100C small car impacted the U-channel sign support system oriented at 0 degrees, or head-on to the vehicle, at a speed of 20.0 mph (32.2 km/h), resulting in an kinetic energy of 32.6 kip-ft. (44.1 kJ). After impact, the system deformed and the vehicle to continued onward without major windshield damage occupant compartment penetration. All occupant risk criteria were satisfied, and the test successfully met the safety performance criteria of MASH 2016 test designation no. 3-60.

With the successful completion of all three crash tests within the TL-3 testing matrix, the MoDOT dual-post, U-channel sign support system with four connection bolts at the base was determined to be crashworthy to MASH 2016 TL-3 criteria. Any deviations to the system configuration can potentially lead to very different results. Therefore, the safety performance of variations can only be verified through the use of full-scale crash testing.

10 REFERENCES

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4. Bullard, Jr., D.L., Bligh, R.P., Menges, W.L., and Haug, R.R., *NCHRP Web-Only Document 157: Volume I: Evaluation of Existing Roadside Safety Hardware Using Updated Criteria – Technical Report*, National Cooperative Highway Research Program (NCHRP) Project 22-12(03), Transportation Research Board, Washington, D.C., 2010.

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11 APPENDICES

Appendix A. Material Specifications

Table A-1. Bill of Materials, Test Nos. MOS-5 through MOS-7

Item No.	Description	Material Specification	Reference No.
a1	3.0 lb/ft [4.5 kg/m] U-Channel Sign Post, 132" [3,353] Long	ASTM A499 Gr. 60 Min. Yield = 60 ksi [414 Mpa]	H#109058
a2	3.0 lb/ft [4.5 kg/m] U-Channel Sign Post, 54" [1,372] Long	ASTM A499 Gr. 60 Min. Yield = 60 ksi [414 Mpa]	H#109058
b1	48"x48"x0.08" [1219x1219x2] Sign with Reflective Sheeting	Aluminum Alloy 5052 or Similar	Lot#747503 Order#M69056 PO#1236657
b2	24"x24"x0.08" [610x610x2] Sign with Reflective Sheeting	Aluminum Alloy 5052 or Similar	Lot#747503 Order#M69056 PO#1236657
c1	5/16"-18 UNC [M8x1.25], 2 1/2" [70] Long Fully Threaded Hex Bolt	SAE J429 Gr. 5 or equivalent	P#13810 O#110249806 H#8201230BA
c2	5/16" [8] Dia. Plain USS Washer	ASTM F844	L#s54218015502 P#33181 PO#210166277
c3	5/16"-18 UNC [M8x1.25] Heavy Hex Nut	SAE J995 Gr. 5 or equivalent	P#36304 PO#210167611 H#370563

Chicago Heights Steel

REPORT OF CHEMICAL AND PHYSICAL TESTS
CHICAGO HEIGHTS STEEL CHICAGO HEIGHTS, IL 60411

Page 1 of 1 11/7/2018

FOR 3# CHANNEL

HeatNumber	Tensile	Yield	C	Mn	P	S	Si	Cu	Ni	Mo	Cr
109058	178,900	112,700	.91	1.00	.009	.008	.34	.20	.07	.02	.23

Above material meets ASTM A1, A499 and A1075 requirements.
Galvanized material meets ATM A123 specs.
All material conforms to FHWA buy America Act 23-ERC23-635.410 requirements.
Melted and manufactured in the U.S.A.

WE HEREBY CERTIFY THAT THE STATED FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY

SUPERVISOR

Figure A-1. U-Channel Sign Post, Test Nos. MOS-5 through MOS-7

Arconic
Global Rolled Products
Alumax Mill Products, Inc.
1480 Manheim Pike
Lancaster, Pa. 17601

Certification of Test Results

SOLD TO
GRIMCO INC
1585 FENCORP
FENTON, MO 63026

SHIP TO
GRIMCO, INC.
GRIMCO AKRON WAREHOUSE
861 E TALLMADGE AVE
AKRON , OH 44310-3511

CERT NO 0002184288
DATE 6/09/2018
SKID NO 876449
SKID WGT 9,175
PAGE 1 **OF** 1

ORDER NO	M69056	**PO NO**	1236657		
ITEM NO	1	**PART NO**	MCOIL84805		
ALLOY	5052	**TEMPER**	H38	**FORM**	COIL
GAUGE	.08000	**WIDTH**	48.0000	**LENGTH**	0.0000

MILL FINISH
NON ANODIZE QUALITY
OUT: STANDARD MILL FINISH
IN: STANDARD MILL FINISH
NOT EMBOSSED

LOT: 747503 COIL: B01 DROP: 822652 Estimated Aluminum Content: 96.7726%

INGOT	SI	FE	CU	MN	MG	CR	NI	ZN	TI
8226523	0.12	0.27	0.06	0.08	2.5	0.18	0.005	0.01	0.03

HEAD ULTIMATE STRENGTH LONG 43.1 KSI
TAIL ULTIMATE STRENGTH LONG 43.4 KSI
HEAD YIELD STRENGTH OFFSET=.2% LONG 37.6 KSI
TAIL YIELD STRENGTH OFFSET=.2% LONG 37.2 KSI
HEAD ELG IN 2 IN., AT FRACTURE 8 %
TAIL ELG IN 2 IN., AT FRACTURE 8 %

CHEMICAL COMPOSITION ACCORDING TO ASTM E-1251-11
CHEMISTRY EXPRESSED AS % W/W FOR EACH REPORTED ELEMENT
MECHANICAL PROPERTIES ACCORDING TO ASTM B-557-15

MECHANICAL AND CHEMICAL PROPERTIES MEET THE REQUIREMENTS OF:
ASME SB209-11A 5052 H38, ASTM B209-14 5052 H38

** END OF CERTIFICATION **

We hereby certify that, unless otherwise indicated, the material covered by this report has been manufactured, inspected, and tested in accordance with, and has been found to meet, the applicable requirements described herein, including any specifications forming a part of the description and that samples representative of the material met the composition. Also, note that mercury is not a normal contaminant in aluminum alloys and neither it nor any of its compounds are used in the manufacture of our product. Certification of test results shall not be reproduced except in full. This material was melted in the United States or a qualifying country (REF DFARS 225.872.1A); It was manufactured in the United States.

These commodities, technology and software exported from the United States in accordance with the Export Administration Regulations. Diversion contrary to U.S. law prohibited. This certification complies with EN 10204:2004.

Authorized By: Elizabeth High-Lab Supervisor

Figure A-2. Sign Post with Reflective Sheeting, Test Nos. MOS-5 through MOS-7

QUALITY CERTIFICATE

NINGBO JINDING FASTENING PIECE CO.,LTD

XIJINGTANG JIULONGHU NINGBO CHINA TEL:+86-574-86530122 FAX: +86-574-86530858

Customer:	FASTENAL COMPANY PURCHASING--IMPORT	Date :	2018-05-01
Product:	HEX TAP BOLT	Contract No:	17JDF778T
Class:	5	Invoice No:	18-00452710
Size:	5/16-18X2-1/2	Lot No:	3500880001
Marking:	JDF three radius	Order No.	110249806
Quantity:	26.825 mpcs	Part No.	13810
		Production Date	2018-03-21
Dimensions Of SPEC:		Certificate No.:	2018041500094

Inspection Items		Standard	Result	Sample	Pass
Visual Appearance		----------	OK	20	20
Body Diameter		0.307-0.313	0.307-0.313	20	20
Thread	Go	3A	OK	20	20
	No Go	2A	OK	20	20
Width Across Flats		0.500-0.484	0.492-0.493	20	20
Width Across Corners		0.577-0.552	0.562-0.563	20	20
Major Diameter		0.303-0.311	0.303-0.308	20	20
Head Height		0.235-0.195	0.204-0.208	20	20
Total Length		2.454-2.500	2.474-2.475	20	20
Thread Length		min 2.362	2.402-2.402	20	20
Mechanical Properties					
CharacTeristics		Standard	Result		
Core Hardness	[HRC]	25-34	28.5-30	10	10
Wedge Strength	[psi]	min 120000	124814-133377	8	8
Yield Strength	[psi]	min 92000	106818-107543	8	8
Elongation	[%]	min 14	16.9-17.0	8	8
Reduction Of area	[%]	min 35	46.6-47.3	8	8
Proof Load	[lb]	4500	4500	4	4

CHEMICAL COMPOSITION(%)

Heat No		C	Si	Mn	P	S	Cr	Ni	Cu	Mo	B
Spec.:	min	0.2500									
	max	0.5500			0.0250	0.0250					0.0030
35#	8201230BA	0.34	0.16	0.66	0.015	0.010	0.03	0.01	0.03		
Thickness	[UM]		min 5			5.03-5.6		20		20	

Surface Coating:	ZPCr3+ 5μm(coating test method: X ray according to ASTM B568M 2007 standard test method for measurement of coating thickness by X-Ray spectrometry)
Thread Specification: ASME B1.1 2008, UNIFIED INCH SCREW THREADS(UN AND UNR THREAD FORM)	
Sampling Dimension Specification: ASME B18.18-2017 inspection and quality assurance for high-volume machine assembly fasteners	
Dimension Specification: ASME B18.2.1 2012, HEX CAP SCREWS	
Sampling mechanical properties specification: ASTM F1470 2012 Standard Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection	
Mechanical Properties: SAE J429 2014, MECHANICAL AND MATERIAL REQUIREMENTS FOR EXTERNALLY THREADED FASTENERS	
Surface Defect:ASTM F788/F788M-2013, SURFACE DISCONTINUITIES OF BOLTS, SCREWS, AND STUDS	
Plating Specification: ASTM 1941 2014 Electrodeposited Coatings On Threaded Fasteners	
this report is complied to DIN EN 10204 3.1 certification	
Quality Control Supervisor	Quality Control Manager 9

沈健狄

Figure A-3. $^{5}/_{16}$-in. (8-mm) Dia. Fully Threaded Hex Bolt, Test Nos. MOS-5 through MOS-7

FNL PART# 33181
FNL PO# 210166277

Certificate of Compliance

BRIGHTON-BEST INTERNATIONAL, INC.
940 ENTERPRISE ST
AURORA IL 60504-4906
630-898-9600

R31101
FASTENAL CO-WINONA PRODUCT
SUPPORT CENTER
1801 THEURER BLVD.
WINONA MN 55987

Date : 11/14/2018

This is to certify that the USS FLAT WASHER, HDG (INCH) stated below conforms to the requirements and specifications per

ASME B18.21.1, Type-A, ASTM F2329 H.D.G.

or the revision in effect at the time of manufacture.

Item code	Size	Description	Lot#	Country Of Origin
345002	5/16"	USS FLAT WASHER, HDG (INCH)	s54218015502	CHINA

Stephen McFalls
Quality Control Manager

Figure A-4. $^{5}/_{16}$-in. (8-mm) Dia. Plain USS Washer, Test Nos. MOS-5 through MOS-7

SUPER CHENG INDUSTRIAL CO.,LTD.

NO. 18 BEN-GONG 2nd ROAD., BEN CHOU INDUSTRIAL PARK, KAOHSIUNG COUNTY 820, TAIWAN R.O.C.
TEL：886-7-6225326-30(5 LINES) FAX：886-7-6215377/6212335/6235829

CERTIFICATE OF INSPECTION

CERT. #： P58180504 ISSUED DATE： 2018/8/10 PAGE 1 OF 1

CLIENT：SUPER CHENG INDUSTRIAL CO., LTD.
ADDRESS：NO. 18 BEN-GONG 2nd ROAD., BEN CHOU INDUSTRIAL PARK, KAOHSIUNG COUNTY 820, TAIWAN R.O.C.

PURCHASER： FASTENAL COMPANY PURCHASING PO #：210167611
PART # 36304 QTY SHIPPED：162,000 PCS

COMMODITY：GRADE 5 FIN HEX NUT FINISH： TRIVALENT ZINC
SIZE： 5/16-18 LOT#： P58180504 SAMPLING PLAN：ASME B18.18-17 / ASTM F1470-12
QTY： 711157 PCS MATERIAL： 1010AM HEAT NO.： 370563
MANUFACTURER：SUPER CHENG IND. CO., LTD. MANU. DATE： 2018/6/29

DIMENSIONAL INSPECTION SPEC.：ASME B18.2.2-15 SAMPLED BY：YI FANG HSIEH

ITEM	SAMPLE SIZE	SPECIFIED	ACTUAL RESULT	JUDGMENT
APPEARANCE	29	ASTM F812-12	GOOD	OK
THREAD	15	ASME B1.1-03	PASS	OK
W.A.F.	7	0.500 ~ 0.489 in	0.493 ~ 0.491 in.	OK
W.A.C.	7	0.577 ~ 0.557 in	0.563 ~ 0.561 in.	OK
THICKNESS	7	0.273 ~ 0.258 in	0.264 ~ 0.262 in.	OK

MECHANICAL PROPERTIES SPEC.：SAE J995-17 SAMPLED BY：YI FANG HSIEH

ITEM	SAMPLE SIZE	TEST METHOD	SPECIFIED	ACTUAL RESULT	JUDGMENT
HARDNESS	7	ASTM F606/F606M-16	MAX HRC32	94 ~ 89 HRBW	PASS
PROOF LOAD	5	ASTM F606/F606M-16	MIN 6300 LB	6411 ~ 6407 LB	PASS

SURFACE FINISH SPEC.：ASTM F1941/F1941M-16 SAMPLED BY：CHENG HSIEN SU

ITEM	SAMPLE SIZE	TEST METHOD	SPECIFIED	ACTUAL RESULT	JUDGMENT
PLATING THICKNESS	15	ASTM B568-98	MIN 0.0001 in	0.00019 ~ 0.00014 in	PASS

REMARK：
1、THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT WRITTEN APPROVAL OF THE LAB.
2、THIS INSPECTION CERTIFICATE IS FOR RESPONSIBILITY UNDER SAMPLE ONLY.
3、ABOVE SAMPLES TESTED CONFORM TO THE FASTENER SPECIFICATION OR STANDARDS.
4、THIS INSPECTION CERTIFICATE IS ISSUED ACCORDING TO DIN EN10204 TYPE 3.1

LAB. DIRECTOR(SIGNATORY)：

表單編號：LQC 10E Rev.0

Figure A-5. $^{5}/_{16}$-in. (18-mm) Dia. Heavy Hex Nut, Test Nos. MOS-5 through MOS-7

Appendix B. Vehicle Center of Gravity Determination

Date:	4/9/2019	Test Name:	MOS-5	VIN:	1D7RB1CT2BS657795
Year:	2011	Make:	Dodge	Model:	Ram 1500

Vehicle CG Determination

VEHICLE	Equipment	Weight (lb.)	Vertical CG (in.)	Vertical M (lb.-in.)
+	Unballasted Truck (Curb)	5302	29.244059	155052
+	Hub	19	15.75	299.25
+	Brake activation cylinder & frame	8	30 7/8	247
+	Pneumatic tank (Nitrogen)	31	25 1/2	790.5
+	Strobe/Brake Battery	5	27 3/8	136.875
+	Brake Receiver/Wires	6	54	324
+	CG Plate including DAS	50	32 3/8	1618.75
-	Battery	-47	41 3/4	-1962.25
-	Oil	-6	17 1/4	-103.5
-	Interior	-114	40	-4560
-	Fuel	-169	18 7/8	-3189.875
-	Coolant	-9	38 1/2	-346.5
-	Washer fluid	0	0	0
+	Water Ballast (In Fuel Tank)	0	0	0
+	Onboard Supplemental Battery	13	26 1/4	341.25
-	Spare Tire	-84	24 1/2	-2058
+				0
				146589.5

Note: (+) is added equipment to vehicle, (-) is removed equipment from vehicle

Estimated Total Weight (lb.)	5005
Vertical CG Location (in.)	29.2886

Vehicle Dimensions for C.G. Calculations

Wheel Base:	140.25 in.	Front Track Width:	68.125 in.
		Rear Track Width:	68 in.

Center of Gravity	2270P MASH Targets	Test Inertial	Difference
Test Inertial Weight (lb.)	5000 ± 110	5026	26.0
Longitudinal CG (in.)	63 ± 4	60.079238	-2.92076
Lateral CG (in.)	NA	-0.216673	NA
Vertical CG (in.)	28 or greater	29.29	1.28861

Note: Long. CG is measured from front axle of test vehicle

Note: Lateral CG measured from centerline - positive to vehicle right (passenger) side

CURB WEIGHT (lb.)

	Left	Right	
Front	1497	1447	
Rear	1191	1167	
FRONT	2944		lb.
REAR	2358		lb.
TOTAL	5302		lb.

TEST INERTIAL WEIGHT (lb.)

	Left	Right	
Front	1445	1428	
Rear	1084	1069	
FRONT	2873		lb.
REAR	2153		lb.
TOTAL	5026		lb.

Figure B-1. Vehicle Mass Distribution, Test No. MOS-5

Date:	6/12/2019	Test Name:	MOS-6	VIN:	KNADE223296512940
Year:	2009	Make:	Kia	Model:	Rio

Vehicle CG Determination

	Vehicle Equipment	Weight (lb.)
+	Unballasted Car (Curb)	2510
+	Hub	19
+	Brake activation cylinder & frame	8
+	Pneumatic tank (Nitrogen)	22
+	Strobe/Brake Battery	5
+	Brake Receiver/Wires	6
+	CG Plate including DAS	22
-	Battery	-31
-	Oil	-5
-	Interior	-63
-	Fuel	-40
-	Coolant	-7
-	Washer fluid	-8
+	Water Ballast (In Fuel Tank)	0
+	Onboard Supplemental Battery	0

Note: (+) is added equipment to vehicle, (-) is removed equipment from vehicle

Estimated Total Weight (lb.) 2438

Vehicle Dimensions for C.G. Calculations

Wheel Base:	98.5	in.	Front Track Width:	57.75	in.
Roof Height:	57.5	in.	Rear Track Width:	57.5	in.

Center of Gravity	1100C MASH Targets	Test Inertial	Difference
Test Inertial Weight (lb.)	2420 ± 55	2420	0.0
Longitudinal CG (in.)	39 ± 4	36.144	-2.856
Lateral CG (in.)	NA	-0.595	NA
Vertical CG (in.)	NA	22.73	NA

Note: Long. CG is measured from front axle of test vehicle

Note: Lateral CG measured from centerline - positive to vehicle right (passenger) side

CURB WEIGHT (lb.)

	Left	Right	
Front	818	760	
Rear	453	479	
FRONT	1578	lb.	
REAR	932	lb.	
TOTAL	2510	lb.	

TEST INERTIAL WEIGHT (lb.)

	Left	Right	
Front	821	711	
Rear	414	474	
FRONT	1532	lb.	
REAR	888	lb.	
TOTAL	2420	lb.	

Figure B-2. Vehicle Mass Distribution, Test No. MOS-6

Date:	6/28/2019	Test Name:	MOS-7	VIN:	KNADE223896580563
Year:	2009	Make:	Kia	Model:	Rio

Vehicle CG Determination

	Vehicle Equipment	Weight (lb)
+	Unballasted Car (Curb)	2499
+	Hub	19
+	Brake activation cylinder & frame	7
+	Pneumatic tank (Nitrogen)	31
+	Strobe/Brake Battery	5
+	Brake Receiver/Wires	6
+	CG Plate including DAQ	22
-	Battery	-35
-	Oil	-11
-	Interior	-78
-	Fuel	-15
-	Coolant	-6
-	Washer fluid	-9
+	Water Ballast (In Fuel Tank)	
+	Onboard Supplemental Battery	0

Note: (+) is added equipment to vehicle, (-) is removed equipment from vehicle

Estimated Total Weight (lb): 2435

Vehicle Dimensions for C.G. Calculations

Wheel Base:	98.5	in.	Front Track Width:	57.375	in.
Roof Height:	58.25	in.	Rear Track Width:	57.375	in.

Center of Gravity	1100C MASH Targets	Test Inertial	Difference
Test Inertial Weight (lb)	2420 ± 55	2435	15.0
Longitudinal CG (in.)	39 ± 4	35.921	-3.079
Lateral CG (in.)	NA	-0.813	NA
Vertical CG (in.)	NA	22.783	NA

Note: Long. CG is measured from front axle of test vehicle

Note: Lateral CG measured from centerline - positive to vehicle right (passenger) side

CURB WEIGHT (lb)

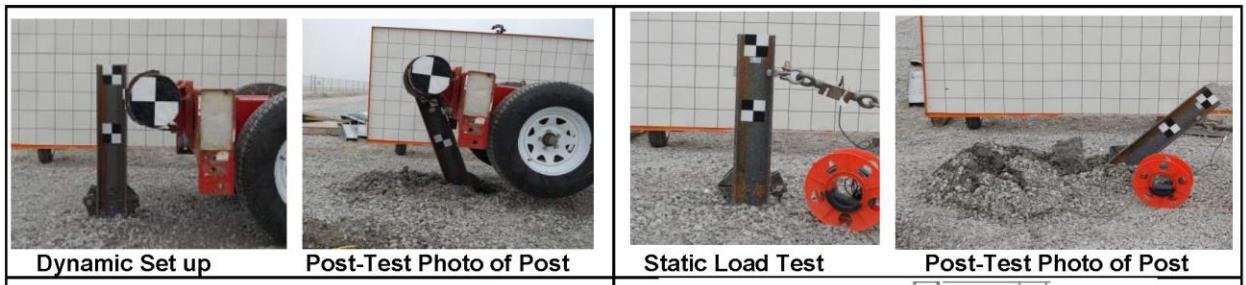
	Left	Right	
Front	825	781	
Rear	440	453	
FRONT	1606	lb	
REAR	893	lb	
TOTAL	2499	lb	

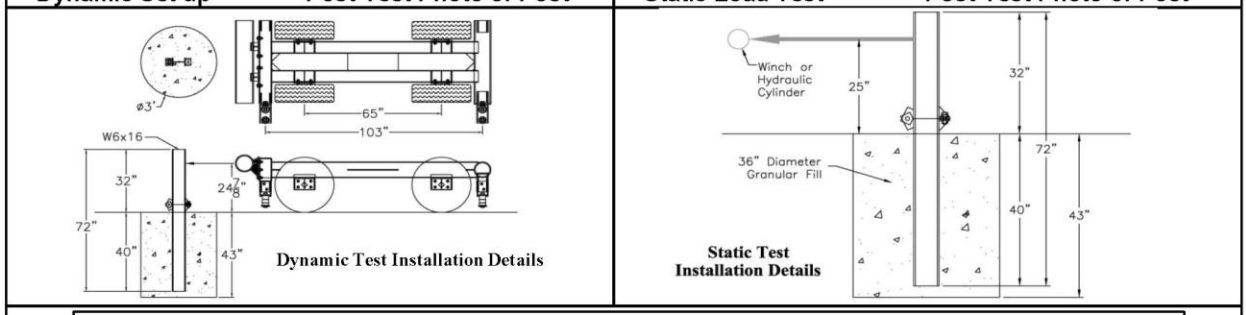
TEST INERTIAL WEIGHT (lb)

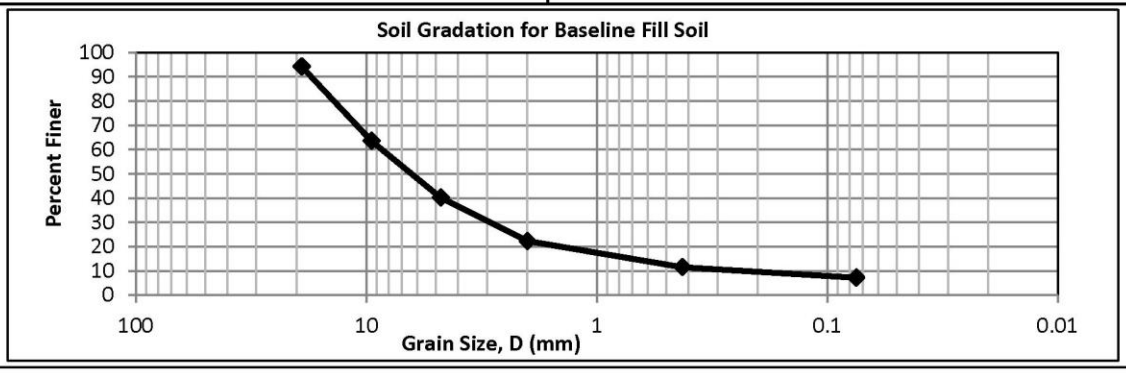
	Left	Right	
Front	807	740	
Rear	445	443	
FRONT	1547	lb	
REAR	888	lb	
TOTAL	2435	lb	

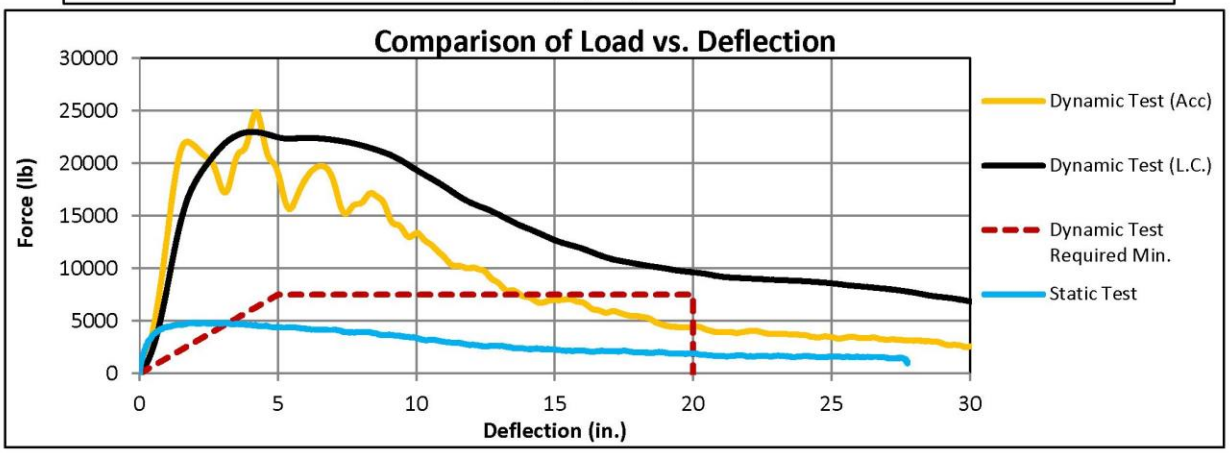
Figure B-3. Vehicle Mass Distribution, Test No. MOS-7

Appendix C. Static Soil Tests





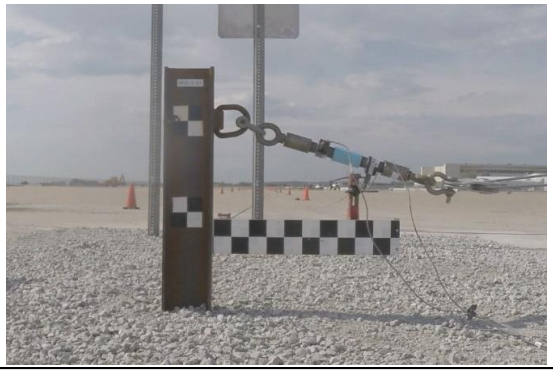




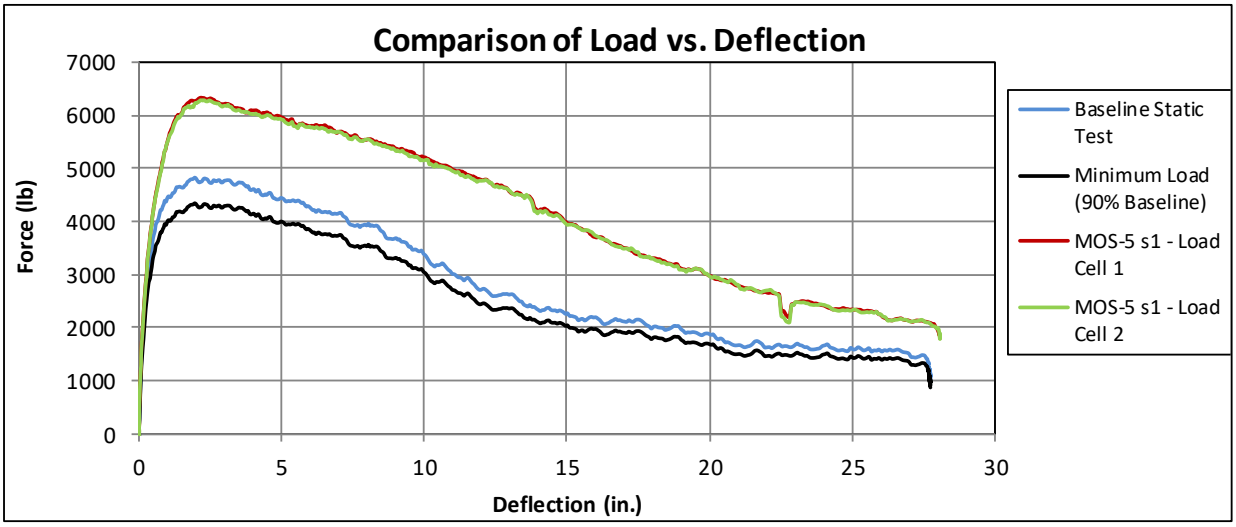
Date	2/16/2018		
Test Facility & Site Location	Midwest Roadside Safety Facility		
In situ soil description (ASTM D2487)	Well-Graded Gravel (GW)		
Fill material description (ASTM D2487)	Well-Graded Gravel (GW) (see sieve analyses above)		
Description of fill placement procedure	H.E.-8		
Bogie Weight	1786	lb	810 kg
Impact Velocity	20.9	mph	33.7 km/h

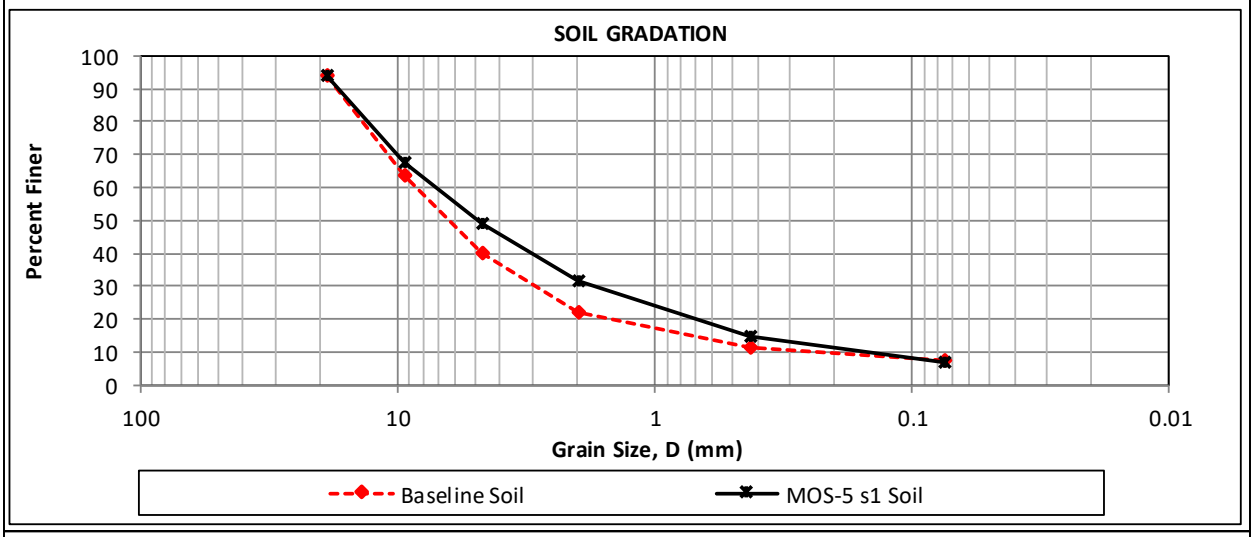
Figure C-1. Soil Strength, Initial Calibration Tests

Static Load Test Setup



Post-Test Photo of Post



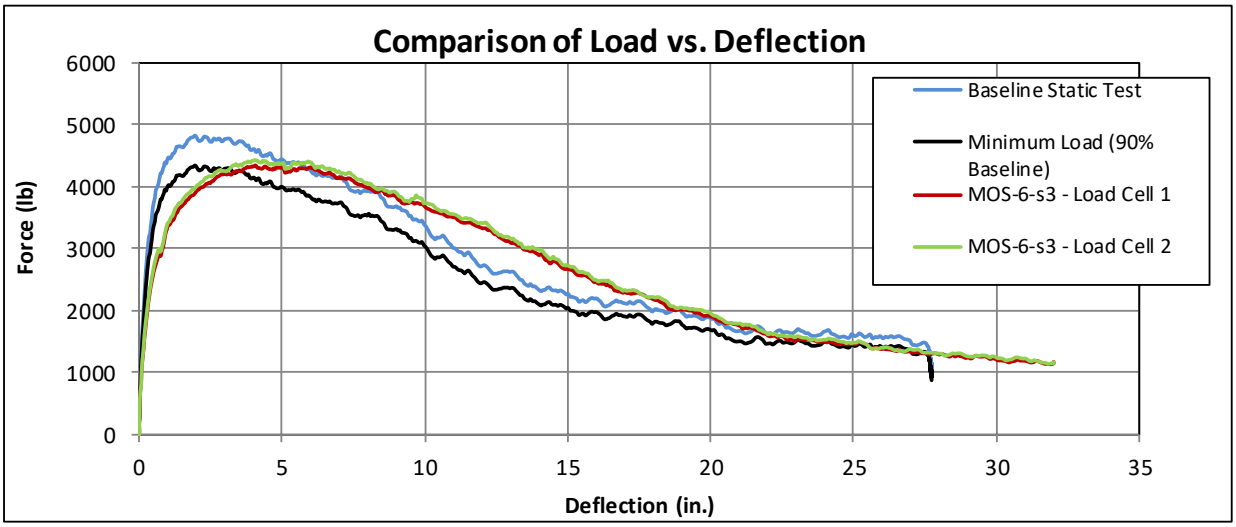


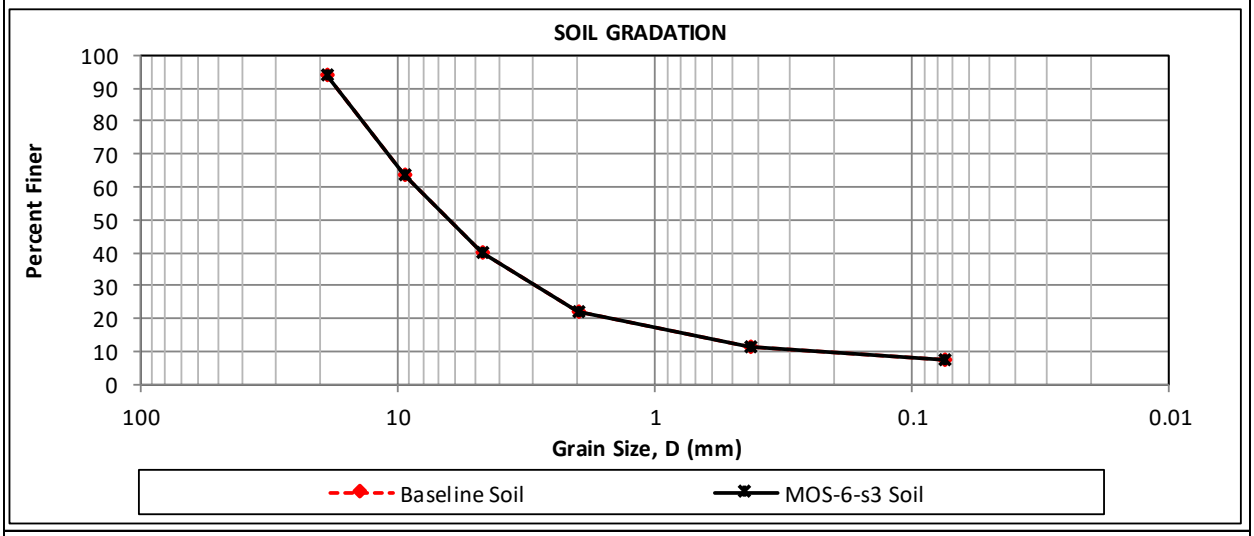
Date	5/15/2019
Test Facility & Site Location	Midwest Roadside Safety Facility
In situ soil description (ASTM D2487)	Well-Graded Gravel (GW)
Fill material description (ASTM D2487)	Well-Graded Gravel (GW) (see sieve analyses above)
Description of fill placement procedure	8-inch lifts tamped with a pneumatic compactor

Figure C-2. Static Soil Test, Test No. MOS-5

Static Load Test Setup

Post-Test Photo of Post



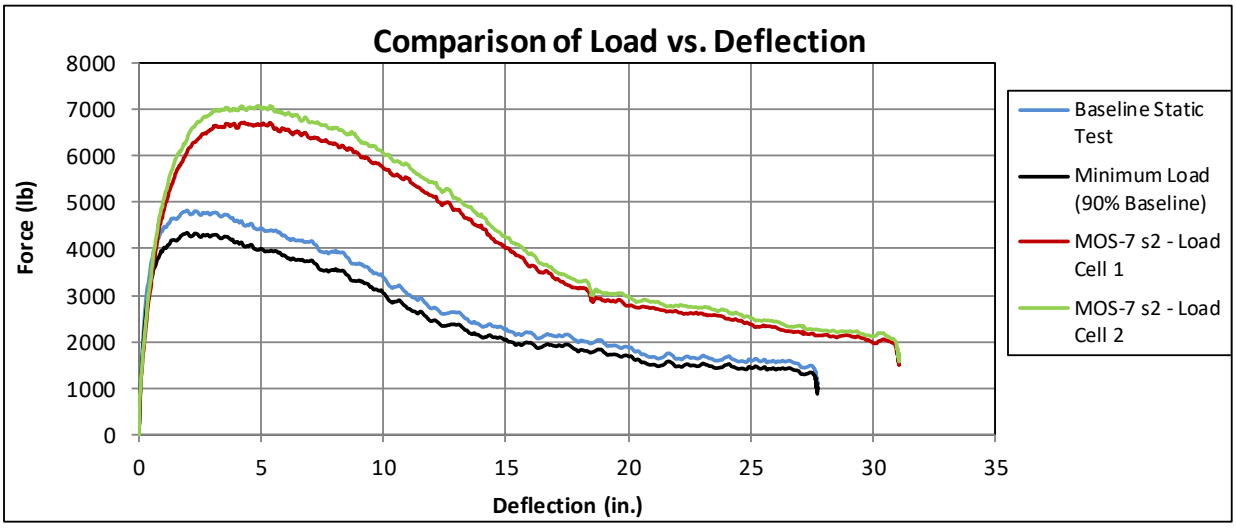


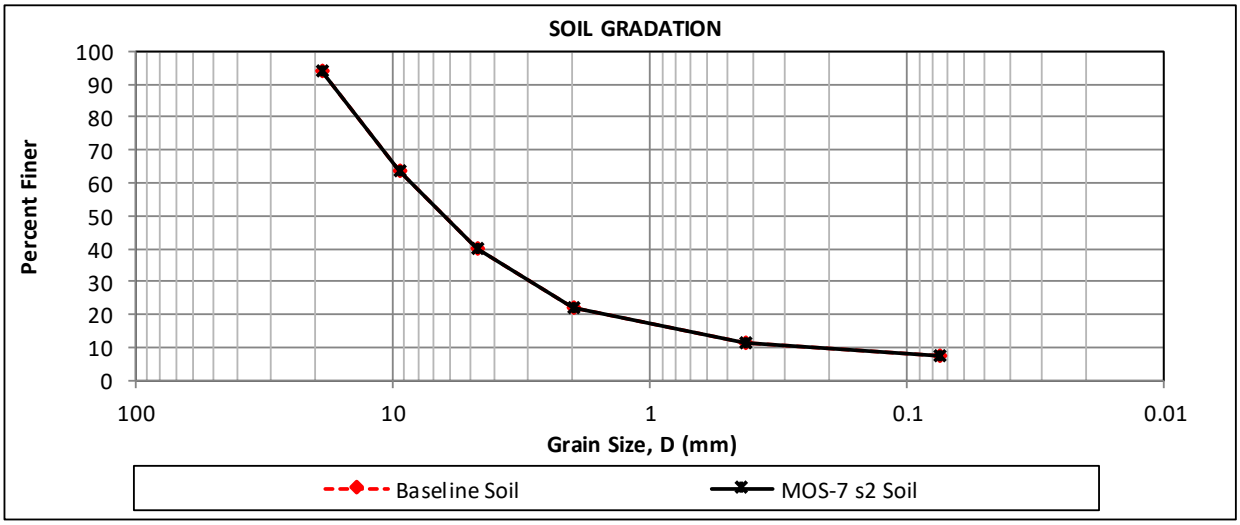
Date	6/12/2019
Test Facility & Site Location	Midwest Roadside Safety Facility
In situ soil description (ASTM D2487)	Well-Graded Gravel (GW)
Fill material description (ASTM D2487)	Well-Graded Gravel (GW) (see sieve analyses above)
Description of fill placement procedure	8-inch lifts tamped with a pneumatic compactor

Figure C-3. Static Soil Test, Test No. MOS-6

Static Load Test Setup

Post-Test Photo of Post





Date	6/28/2019
Test Facility & Site Location	Midwest Roadside Safety Facility
In situ soil description (ASTM D2487)	Well-Graded Gravel (GW)
Fill material description (ASTM D2487)	Well-Graded Gravel (GW) (see sieve analyses above)
Description of fill placement procedure	8-inch lifts tamped with a pneumatic compactor

Figure C-4. Static Soil Test, Test No. MOS-7

Appendix D. Vehicle Deformation Records

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
DRIVER SIDE FLOOR PAN - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	58.8247	-8.0811	2.5687	58.8522	-8.0764	2.4094	-0.0275	0.0047	0.1593	0.1617	0.1593	Z
	2	58.9654	-11.3739	2.4761	58.9762	-11.3652	2.3209	-0.0108	0.0087	0.1552	0.1558	0.1552	Z
	3	58.8772	-14.3894	2.5138	58.9256	-14.4079	2.3331	-0.0484	-0.0185	0.1807	0.1880	0.1807	Z
	4	59.0089	-18.5161	2.4156	59.0240	-18.5006	2.2482	-0.0151	0.0155	0.1674	0.1688	0.1674	Z
	5	59.2016	-22.3820	2.2958	59.1903	-22.3731	2.1377	0.0113	0.0089	0.1581	0.1588	0.1585	X, Z
	6	55.5582	-7.4327	4.3032	55.5776	-7.4725	4.1592	-0.0194	-0.0398	0.1440	0.1507	0.1440	Z
	7	55.3908	-11.2818	4.3749	55.3728	-11.2893	4.2478	0.0180	-0.0075	0.1271	0.1286	0.1284	X, Z
	8	55.3296	-14.6091	4.3949	55.3173	-14.6186	4.2555	0.0123	-0.0095	0.1394	0.1403	0.1399	X, Z
	9	55.3922	-18.6557	4.3558	55.3879	-18.6640	4.2058	0.0043	-0.0083	0.1500	0.1503	0.1501	X, Z
	10	55.5165	-21.9944	4.2749	55.4741	-22.0291	4.1395	0.0424	-0.0347	0.1354	0.1461	0.1419	X, Z
FLOOR PAN (Z)	11	51.0127	-7.4067	5.3252	51.0069	-7.4427	5.1966	0.0058	-0.0360	0.1286	0.1337	0.1286	Z
	12	50.8475	-12.1410	5.3324	50.8294	-12.1708	5.1962	0.0181	-0.0298	0.1362	0.1406	0.1362	Z
	13	50.7587	-15.9494	5.3138	50.7861	-15.9644	5.1727	-0.0274	-0.0150	0.1411	0.1445	0.1411	Z
	14	50.8084	-19.2808	5.3058	50.8393	-19.3109	5.1617	-0.0309	-0.0301	0.1441	0.1504	0.1441	Z
	15	50.6741	-22.2995	5.2911	50.6867	-22.2974	5.1437	-0.0126	0.0021	0.1474	0.1480	0.1474	Z
	16	47.1445	-7.1174	5.2241	47.1686	-7.1244	5.1023	-0.0241	-0.0070	0.1218	0.1244	0.1218	Z
	17	46.8650	-10.9167	5.3336	46.8635	-10.8970	5.2102	0.0015	0.0197	0.1234	0.1250	0.1234	Z
	18	46.7273	-14.8412	5.3194	46.7078	-14.7792	5.1880	0.0195	0.0620	0.1314	0.1466	0.1314	Z
	19	46.4634	-19.0558	5.2990	46.4914	-19.0592	5.1649	-0.0280	-0.0034	0.1341	0.1370	0.1341	Z
	20	46.4586	-22.3894	5.3018	46.4714	-22.3718	5.1652	-0.0128	0.0176	0.1366	0.1383	0.1366	Z
	21	42.4086	-7.4804	5.2903	42.3973	-7.4984	5.1812	0.0113	-0.0180	0.1091	0.1112	0.1091	Z
	22	42.1295	-10.3296	5.3318	42.1487	-10.3488	5.2208	-0.0192	-0.0192	0.1110	0.1143	0.1110	Z
	23	41.7948	-13.9481	5.3029	41.8091	-13.9538	5.1849	-0.0143	-0.0057	0.1180	0.1190	0.1180	Z
	24	41.5918	-17.6280	5.2843	41.6034	-17.6358	5.1637	-0.0116	-0.0078	0.1206	0.1214	0.1206	Z
	25	41.3593	-21.8614	5.2945	41.3365	-21.8577	5.1715	0.0228	0.0037	0.1230	0.1252	0.1230	Z
	26	37.5873	-7.3319	4.3066	37.6291	-7.4019	4.2461	-0.0418	-0.0700	0.0605	0.1015	0.0605	Z
	27	37.4534	-12.1680	4.5480	37.4637	-12.1951	4.4534	-0.0103	-0.0271	0.0946	0.0989	0.0946	Z
	28	37.4069	-16.5447	4.5162	37.4256	-16.5483	4.4144	-0.0187	-0.0036	0.1018	0.1036	0.1018	Z
	29	37.2607	-19.8657	4.2820	37.2804	-19.8486	4.1748	-0.0197	0.0171	0.1072	0.1103	0.1072	Z
	30	37.3915	-23.5507	4.5129	37.3618	-23.5304	4.4007	0.0297	0.0203	0.1122	0.1178	0.1122	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-1. Floor Pan Deformation Data – Set 1, Left, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
PASSENGER SIDE FLOOR PAN - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	59.7658	19.9074	-2.2364	59.8216	19.8630	-2.4359	-0.0558	0.0444	0.1995	0.2119	0.1995	Z
	2	61.6115	22.1442	0.1495	61.6647	22.0895	-0.0620	-0.0532	0.0547	0.2115	0.2248	0.2115	Z
	3	62.0911	25.2892	0.5270	62.1274	25.2783	0.3292	-0.0363	0.0109	0.1978	0.2014	0.1978	Z
	4	62.2548	27.3387	0.4331	62.2675	27.2713	0.2453	-0.0127	0.0674	0.1878	0.1999	0.1878	Z
	5	62.3008	30.1726	-0.8080	62.2800	30.1792	-0.9888	0.0208	-0.0066	0.1808	0.1821	0.1820	X, Z
	6	55.2954	18.8247	-0.3768	55.2865	18.7835	-0.5186	0.0089	0.0412	0.1418	0.1479	0.1421	X, Z
	7	56.4376	22.0342	2.8382	56.5247	22.0663	2.7009	-0.0871	-0.0321	0.1373	0.1657	0.1373	Z
	8	56.6345	26.5916	3.3113	56.7029	26.5638	3.1164	-0.0684	0.0278	0.1949	0.2084	0.1949	Z
	9	56.6352	29.9495	3.3095	56.6796	29.9434	3.1273	-0.0444	0.0061	0.1822	0.1876	0.1822	Z
	10	56.6762	33.4173	3.2974	56.6924	33.3989	3.1334	-0.0162	0.0184	0.1640	0.1658	0.1640	Z
FLOOR PAN (Z)	11	50.2539	15.5428	1.5690	50.2653	15.5358	1.4693	-0.0114	0.0070	0.0997	0.1006	0.0997	Z
	12	51.0614	18.4835	4.3806	51.0893	18.4767	4.2656	-0.0279	0.0068	0.1150	0.1185	0.1150	Z
	13	51.4916	25.2227	5.3318	51.5541	25.2119	5.1710	-0.0625	0.0108	0.1608	0.1729	0.1608	Z
	14	51.4554	29.1022	5.3322	51.4841	29.1012	5.1711	-0.0287	0.0010	0.1611	0.1636	0.1611	Z
	15	51.3197	32.2301	5.3212	51.3893	32.2170	5.1584	-0.0696	0.0131	0.1628	0.1775	0.1628	Z
	16	47.0047	14.4301	3.2823	47.0572	14.3906	3.1163	-0.0525	0.0395	0.1660	0.1785	0.1660	Z
	17	47.9558	21.1767	5.3483	48.0464	21.1511	5.2008	-0.0906	0.0256	0.1475	0.1750	0.1475	Z
	18	47.8431	25.3673	5.3304	47.9268	25.2415	5.1868	-0.0837	0.1258	0.1436	0.2085	0.1436	Z
	19	47.8945	28.1906	5.3224	47.9207	28.1401	5.1767	-0.0262	0.0505	0.1457	0.1564	0.1457	Z
	20	47.9212	32.0678	5.3184	48.0149	32.1108	5.1723	-0.0937	-0.0430	0.1461	0.1788	0.1461	Z
	21	43.4358	14.6778	4.2357	43.5110	14.6594	4.1161	-0.0752	0.0184	0.1196	0.1425	0.1196	Z
	22	43.8104	20.6004	5.1087	43.8874	20.5605	4.9637	-0.0770	0.0399	0.1450	0.1690	0.1450	Z
	23	43.7806	24.5388	5.0921	43.8298	24.5167	4.9502	-0.0492	0.0221	0.1419	0.1518	0.1419	Z
	24	43.8510	27.9935	5.0901	43.8976	27.9635	4.9515	-0.0466	0.0300	0.1386	0.1493	0.1386	Z
	25	43.7699	32.4349	5.0916	43.8194	32.4182	4.9541	-0.0495	0.0167	0.1375	0.1471	0.1375	Z
	26	40.2150	17.6676	5.3467	40.2471	17.6359	5.2235	-0.0321	0.0317	0.1232	0.1312	0.1232	Z
	27	40.5257	24.5769	5.3137	40.5951	24.6269	5.1893	-0.0694	-0.0500	0.1244	0.1510	0.1244	Z
	28	40.6734	32.0721	5.3361	40.7553	32.0430	5.2043	-0.0819	0.0291	0.1318	0.1579	0.1318	Z
	29	33.6997	18.2398	1.3827	33.7246	18.1910	1.2727	-0.0249	0.0488	0.1100	0.1229	0.1100	Z
	30	33.6835	28.4127	1.3643	33.7478	28.4621	1.2471	-0.0643	-0.0494	0.1172	0.1425	0.1172	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-2. Floor Pan Deformation Data – Set 1, Right, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
DRIVER SIDE FLOOR PAN - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	60.0988	-22.9724	-1.6210	60.1613	-22.9760	-1.6094	-0.0625	-0.0036	-0.0116	0.0637	0.0000	NA
	2	60.3877	-26.3024	-1.7356	60.3902	-26.2593	-1.6943	-0.0025	0.0431	-0.0413	0.0597	0.0000	NA
	3	60.4229	-29.3289	-1.7149	60.4364	-29.3020	-1.6794	-0.0135	0.0269	-0.0355	0.0465	0.0000	NA
	4	60.6704	-33.4276	-1.8027	60.6655	-33.3896	-1.7600	0.0049	0.0380	-0.0427	0.0574	0.0049	X
	5	60.9299	-37.2873	-1.8932	60.9554	-37.2550	-1.8663	-0.0255	0.0323	-0.0269	0.0492	0.0000	NA
	6	56.8443	-22.4429	0.0914	56.8629	-22.4752	0.1283	-0.0186	-0.0323	-0.0369	0.0524	0.0000	NA
	7	56.7221	-26.2977	0.2073	56.7794	-26.2966	0.2198	-0.0573	0.0011	-0.0125	0.0587	0.0000	NA
	8	56.8383	-29.6321	0.1854	56.8299	-29.6259	0.2304	0.0084	0.0062	-0.0450	0.0462	0.0084	X
	9	57.0101	-33.7342	0.1574	57.0294	-33.6671	0.1849	-0.0193	0.0671	-0.0275	0.0750	0.0000	NA
	10	57.2239	-37.0234	0.0833	57.2230	-37.0278	0.1221	0.0009	-0.0044	-0.0388	0.0391	0.0009	X
FLOOR PAN (Z)	11	52.3437	-22.6155	1.1146	52.2900	-22.5901	1.1495	0.0537	0.0254	-0.0349	0.0689	-0.0349	Z
	12	52.2701	-27.3552	1.1201	52.2630	-27.3215	1.1530	0.0071	0.0337	-0.0329	0.0476	-0.0329	Z
	13	52.3122	-31.1015	1.1020	52.3406	-31.1145	1.1329	-0.0284	-0.0130	-0.0309	0.0439	-0.0309	Z
	14	52.4904	-34.4490	1.0956	52.5004	-34.4576	1.1253	-0.0100	-0.0086	-0.0297	0.0325	-0.0297	Z
	15	52.4381	-37.4740	1.0808	52.4430	-37.4475	1.1097	-0.0049	0.0265	-0.0289	0.0395	-0.0289	Z
	16	48.4305	-22.4038	1.0033	48.4438	-22.3942	1.0413	-0.0133	0.0096	-0.0380	0.0414	-0.0380	Z
	17	48.2343	-26.1700	1.1188	48.2586	-26.1746	1.1517	-0.0243	-0.0046	-0.0329	0.0412	-0.0329	Z
	18	48.2473	-30.1377	1.1067	48.2266	-30.0597	1.1327	0.0207	0.0780	-0.0260	0.0848	-0.0260	Z
	19	48.1071	-34.3862	1.0869	48.1466	-34.3445	1.1129	-0.0395	0.0417	-0.0260	0.0630	-0.0260	Z
	20	48.2278	-37.6721	1.0907	48.2322	-37.6560	1.1163	-0.0044	0.0161	-0.0256	0.0306	-0.0256	Z
	21	43.6783	-22.9048	1.0652	43.6866	-22.9199	1.1038	-0.0083	-0.0151	-0.0386	0.0423	-0.0386	Z
	22	43.5343	-25.7662	1.1131	43.5287	-25.7768	1.1452	0.0056	-0.0106	-0.0321	0.0343	-0.0321	Z
	23	43.2335	-29.4065	1.0856	43.3042	-29.3908	1.1115	-0.0707	0.0157	-0.0259	0.0769	-0.0259	Z
	24	43.2109	-33.0747	1.0663	43.2159	-33.0774	1.0931	-0.0050	-0.0027	-0.0268	0.0274	-0.0268	Z
	25	43.1103	-37.3261	1.0784	43.0835	-37.3057	1.1040	0.0268	0.0204	-0.0256	0.0423	-0.0256	Z
	26	38.8973	-22.9257	0.0985	38.9210	-22.9761	0.1517	-0.0237	-0.0504	-0.0532	0.0770	-0.0532	Z
	27	38.9475	-27.7663	0.3378	38.9076	-27.7719	0.3630	0.0399	-0.0056	-0.0252	0.0475	-0.0252	Z
	28	38.9843	-32.1139	0.3049	39.0083	-32.1242	0.3281	-0.0240	-0.0103	-0.0232	0.0349	-0.0232	Z
	29	38.9352	-35.4705	0.0703	38.9691	-35.4276	0.0911	-0.0339	0.0429	-0.0208	0.0585	-0.0208	Z
	30	39.1847	-39.0862	0.3030	39.1668	-39.1048	0.3208	0.0179	-0.0186	-0.0178	0.0314	-0.0178	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-3. Floor Pan Deformation Data – Set 2, Left, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
PASSENGER SIDE FLOOR PAN - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	60.1977	4.9902	-6.4587	60.2227	5.0053	-6.4671	-0.0250	-0.0151	0.0084	0.0304	0.0084	Z
	2	61.9715	7.2840	-4.0725	61.9842	7.2913	-4.0877	-0.0127	-0.0073	0.0152	0.0211	0.0152	Z
	3	62.3521	10.4425	-3.6953	62.3419	10.4935	-3.6964	0.0102	-0.0510	0.0011	0.0520	0.0103	X, Z
	4	62.4516	12.4962	-3.7895	62.4175	12.4900	-3.7807	0.0341	0.0062	-0.0088	0.0358	0.0341	X
	5	62.4092	15.3300	-5.0310	62.3402	15.3963	-5.0161	0.0690	-0.0663	-0.0149	0.0968	0.0690	X
	6	55.7628	3.7682	-4.6006	55.7182	3.7800	-4.5653	0.0446	-0.0118	-0.0353	0.0581	0.0446	X
	7	56.8026	7.0123	-1.3856	56.8378	7.1024	-1.3430	-0.0352	-0.0901	-0.0426	0.1057	0.0000	NA
	8	56.8564	11.5737	-0.9132	56.8686	11.6034	-0.9290	-0.0122	-0.0297	0.0158	0.0358	0.0158	Z
	9	56.7518	14.9299	-0.9155	56.7357	14.9805	-0.9198	0.0161	-0.0506	0.0043	0.0533	0.0167	X, Z
	10	56.6842	18.3974	-0.9281	56.6365	18.4346	-0.9152	0.0477	-0.0372	-0.0129	0.0619	0.0477	X
FLOOR PAN (Z)	11	50.8259	0.3300	-2.6560	50.7979	0.3719	-2.5937	0.0280	-0.0419	-0.0623	0.0801	-0.0623	Z
	12	51.5398	3.2950	0.1553	51.5162	3.3389	0.2041	0.0236	-0.0439	-0.0488	0.0698	-0.0488	Z
	13	51.7582	10.0445	1.1057	51.7591	10.0860	1.1080	-0.0009	-0.0415	-0.0023	0.0416	-0.0023	Z
	14	51.6004	13.9210	1.1055	51.5631	13.9710	1.1060	0.0373	-0.0500	-0.0005	0.0624	-0.0005	Z
	15	51.3668	17.0431	1.0940	51.3673	17.0821	1.0915	-0.0005	-0.0390	0.0025	0.0391	0.0025	Z
	16	47.6126	-0.8837	-0.9438	47.6228	-0.8762	-0.9575	-0.0102	0.0075	0.0137	0.0187	0.0137	Z
	17	48.3509	5.8897	1.1216	48.3849	5.9136	1.1272	-0.0340	-0.0239	-0.0056	0.0419	-0.0056	Z
	18	48.1070	10.0748	1.1029	48.1327	9.9980	1.1110	-0.0257	0.0768	-0.0081	0.0814	-0.0081	Z
	19	48.0699	12.8983	1.0945	48.0327	12.8949	1.0994	0.0372	0.0034	-0.0049	0.0377	-0.0049	Z
	20	47.9750	16.7744	1.0900	47.9981	16.8665	1.0935	-0.0231	-0.0921	-0.0035	0.0950	-0.0035	Z
	21	44.0373	-0.7478	0.0083	44.0663	-0.7222	0.0297	-0.0290	0.0256	-0.0214	0.0442	-0.0214	Z
	22	44.2257	5.1837	0.8805	44.2481	5.1884	0.8757	-0.0224	-0.0047	0.0048	0.0234	0.0048	Z
	23	44.0725	9.1192	0.8633	44.0623	9.1406	0.8602	0.0102	-0.0214	0.0031	0.0239	0.0031	Z
	24	44.0346	12.5745	0.8608	44.0182	12.5878	0.8601	0.0164	-0.0133	0.0007	0.0211	0.0007	Z
	25	43.8143	17.0111	0.8616	43.7957	17.0376	0.8603	0.0186	-0.0265	0.0013	0.0324	0.0013	Z
	26	40.7239	2.1397	1.1177	40.7037	2.1473	1.1241	0.0202	-0.0076	-0.0064	0.0225	-0.0064	Z
	27	40.8179	9.0553	1.0837	40.8249	9.1459	1.0878	-0.0070	-0.0906	-0.0041	0.0910	-0.0041	Z
	28	40.7306	16.5515	1.1051	40.7445	16.5633	1.0999	-0.0139	-0.0118	0.0052	0.0190	0.0052	Z
	29	34.1954	2.5069	-2.8487	34.1807	2.4892	-2.8500	0.0147	0.0177	0.0013	0.0230	0.0013	Z
	30	33.8603	12.6743	-2.8687	33.8708	12.7556	-2.8805	-0.0105	-0.0813	0.0118	0.0828	0.0118	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

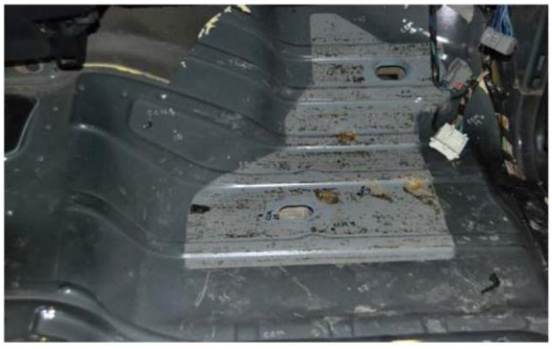
Pretest Floor Pan	Posttest Floor Pan
	

Figure D-4. Floor Pan Deformation Data – Set 2, Right Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
DRIVER SIDE INTERIOR CRUSH - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	49.1898	1.6305	-27.9275	49.2243	1.5360	-28.0022	-0.0345	0.0945	-0.0747	0.1253	0.1253	X, Y, Z
	2	47.7780	-11.1548	-29.4729	47.7820	-11.3336	-29.5262	-0.0040	-0.1788	-0.0533	0.1866	0.1866	X, Y, Z
	3	48.6049	-20.2712	-28.6598	48.4628	-20.4745	-28.6579	0.1421	-0.2033	0.0019	0.2480	0.2480	X, Y, Z
	4	42.1840	0.5394	-17.1129	42.1560	0.4403	-17.2066	0.0280	0.0991	-0.0937	0.1392	0.1392	X, Y, Z
	5	43.6308	-14.4268	-14.3714	43.5978	-14.5082	-14.4273	0.0330	-0.0814	-0.0559	0.1041	0.1041	X, Y, Z
	6	45.1436	-25.1882	-15.7569	45.0896	-25.2777	-15.8033	0.0540	-0.0895	-0.0464	0.1144	0.1144	X, Y, Z
SIDE PANEL (Y)	7	54.1078	-28.0166	-4.1540	54.0581	-28.0709	-4.2326	0.0497	-0.0543	-0.0786	0.1077	-0.0543	Y
	8	54.1988	-28.0169	-0.9124	54.1488	-28.0645	-1.0451	0.0500	-0.0476	-0.1327	0.1496	-0.0476	Y
	9	57.8218	-27.9354	-2.2871	57.7629	-27.9857	-2.4026	0.0589	-0.0503	-0.1155	0.1391	-0.0503	Y
IMPACT SIDE DOOR (Y)	10	43.4960	-29.9423	-20.2156	43.4199	-30.0216	-20.2160	0.0761	-0.0793	-0.0004	0.1099	-0.0793	Y
	11	33.9377	-29.8795	-19.8454	33.8433	-29.9467	-19.8047	0.0944	-0.0672	0.0407	0.1228	-0.0672	Y
	12	22.3800	-30.0084	-19.6874	22.3304	-30.0904	-19.6717	0.0496	-0.0820	0.0157	0.0971	-0.0820	Y
	13	43.7987	-29.1333	-6.5120	43.7633	-29.1422	-6.5751	0.0354	-0.0089	-0.0631	0.0729	-0.0089	Y
	14	33.7632	-31.3105	-4.3014	33.6753	-31.3426	-4.3007	0.0879	-0.0321	0.0007	0.0936	-0.0321	Y
	15	23.5852	-30.4765	-3.2173	23.5962	-30.5090	-3.2238	-0.0110	-0.0325	-0.0065	0.0349	-0.0325	Y
ROOF - (Z)	16	37.8580	2.1670	-43.1740	37.8029	2.0714	-43.2372	0.0551	0.0956	-0.0632	0.1272	-0.0632	Z
	17	37.6939	-1.6230	-43.1256	37.5138	-1.7439	-43.2199	0.1801	-0.1209	-0.0943	0.2365	-0.0943	Z
	18	37.1001	-5.8855	-43.1122	37.0036	-6.0042	-43.1788	0.0965	-0.1187	-0.0666	0.1668	-0.0666	Z
	19	36.2461	-10.5735	-43.0277	36.0623	-10.6640	-43.1213	0.1838	-0.0905	-0.0936	0.2252	-0.0936	Z
	20	36.2641	-15.5990	-42.8696	36.1619	-15.7132	-42.9185	0.1022	-0.1142	-0.0489	0.1609	-0.0489	Z
	21	31.4721	2.0225	-46.0039	31.3645	1.9781	-46.0463	0.1076	0.0444	-0.0424	0.1239	-0.0424	Z
	22	31.3402	-2.5291	-45.9526	31.3195	-2.6338	-45.9790	0.0207	-0.1047	-0.0264	0.1099	-0.0264	Z
	23	30.8261	-6.9696	-45.8773	30.7147	-7.1266	-45.9115	0.1114	-0.1570	-0.0342	0.1955	-0.0342	Z
	24	30.0009	-11.4835	-45.7535	29.8761	-11.6861	-45.7833	0.1248	-0.2026	-0.0298	0.2398	-0.0298	Z
	25	28.9769	-15.8569	-45.5677	28.8701	-16.0578	-45.5906	0.1068	-0.2009	-0.0229	0.2287	-0.0229	Z
	26	25.4908	2.2425	-46.5703	25.4103	2.2248	-46.5153	0.0805	0.0177	0.0550	0.0991	0.0550	Z
	27	25.2184	-2.7212	-46.5217	25.1221	-2.8006	-46.4747	0.0963	-0.0794	0.0470	0.1334	0.0470	Z
	28	24.8268	-8.3177	-46.3624	24.6452	-8.4435	-46.3448	0.1816	-0.1258	0.0176	0.2216	0.0176	Z
	29	24.3740	-12.3752	-46.2543	24.2180	-12.4898	-46.2569	0.1560	-0.1146	-0.0026	0.1936	-0.0026	Z
	30	23.6910	-16.3354	-46.0396	23.5792	-16.5181	-46.0536	0.1118	-0.1827	-0.0140	0.2146	-0.0140	Z
A-PILLAR Maximum (X, Y, Z)	31	54.0115	-26.7159	-28.7050	53.9547	-26.8076	-28.7550	0.0568	-0.0917	-0.0500	0.1189	0.0568	X
	32	51.2254	-26.0671	-30.6343	51.2662	-26.1931	-30.6623	-0.0408	-0.1260	-0.0280	0.1354	0.0000	NA
	33	48.9219	-25.4771	-32.4395	48.9647	-25.5987	-32.4372	-0.0428	-0.1216	0.0023	0.1289	0.0023	Z
	34	45.6732	-24.7573	-34.5211	45.6417	-24.8602	-34.5810	0.0315	-0.1029	-0.0599	0.1232	0.0315	X
	35	42.8437	-23.8357	-36.4727	42.8606	-23.9662	-36.4944	-0.0169	-0.1305	-0.0217	0.1334	0.0000	NA
	36	38.2557	-23.3233	-39.4924	38.2064	-23.4205	-39.4821	0.0493	-0.0972	0.0103	0.1095	0.0504	X, Z
A-PILLAR Lateral (Y)	31	54.0115	-26.7159	-28.7050	53.9547	-26.8076	-28.7550	0.0568	-0.0917	-0.0500	0.1189	-0.0917	Y
	32	51.2254	-26.0671	-30.6343	51.2662	-26.1931	-30.6623	-0.0408	-0.1260	-0.0280	0.1354	-0.1260	Y
	33	48.9219	-25.4771	-32.4395	48.9647	-25.5987	-32.4372	-0.0428	-0.1216	0.0023	0.1289	-0.1216	Y
	34	45.6732	-24.7573	-34.5211	45.6417	-24.8602	-34.5810	0.0315	-0.1029	-0.0599	0.1232	-0.1029	Y
	35	42.8437	-23.8357	-36.4727	42.8606	-23.9662	-36.4944	-0.0169	-0.1305	-0.0217	0.1334	-0.1305	Y
	36	38.2557	-23.3233	-39.4924	38.2064	-23.4205	-39.4821	0.0493	-0.0972	0.0103	0.1095	-0.0972	Y
B-PILLAR Maximum (X, Y, Z)	37	11.2564	-23.8483	-39.4081	11.1842	-23.9496	-39.4179	0.0722	-0.1013	-0.0098	0.1248	0.0722	X
	38	9.2070	-25.8764	-32.1045	9.1621	-25.9584	-32.1716	0.0449	-0.0820	-0.0671	0.1151	0.0449	X
	39	13.4769	-26.9348	-29.4082	13.3890	-27.0125	-29.4287	0.0879	-0.0777	-0.0205	0.1191	0.0879	X
	40	10.2129	-27.5650	-24.8905	10.1772	-27.6262	-24.9372	0.0357	-0.0612	-0.0467	0.0849	0.0357	X
B-PILLAR Lateral (Y)	37	11.2564	-23.8483	-39.4081	11.1842	-23.9496	-39.4179	0.0722	-0.1013	-0.0098	0.1248	-0.1013	Y
	38	9.2070	-25.8764	-32.1045	9.1621	-25.9584	-32.1716	0.0449	-0.0820	-0.0671	0.1151	-0.0820	Y
	39	13.4769	-26.9348	-29.4082	13.3890	-27.0125	-29.4287	0.0879	-0.0777	-0.0205	0.1191	-0.0777	Y
	40	10.2129	-27.5650	-24.8905	10.1772	-27.6262	-24.9372	0.0357	-0.0612	-0.0467	0.0849	-0.0612	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-5. Occupant Compartment Deformation Data – Set 1, Left, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
PASSENGER SIDE INTERIOR CRUSH - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	49.1432	9.1385	-27.8346	49.0880	9.1381	-27.9685	0.0552	0.0004	-0.1339	0.1448	0.1448	X, Y, Z
	2	49.7393	21.2090	-27.3929	49.6858	21.1960	-27.5253	0.0535	0.0130	-0.1324	0.1434	0.1434	X, Y, Z
	3	50.2698	32.6903	-26.7748	50.2079	32.6972	-26.9171	0.0619	-0.0069	-0.1423	0.1553	0.1553	X, Y, Z
	4	42.1593	6.9636	-17.0284	42.1140	6.8943	-17.1170	0.0453	0.0693	-0.0886	0.1213	0.1213	X, Y, Z
	5	44.3064	22.7196	-16.1282	44.2601	22.6697	-16.2291	0.0463	0.0499	-0.1009	0.1217	0.1217	X, Y, Z
	6	45.2295	34.6701	-15.7868	45.1848	34.7032	-15.9105	0.0447	-0.0331	-0.1237	0.1356	0.1356	X, Y, Z
SIDE PANEL (Y)	7	54.0896	36.2943	2.0182	54.1704	36.2795	1.9179	-0.0808	0.0148	-0.1003	0.1296	0.0148	Y
	8	57.1589	36.3277	-1.2564	57.0929	36.3082	-1.4265	0.0660	0.0195	-0.1701	0.1835	0.0195	Y
	9	54.3281	36.4196	-3.2005	54.4953	36.4007	-3.2110	-0.1672	0.0189	-0.0105	0.1686	0.0189	Y
IMPACT SIDE DOOR (Y)	10	44.4607	38.4321	-19.6730	44.4158	38.4231	-19.8183	0.0449	0.0090	-0.1453	0.1523	0.0090	Y
	11	33.0549	38.3729	-19.4215	32.9492	38.3661	-19.5144	0.1057	0.0068	-0.0929	0.1409	0.0068	Y
	12	20.6774	38.7337	-19.1717	20.5616	38.7478	-19.2225	0.1158	-0.0141	-0.0508	0.1272	-0.0141	Y
	13	41.5607	39.2803	0.7447	41.5642	39.2752	0.6965	-0.0035	0.0051	-0.0482	0.0486	0.0051	Y
	14	35.1127	39.2546	1.0023	35.0999	39.2493	0.8715	0.0128	0.0053	-0.1308	0.1315	0.0053	Y
	15	24.2925	38.6999	0.2481	24.2856	38.6955	0.1721	0.0069	0.0044	-0.0760	0.0764	0.0044	Y
ROOF - (Z)	16	37.9746	8.6853	-43.0494	37.7779	8.6165	-43.1848	0.1967	0.0688	-0.1354	0.2485	-0.1354	Z
	17	37.4692	15.0361	-42.9039	37.2385	15.0162	-43.0442	0.2307	0.0199	-0.1403	0.2707	-0.1403	Z
	18	36.3715	20.8721	-42.7285	36.2398	20.7758	-42.8484	0.1317	0.0963	-0.1199	0.2025	-0.1199	Z
	19	34.5334	25.8204	-42.7304	34.2966	25.7961	-42.8512	0.2368	0.0243	-0.1208	0.2669	-0.1208	Z
	20	33.0345	28.5154	-42.3974	32.8164	28.5126	-42.5122	0.2181	0.0028	-0.1148	0.2465	-0.1148	Z
	21	32.1290	6.8840	-45.8523	31.8549	6.7989	-45.9431	0.2741	0.0851	-0.0908	0.3010	-0.0908	Z
	22	32.4436	11.1378	-45.7016	32.2072	11.1469	-45.7932	0.2364	-0.0091	-0.0916	0.2537	-0.0916	Z
	23	32.3696	15.0110	-45.5514	32.1624	14.9369	-45.6478	0.2072	0.0741	-0.0964	0.2402	-0.0964	Z
	24	31.9191	19.1682	-45.3776	31.7480	19.1234	-45.4684	0.1711	0.0448	-0.0908	0.1988	-0.0908	Z
	25	30.8806	24.4583	-45.1003	30.6827	24.4537	-45.1756	0.1979	0.0046	-0.0753	0.2118	-0.0753	Z
	26	26.1863	6.6764	-46.5493	25.9278	6.6135	-46.5313	0.2585	0.0629	0.0180	0.2667	0.0180	Z
	27	26.2200	11.8518	-46.4362	25.9744	11.7419	-46.4312	0.2456	0.1099	0.0050	0.2691	0.0050	Z
	28	26.2773	15.3442	-46.2402	26.0984	15.3038	-46.2505	0.1789	0.0404	-0.0103	0.1837	-0.0103	Z
	29	26.1101	18.8466	-46.0749	25.8424	18.7987	-46.1080	0.2677	0.0479	-0.0331	0.2740	-0.0331	Z
	30	25.8919	23.6315	-45.7659	25.6578	23.6469	-45.8138	0.2341	-0.0154	-0.0479	0.2394	-0.0479	Z
A-PILLAR Maximum (X, Y, Z)	31	51.1920	34.7651	-29.2456	51.0423	34.7528	-29.4223	0.1497	0.0123	-0.1767	0.2319	0.1502	X, Y
	32	48.2658	33.3913	-31.6860	48.2080	33.3890	-31.8005	0.0578	0.0023	-0.1145	0.1283	0.0578	X, Y
	33	45.4049	32.7782	-33.8699	45.2661	32.7578	-34.0003	0.1388	0.0204	-0.1304	0.1915	0.1403	X, Y
	34	41.9507	32.0128	-36.3032	41.8209	31.9981	-36.4320	0.1298	0.0147	-0.1288	0.1834	0.1306	X, Y
	35	38.9635	31.2890	-38.1571	38.8847	31.3295	-38.3330	0.0788	-0.0405	-0.1759	0.1970	0.0788	X
	36	35.6071	30.6123	-40.8898	35.4994	30.6628	-41.0296	0.1077	-0.0505	-0.1398	0.1836	0.1077	X
A-PILLAR Lateral (Y)	31	51.1920	34.7651	-29.2456	51.0423	34.7528	-29.4223	0.1497	0.0123	-0.1767	0.2319	0.0123	Y
	32	48.2658	33.3913	-31.6860	48.2080	33.3890	-31.8005	0.0578	0.0023	-0.1145	0.1283	0.0023	Y
	33	45.4049	32.7782	-33.8699	45.2661	32.7578	-34.0003	0.1388	0.0204	-0.1304	0.1915	0.0204	Y
	34	41.9507	32.0128	-36.3032	41.8209	31.9981	-36.4320	0.1298	0.0147	-0.1288	0.1834	0.0147	Y
	35	38.9635	31.2890	-38.1571	38.8847	31.3295	-38.3330	0.0788	-0.0405	-0.1759	0.1970	-0.0405	Y
	36	35.6071	30.6123	-40.8898	35.4994	30.6628	-41.0296	0.1077	-0.0505	-0.1398	0.1836	-0.0505	Y
B-PILLAR Maximum (X, Y, Z)	37	13.9501	35.9315	-24.4916	13.8886	35.9488	-24.5026	0.0615	-0.0173	-0.0110	0.0648	0.0615	X
	38	9.4568	34.3470	-30.9472	9.3316	34.3492	-30.9946	0.1252	-0.0022	-0.0474	0.1339	0.1252	X
	39	13.0230	33.5863	-34.9154	12.9319	33.5930	-34.9710	0.0911	-0.0067	-0.0556	0.1069	0.0911	X
	40	11.2013	32.3156	-39.0182	10.9811	32.3208	-39.0758	0.2202	-0.0052	-0.0576	0.2277	0.2202	X
B-PILLAR Lateral (Y)	37	13.9501	35.9315	-24.4916	13.8886	35.9488	-24.5026	0.0615	-0.0173	-0.0110	0.0648	-0.0173	Y
	38	9.4568	34.3470	-30.9472	9.3316	34.3492	-30.9946	0.1252	-0.0022	-0.0474	0.1339	-0.0022	Y
	39	13.0230	33.5863	-34.9154	12.9319	33.5930	-34.9710	0.0911	-0.0067	-0.0556	0.1069	-0.0067	Y
	40	11.2013	32.3156	-39.0182	10.9811	32.3208	-39.0758	0.2202	-0.0052	-0.0576	0.2277	-0.0052	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-6. Occupant Compartment Deformation Data – Set 1, Right, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
DRIVER SIDE INTERIOR CRUSH - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	50.2519	-13.6551	-32.1002	50.3413	-13.6587	-32.0586	-0.0894	-0.0036	0.0416	0.0987	0.0987	X, Y, Z
	2	49.2516	-26.4831	-33.6129	49.3261	-26.5697	-33.5773	-0.0745	-0.0866	0.0356	0.1197	0.1197	X, Y, Z
	3	50.3673	-35.5662	-32.7730	50.3023	-35.6828	-32.6991	0.0650	-0.1166	0.0739	0.1526	0.1526	X, Y, Z
	4	43.2631	-14.9399	-21.2958	43.2737	-14.9776	-21.2875	-0.0106	-0.0377	0.0083	0.0400	0.0400	X, Y, Z
	5	45.1811	-29.8448	-18.5103	45.1935	-29.8690	-18.4910	-0.0124	-0.0242	0.0193	0.0333	0.0333	X, Y, Z
	6	47.0391	-40.5562	-19.8631	47.0417	-40.5848	-19.8528	-0.0026	-0.0286	0.0103	0.0305	0.0305	X, Y, Z
SIDE PANEL (Y)	7	56.0662	-43.0659	-8.2356	56.0550	-43.0752	-8.2477	0.0112	-0.0093	-0.0121	0.0189	-0.0093	Y
	8	56.1507	-43.0545	-4.9939	56.1338	-43.0636	-5.0600	0.0169	-0.0091	-0.0661	0.0688	-0.0091	Y
	9	59.7720	-42.8611	-6.3620	59.7484	-42.8676	-6.4045	0.0236	-0.0065	-0.0425	0.0490	-0.0065	Y
IMPACT SIDE DOOR (Y)	10	45.5528	-45.3725	-24.3118	45.5439	-45.3839	-24.2676	0.0089	-0.0114	0.0442	0.0465	-0.0114	Y
	11	35.9966	-45.6137	-23.9598	35.9686	-45.6220	-23.8907	0.0280	-0.0083	0.0691	0.0750	-0.0083	Y
	12	24.4487	-46.1108	-23.8232	24.4662	-46.1420	-23.7989	-0.0175	-0.0312	0.0243	0.0432	-0.0312	Y
	13	45.8026	-44.5172	-10.6099	45.8092	-44.4843	-10.6263	-0.0066	0.0329	-0.0164	0.0373	0.0329	Y
	14	35.8372	-47.0075	-8.4122	35.7904	-47.0118	-8.3863	0.0468	-0.0043	0.0259	0.0537	-0.0043	Y
	15	25.6357	-46.4957	-7.3496	25.6856	-46.5075	-7.3462	-0.0499	-0.0118	0.0034	0.0514	-0.0118	Y
ROOF - (Z)	16	38.9387	-13.5216	-47.3694	38.9636	-13.5077	-47.3349	-0.0249	0.0139	0.0345	0.0448	0.0345	Z
	17	38.8955	-17.3147	-47.3108	38.7993	-17.3304	-47.3156	0.0962	-0.0157	-0.0048	0.0976	-0.0048	Z
	18	38.4380	-21.5940	-47.2868	38.4286	-21.6051	-47.2728	0.0094	-0.0111	0.0140	0.0202	0.0140	Z
	19	37.7338	-26.3066	-47.1909	37.6399	-26.2932	-47.2148	0.0939	0.0134	-0.0239	0.0978	-0.0239	Z
	20	37.9117	-31.3285	-47.0189	37.9039	-31.3363	-47.0076	0.0078	-0.0078	0.0113	0.0158	0.0113	Z
	21	32.5662	-13.8774	-50.2109	32.5418	-13.8135	-50.1669	0.0244	0.0639	0.0440	0.0813	0.0440	Z
	22	32.5795	-18.4307	-50.1473	32.6474	-18.4244	-50.0961	-0.0679	0.0063	0.0512	0.0853	0.0512	Z
	23	32.2072	-22.8851	-50.0606	32.1896	-22.9346	-50.0271	0.0176	-0.0495	0.0335	0.0623	0.0335	Z
	24	31.5261	-27.4227	-49.9259	31.5001	-27.5189	-49.8981	0.0260	-0.0962	0.0278	0.1035	0.0278	Z
	25	30.6418	-31.8260	-49.7300	30.6369	-31.9210	-49.7055	0.0049	-0.0950	0.0245	0.0982	0.0245	Z
	26	26.5821	-13.8498	-50.7892	26.5844	-13.7620	-50.6575	-0.0023	0.0878	0.1317	0.1583	0.1317	Z
	27	26.4681	-18.8196	-50.7274	26.4606	-18.7941	-50.6138	0.0075	0.0255	0.1136	0.1167	0.1136	Z
	28	26.2549	-24.4252	-50.5534	26.1680	-24.4495	-50.4811	0.0869	-0.0243	0.0723	0.1156	0.0723	Z
	29	25.9315	-28.4948	-50.4348	25.8731	-28.5076	-50.3914	0.0584	-0.0128	0.0434	0.0739	0.0434	Z
	30	25.3748	-32.4742	-50.2105	25.3656	-32.5545	-50.1871	0.0092	-0.0803	0.0234	0.0841	0.0234	Z
A-PILLAR Maximum (X, Y, Z)	31	55.9768	-41.8352	-32.7903	55.9987	-41.8330	-32.7714	-0.0219	0.0022	0.0189	0.0290	0.0190	Y, Z
	32	53.1751	-41.2809	-34.7266	53.2985	-41.3081	-34.6889	-0.1234	-0.0272	0.0377	0.1319	0.0377	Z
	33	50.8575	-40.7695	-36.5377	50.9852	-40.7905	-36.4725	-0.1277	-0.0210	0.0652	0.1449	0.0652	Z
	34	47.5917	-40.1594	-38.6275	47.6476	-40.1626	-38.6287	-0.0559	-0.0032	-0.0012	0.0560	0.0000	NA
	35	44.7381	-39.3338	-40.5869	44.8457	-39.3613	-40.5528	-0.1076	-0.0275	0.0341	0.1162	0.0341	Z
	36	40.1421	-38.9762	-43.6166	40.1869	-38.9703	-43.5576	-0.0448	0.0059	0.0590	0.0743	0.0593	Y, Z
A-PILLAR Lateral (Y)	31	55.9768	-41.8352	-32.7903	55.9987	-41.8330	-32.7714	-0.0219	0.0022	0.0189	0.0290	0.0022	Y
	32	53.1751	-41.2809	-34.7266	53.2985	-41.3081	-34.6889	-0.1234	-0.0272	0.0377	0.1319	-0.0272	Y
	33	50.8575	-40.7695	-36.5377	50.9852	-40.7905	-36.4725	-0.1277	-0.0210	0.0652	0.1449	-0.0210	Y
	34	47.5917	-40.1594	-38.6275	47.6476	-40.1626	-38.6287	-0.0559	-0.0032	-0.0012	0.0560	-0.0032	Y
	35	44.7381	-39.3338	-40.5869	44.8457	-39.3613	-40.5528	-0.1076	-0.0275	0.0341	0.1162	-0.0275	Y
	36	40.1421	-38.9762	-43.6166	40.1869	-38.9703	-43.5576	-0.0448	0.0059	0.0590	0.0743	0.0059	Y
B-PILLAR Maximum (X, Y, Z)	37	13.1731	-40.3620	-43.5817	13.1964	-40.3827	-43.5898	-0.0233	-0.0207	-0.0081	0.0322	0.0000	NA
	38	11.1750	-42.4347	-36.2764	11.2149	-42.4516	-36.3492	-0.0399	-0.0169	-0.0728	0.0847	0.0000	NA
	39	15.4712	-43.3491	-33.5691	15.4641	-43.3649	-33.5903	0.0071	-0.0158	-0.0212	0.0274	0.0071	X
	40	12.2201	-44.0708	-29.0559	12.2579	-44.0803	-29.1099	-0.0378	-0.0095	-0.0540	0.0666	0.0000	NA
B-PILLAR Lateral (Y)	37	13.1731	-40.3620	-43.5817	13.1964	-40.3827	-43.5898	-0.0233	-0.0207	-0.0081	0.0322	-0.0207	Y
	38	11.1750	-42.4347	-36.2764	11.2149	-42.4516	-36.3492	-0.0399	-0.0169	-0.0728	0.0847	-0.0169	Y
	39	15.4712	-43.3491	-33.5691	15.4641	-43.3649	-33.5903	0.0071	-0.0158	-0.0212	0.0274	-0.0158	Y
	40	12.2201	-44.0708	-29.0559	12.2579	-44.0803	-29.1099	-0.0378	-0.0095	-0.0540	0.0666	-0.0095	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-7. Occupant Compartment Deformation Data – Set 2, Left, Test No. MOS-5

Date: 4/9/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795
Year: 2011 Make: Dodge Model: Ram 1500

VEHICLE DEFORMATION
PASSENGER SIDE INTERIOR CRUSH - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	49.9442	-6.1007	-32.0359	49.9365	-6.0962	-32.0485	0.0077	0.0045	-0.0126	0.0154	0.0154	X, Y, Z
	2	50.1598	5.9826	-31.5949	50.1520	5.9746	-31.6049	0.0078	0.0080	-0.0100	0.0150	0.0150	X, Y, Z
	3	50.3281	17.4750	-30.9776	50.3090	17.4866	-30.9966	0.0191	-0.0116	-0.0190	0.0293	0.0293	X, Y, Z
	4	43.0227	-8.4934	-21.2355	43.0036	-8.5587	-21.2181	0.0191	-0.0653	0.0174	0.0702	0.0702	X, Y, Z
	5	44.6722	7.3224	-20.3351	44.6480	7.2766	-20.3255	0.0242	0.0458	0.0096	0.0527	0.0527	X, Y, Z
	6	45.2184	19.2961	-19.9942	45.1914	19.3332	-20.0056	0.0270	-0.0371	-0.0114	0.0473	0.0473	X, Y, Z
SIDE PANEL (Y)	7	54.0074	21.1997	-2.1818	54.0684	21.1928	-2.1500	-0.0610	0.0069	0.0318	0.0691	0.0069	Y
	8	57.0770	21.3294	-5.4537	56.9987	21.3137	-5.4855	0.0783	0.0157	-0.0318	0.0860	0.0157	Y
	9	54.2464	21.3321	-7.4003	54.4049	21.3242	-7.2780	-0.1585	0.0079	0.1223	0.2004	0.0079	Y
IMPACT SIDE DOOR (Y)	10	44.3349	23.0317	-23.8815	44.3174	23.0269	-23.9162	0.0175	0.0048	-0.0347	0.0392	0.0048	Y
	11	32.9365	22.6136	-23.6399	32.8574	22.6080	-23.6472	0.0791	0.0056	-0.0073	0.0796	0.0056	Y
	12	20.5535	22.5847	-23.4009	20.4631	22.5986	-23.3932	0.0904	-0.0139	0.0077	0.0918	-0.0139	Y
	13	41.3919	23.7899	-3.4664	41.3776	23.7892	-3.4102	0.0143	0.0007	0.0562	0.0580	0.0007	Y
	14	34.9477	23.5613	-3.2144	34.9169	23.5591	-3.2550	0.0308	0.0022	-0.0406	0.0510	0.0022	Y
	15	24.1509	22.6662	-3.9779	24.1276	22.6643	-3.9873	0.0233	0.0019	-0.0094	0.0252	0.0019	Y
ROOF - (Z)	16	38.8086	-6.9064	-47.2603	38.6950	-6.9750	-47.2991	0.1136	-0.0686	-0.0388	0.1383	-0.0388	Z
	17	38.1035	-0.5746	-47.1160	37.9534	-0.5955	-47.1610	0.1501	-0.0209	-0.0450	0.1581	-0.0450	Z
	18	36.8224	5.2240	-46.9421	36.7728	5.1298	-46.9690	0.0496	0.0942	-0.0269	0.1098	-0.0269	Z
	19	34.8296	10.1120	-46.9461	34.6721	10.0862	-46.9783	0.1575	0.0258	-0.0322	0.1628	-0.0322	Z
	20	33.2463	12.7585	-46.6148	33.1059	12.7547	-46.6441	0.1404	0.0038	-0.0293	0.1435	-0.0293	Z
	21	33.0250	-8.8910	-50.0681	32.8408	-8.9787	-50.0754	0.1842	-0.0877	-0.0073	0.2041	-0.0073	Z
	22	33.2055	-4.6293	-49.9176	33.0551	-4.6217	-49.9248	0.1504	0.0076	-0.0072	0.1508	-0.0072	Z
	23	33.0095	-0.7604	-49.7679	32.8903	-0.8350	-49.7800	0.1192	-0.0746	-0.0121	0.1411	-0.0121	Z
	24	32.4283	3.3805	-49.5950	32.3435	3.3363	-49.6024	0.0848	0.0442	-0.0074	0.0959	-0.0074	Z
	25	31.2235	8.6354	-49.3191	31.1095	8.6304	-49.3135	0.1140	0.0050	0.0056	0.1142	0.0056	Z
	26	27.0924	-9.2855	-50.7702	26.9243	-9.3511	-50.6816	0.1681	-0.0656	0.0886	0.2010	0.0886	Z
	27	26.9631	-4.1116	-50.6577	26.8086	-4.2237	-50.5820	0.1545	-0.1121	0.0757	0.2053	0.0757	Z
	28	26.9103	-0.6191	-50.4620	26.8196	-0.6596	-50.4013	0.0907	-0.0405	0.0607	0.1164	0.0607	Z
	29	26.6328	2.8763	-50.2973	26.4530	2.8254	-50.2600	0.1798	0.0509	0.0373	0.1906	0.0373	Z
	30	26.2639	7.6519	-49.9889	26.1146	7.6653	-49.9670	0.1493	-0.0134	0.0219	0.1515	0.0219	Z
A-PILLAR Maximum (X, Y, Z)	31	51.1867	19.5776	-33.4478	51.0857	19.5674	-33.4994	0.1010	0.0102	-0.0516	0.1139	0.1015	X, Y
	32	48.3072	18.1122	-35.8906	48.3031	18.1147	-35.8861	0.0041	-0.0025	0.0045	0.0066	0.0061	X, Z
	33	45.4690	17.4092	-38.0770	45.3893	17.3909	-38.0949	0.0797	0.0183	-0.0179	0.0837	0.0818	X, Y
	34	42.0427	16.5353	-40.5132	41.9773	16.5229	-40.5369	0.0654	0.0124	-0.0237	0.0707	0.0666	X, Y
	35	39.0814	15.7176	-42.3696	39.0695	15.7618	-42.4468	0.0119	-0.0442	-0.0772	0.0898	0.0119	X
	36	35.7503	14.9354	-45.1052	35.7151	14.9885	-45.1536	0.0352	-0.0531	-0.0484	0.0800	0.0352	X
A-PILLAR Lateral (Y)	31	51.1867	19.5776	-33.4478	51.0857	19.5674	-33.4994	0.1010	0.0102	-0.0516	0.1139	0.0102	Y
	32	48.3072	18.1122	-35.8906	48.3031	18.1147	-35.8861	0.0041	-0.0025	0.0045	0.0066	-0.0025	Y
	33	45.4690	17.4092	-38.0770	45.3893	17.3909	-38.0949	0.0797	0.0183	-0.0179	0.0837	0.0183	Y
	34	42.0427	16.5353	-40.5132	41.9773	16.5229	-40.5369	0.0654	0.0124	-0.0237	0.0707	0.0124	Y
	35	39.0814	15.7176	-42.3696	39.0695	15.7618	-42.4468	0.0119	-0.0442	-0.0772	0.0898	-0.0442	Y
	36	35.7503	14.9354	-45.1052	35.7151	14.9885	-45.1536	0.0352	-0.0531	-0.0484	0.0800	-0.0531	Y
B-PILLAR Maximum (X, Y, Z)	37	13.9224	19.5717	-28.7263	13.8980	19.5902	-28.6933	0.0244	-0.0185	0.0330	0.0450	0.0410	X, Z
	38	9.4868	17.8461	-35.1857	9.4135	17.8474	-35.1990	0.0733	-0.0013	-0.0133	0.0745	0.0733	X
	39	13.0786	17.1977	-39.1507	13.0480	17.2050	-39.1643	0.0306	-0.0073	-0.0136	0.0343	0.0306	X
	40	11.3014	15.8700	-43.2549	11.1508	15.8719	-43.2749	0.1506	-0.0019	-0.0200	0.1519	0.1506	X
B-PILLAR Lateral (Y)	37	13.9224	19.5717	-28.7263	13.8980	19.5902	-28.6933	0.0244	-0.0185	0.0330	0.0450	-0.0185	Y
	38	9.4868	17.8461	-35.1857	9.4135	17.8474	-35.1990	0.0733	-0.0013	-0.0133	0.0745	-0.0013	Y
	39	13.0786	17.1977	-39.1507	13.0480	17.2050	-39.1643	0.0306	-0.0073	-0.0136	0.0343	-0.0073	Y
	40	11.3014	15.8700	-43.2549	11.1508	15.8719	-43.2749	0.1506	-0.0019	-0.0200	0.1519	-0.0019	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

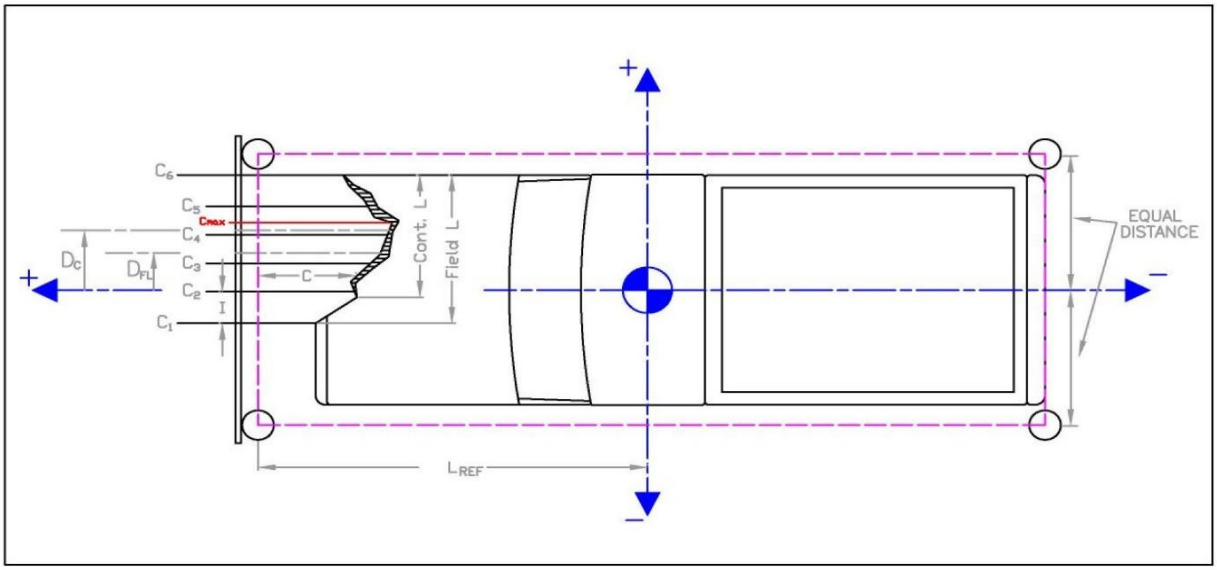
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-8. Occupant Compartment Deformation Data – Set 2, Right, Test No. MOS-5

Date: 5/17/2019 Test Name: MOS-5 VIN: 1D7RB1CT2BS657795

Year: 2011 Make: Dodge Model: Ram 1500



	in.	(mm)
Distance from C.G. to reference line - L_{REF}:	104	(2642)
Total Vehicle Width:	77 1/8	(1959)
Width of contact and induced crush - Field L:	77 1/8	(1959)
Crush measurement spacing interval (L/5) - I:	15 3/8	(391)
Distance from center of vehicle to center of Field L - D_{FL}:	0	()
Width of Contact Damage:	34 1/4	(870)
Distance from center of vehicle to center of contact damage - D_C:	0	()

NOTE: Enter "NA" for crush measurement if distance can not be measured (i.e., side of vehicle has been pushed inward)
NOTE: All values must be filled out above before crush measurements are filled out.

	Crush Measurement		Lateral Location		Original Profile Measurement		Dist. Between Ref. Lines		Actual Crush	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
C_1	N/A	#VALUE!	-38 5/8	-(981)	22 1/2	(572)	- 1/3	-(8)	#VALUE!	#VALUE!
C_2	5 5/8	(143)	-23 1/4	-(591)	6 1/2	(165)			- 4/7	-(14)
C_3	3 7/8	(98)	-7 7/8	-(200)	4 1/4	(108)			-0	-(2)
C_4	3 7/8	(98)	7 1/2	(191)	4 1/4	(108)			-0	-(2)
C_5	5 3/8	(137)	22 7/8	(581)	6 1/8	(156)			- 4/9	-(11)
C_6	N/A	#VALUE!	38 1/4	(972)	20 1/2	(521)			#VALUE!	#VALUE!
C_{MAX}	5 5/8	(143)	-23 1/4	-(591)	6 1/2	(165)			- 4/7	-(14)

Figure D-9. Exterior Vehicle Crush (NASS) – Front, Test No. MOS-5

Date:	4/9/2019	Test Name:	MOS-5	VIN:	1D7RB1CT2BS657795
Year:	2011	Make:	Dodge	Model:	Ram 1500

Driver Side Maximum Deformation

Reference Set 1				Reference Set 2			
Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]	Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]
Roof	0.1	≤ 4	Z	Roof	0.1	≤ 4	Z
Windshield[D]	0.0	≤ 3	X, Z	Windshield[D]	NA	≤ 3	X, Z
A-Pillar Maximum	0.1	≤ 5	X	A-Pillar Maximum	0.1	≤ 5	Z
A-Pillar Lateral	-0.1	≤ 3	Y	A-Pillar Lateral	0.0	≤ 3	Y
B-Pillar Maximum	0.1	≤ 5	X	B-Pillar Maximum	0.0	≤ 5	X
B-Pillar Lateral	-0.1	≤ 3	Y	B-Pillar Lateral	0.0	≤ 3	Y
Toe Pan - Wheel Well	0.2	≤ 9	Z	Toe Pan - Wheel Well	0.0	≤ 9	X
Side Front Panel	0.0	≤ 12	Y	Side Front Panel	0.0	≤ 12	Y
Side Door (above seat)	-0.1	≤ 9	Y	Side Door (above seat)	0.0	≤ 9	Y
Side Door (below seat)	0.0	≤ 12	Y	Side Door (below seat)	0.0	≤ 12	Y
Floor Pan	0.1	≤ 12	Z	Floor Pan	0.0	≤ 12	Z
Dash - no MASH requirement	0.2	NA	X, Y, Z	Dash - no MASH requirement	0.2	NA	X, Y, Z

[A] Items highlighted in red do not meet MASH allowable deformations.

[B] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[C] For Toe Pan - Wheel Well the direction of defromation may include X and Z direction. For A-Pillar Maximum and B-Pillar Maximum the direction of deformation may include X, Y, and Z directions. The direction of deformation for Toe Pan -Wheel Well, A-Pillar Maximum, and B-Pillar Maximum only include components where the deformation is positive and intruding into the occupant compartment. If direction of deformation is "NA" then no intrusion is recorded and deformation will be 0.

[D] If deformation is observered for the windshield then the windshield deformation is measured posttest with an examplar vehicle, therefore only one set of reference is measured and recorded.

Notes on vehicle interior crush:

Figure D-10. Maximum Occupant Compartment Deformation, Left, Test No. MOS-5

Date:	4/9/2019	Test Name:	MOS-5	VIN:	1D7RB1CT2BS657795
Year:	2011	Make:	Dodge	Model:	Ram 1500

Passenger Side Maximum Deformation

Reference Set 1				Reference Set 2			
Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]	Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]
Roof	0.0	≤ 4	Z	Roof	0.1	≤ 4	Z
Windshield[D]	0.0	≤ 3	X, Z	Windshield[D]	NA	≤ 3	X, Z
A-Pillar Maximum	0.2	≤ 5	X, Y	A-Pillar Maximum	0.1	≤ 5	X, Y
A-Pillar Lateral	0.0	≤ 3	Y	A-Pillar Lateral	0.0	≤ 3	Y
B-Pillar Maximum	0.2	≤ 5	X	B-Pillar Maximum	0.2	≤ 5	X
B-Pillar Lateral	0.0	≤ 3	Y	B-Pillar Lateral	0.0	≤ 3	Y
Toe Pan - Wheel Well	0.2	≤ 9	Z	Toe Pan - Wheel Well	0.1	≤ 9	X
Side Front Panel	0.0	≤ 12	Y	Side Front Panel	0.0	≤ 12	Y
Side Door (above seat)	0.0	≤ 9	Y	Side Door (above seat)	0.0	≤ 9	Y
Side Door (below seat)	0.0	≤ 12	Y	Side Door (below seat)	0.0	≤ 12	Y
Floor Pan	0.2	≤ 12	Z	Floor Pan	0.0	≤ 12	Z
Dash - no MASH requirement	0.2	NA	X, Y, Z	Dash - no MASH requirement	0.2	NA	X, Y, Z

[A] Items highlighted in red do not meet MASH allowable deformations.

[B] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[C] For Toe Pan - Wheel Well the direction of defromation may include X and Z direction. For A-Pillar Maximum and B-Pillar Maximum the direction of deformation may include X, Y, and Z directions. The direction of deformation for Toe Pan -Wheel Well, A-Pillar Maximum, and B-Pillar Maximum only include components where the deformation is positive and intruding into the occupant compartment. If direction of deformation is "NA" then no intrusion is recorded and deformation will be 0.

[D] If deformation is observered for the windshield then the windshield deformation is measured posttest with an examplar vehicle, therefore only one set of reference is measured and recorded.

Notes on vehicle interior crush:

Figure D-11. Maximum Occupant Compartment Deformation, Right, Test No. MOS-5

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE FLOOR PAN - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	61.8128	-11.7593	7.2038	61.6657	-11.7489	7.0962	0.1471	0.0104	0.1076	0.1825	0.1823	X, Z
	2	62.0064	-16.3188	7.0223	61.9722	-16.3461	6.8316	0.0342	-0.0273	0.1907	0.1957	0.1937	X, Z
	3	62.3112	-19.5915	6.9105	62.2351	-19.5627	6.7209	0.0761	0.0288	0.1896	0.2063	0.2043	X, Z
	4	62.3161	-21.7595	6.6248	62.2367	-21.7892	6.4727	0.0794	-0.0297	0.1521	0.1741	0.1716	X, Z
	5	62.4873	-24.4572	6.8508	62.3859	-24.4856	6.7240	0.1014	-0.0284	0.1268	0.1648	0.1624	X, Z
	6	59.7978	-12.0193	8.3810	59.8460	-11.9959	8.1879	-0.0482	0.0234	0.1931	0.2004	0.1931	Z
	7	59.6291	-16.7326	8.3959	59.5722	-16.6630	8.2673	0.0569	0.0696	0.1286	0.1569	0.1406	X, Z
	8	59.7817	-19.1878	8.3361	59.7394	-19.2077	8.1994	0.0423	-0.0199	0.1367	0.1445	0.1431	X, Z
	9	59.6272	-22.6077	8.4202	59.5398	-22.6257	8.3492	0.0874	-0.0180	0.0710	0.1140	0.1126	X, Z
	10	59.6037	-24.8317	8.5327	59.5524	-24.8856	8.4816	0.0513	-0.0539	0.0511	0.0903	0.0724	X, Z
FLOOR PAN (Z)	11	54.5480	-12.7430	8.9774	54.5603	-12.7113	8.8467	-0.0123	0.0317	0.1307	0.1351	0.1307	Z
	12	54.7525	-16.1974	9.1428	54.7523	-16.1919	8.9681	0.0002	0.0055	0.1747	0.1748	0.1747	Z
	13	54.4357	-19.2360	9.1195	54.4279	-19.1863	9.0294	0.0078	0.0497	0.0901	0.1032	0.0901	Z
	14	54.5653	-23.3340	9.0670	54.5701	-23.3638	8.9969	-0.0048	-0.0298	0.0701	0.0763	0.0701	Z
	15	54.4178	-28.0799	9.1454	54.3122	-28.0372	9.0694	0.1056	0.0427	0.0760	0.1369	0.0760	Z
	16	51.2540	-12.1059	9.5253	51.2752	-12.0471	9.4030	-0.0212	0.0588	0.1223	0.1373	0.1223	Z
	17	51.1514	-15.8263	9.5432	51.0857	-15.7492	9.4157	0.0657	0.0771	0.1275	0.1628	0.1275	Z
	18	51.1496	-19.4233	9.0922	51.0984	-19.3888	9.0446	0.0512	0.0345	0.0476	0.0780	0.0476	Z
	19	51.0456	-25.1297	9.2921	51.0477	-25.1182	9.2187	-0.0021	0.0115	0.0734	0.0743	0.0734	Z
	20	50.5631	-29.3529	9.4062	50.5799	-29.3280	9.3549	-0.0168	0.0249	0.0513	0.0594	0.0513	Z
	21	46.0457	-12.2138	9.6147	46.1093	-12.2154	9.5453	-0.0636	-0.0016	0.0694	0.0941	0.0694	Z
	22	45.8762	-16.0321	9.6286	45.8558	-15.9996	9.5715	0.0204	0.0325	0.0571	0.0688	0.0571	Z
	23	45.8427	-19.3494	9.0445	45.8270	-19.3263	9.0142	0.0157	0.0231	0.0303	0.0412	0.0303	Z
	24	46.1013	-23.9310	9.0151	46.0269	-23.9332	9.0026	0.0744	-0.0022	0.0125	0.0755	0.0125	Z
	25	46.3118	-29.3862	9.4645	46.3381	-29.3666	9.3605	-0.0263	0.0196	0.1040	0.1090	0.1040	Z
	26	41.3811	-12.6581	9.3365	41.3355	-12.5249	9.2659	0.0456	0.1332	0.0706	0.1575	0.0706	Z
	27	41.1590	-16.5367	9.2133	41.1642	-16.5156	9.1961	-0.0052	0.0211	0.0172	0.0277	0.0172	Z
	28	41.0802	-20.8120	8.8823	41.0675	-20.7933	8.8617	0.0127	0.0187	0.0206	0.0306	0.0206	Z
	29	41.0037	-24.6704	8.9820	41.0094	-24.6674	8.9849	-0.0057	0.0030	-0.0029	0.0071	-0.0029	Z
	30	41.0149	-28.0699	9.1375	40.9861	-28.0818	9.0735	0.0288	-0.0119	0.0640	0.0712	0.0640	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-12. Floor Pan Deformation – Set 1, Left, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE FLOOR PAN - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	61.3264	0.9264	7.3827	61.2473	0.8861	7.1817	0.0791	0.0403	0.2010	0.2197	0.2160	X, Z
	2	61.2017	5.2537	7.3066	61.0331	5.1970	7.0518	0.1686	0.0567	0.2548	0.3107	0.3055	X, Z
	3	60.9344	8.7567	7.4571	60.7798	8.6941	7.2401	0.1546	0.0626	0.2170	0.2737	0.2664	X, Z
	4	60.7751	12.4369	7.5204	60.6581	12.3923	7.3204	0.1170	0.0446	0.2000	0.2360	0.2317	X, Z
	5	60.4151	16.5302	7.1835	60.2598	16.4944	7.1364	0.1553	0.0358	0.0471	0.1662	0.1623	X, Z
	6	59.0255	0.9341	8.6986	58.9355	0.8808	8.5699	0.0900	0.0533	0.1287	0.1658	0.1570	X, Z
	7	59.3825	5.3460	8.3319	59.2399	5.2899	8.1320	0.1426	0.0561	0.1999	0.2519	0.2455	X, Z
	8	59.5417	8.9801	8.2519	59.4163	8.9281	8.1099	0.1254	0.0520	0.1420	0.1965	0.1894	X, Z
	9	59.2882	12.5157	8.3733	59.1940	12.4927	8.2515	0.0942	0.0230	0.1218	0.1557	0.1540	X, Z
	10	59.1963	18.0783	8.3107	58.9378	17.9302	8.1774	0.2585	0.1481	0.1333	0.3264	0.2908	X, Z
FLOOR PAN (Z)	11	54.2931	0.8197	9.0594	54.2430	0.7441	8.9335	0.0501	0.0756	0.1259	0.1552	0.1259	Z
	12	54.2384	5.2474	9.2950	54.2094	5.1668	9.1449	0.0290	0.0806	0.1501	0.1728	0.1501	Z
	13	54.3339	10.5190	9.1274	54.3149	10.4646	9.0807	0.0190	0.0544	0.0467	0.0742	0.0467	Z
	14	54.2053	14.7389	9.3974	54.1990	14.7106	9.2675	0.0063	0.0283	0.1299	0.1331	0.1299	Z
	15	54.1313	18.9783	9.4353	54.1633	18.9542	9.3860	-0.0320	0.0241	0.0493	0.0635	0.0493	Z
	16	49.9326	1.0167	9.7297	49.8795	0.9534	9.6221	0.0531	0.0633	0.1076	0.1357	0.1076	Z
	17	49.5251	5.0024	9.6192	49.4702	4.9842	9.4853	0.0549	0.0182	0.1339	0.1459	0.1339	Z
	18	49.5406	9.4250	9.2256	49.4620	9.4041	9.2647	0.0786	0.0209	-0.0391	0.0902	-0.0391	Z
	19	48.9191	13.5072	9.5421	48.9085	13.4703	9.5193	0.0106	0.0369	0.0228	0.0447	0.0228	Z
	20	48.7576	18.5576	9.6541	48.7686	18.5354	9.6145	-0.0110	0.0222	0.0396	0.0467	0.0396	Z
	21	44.1425	0.8896	9.7232	44.1186	0.8850	9.6438	0.0239	0.0046	0.0794	0.0830	0.0794	Z
	22	43.9058	5.4437	9.4629	43.8415	5.3923	9.4545	0.0643	0.0514	0.0084	0.0827	0.0084	Z
	23	43.7895	9.3371	9.1915	43.7381	9.2816	9.1832	0.0514	0.0555	0.0083	0.0761	0.0083	Z
	24	43.8204	14.0515	9.7289	43.8046	14.0461	9.7686	0.0158	0.0054	-0.0397	0.0431	-0.0397	Z
	25	43.8893	18.7517	9.5030	43.8402	18.7564	9.4072	0.0491	-0.0047	0.0958	0.1078	0.0958	Z
	26	39.7382	0.4289	8.9984	39.7341	0.4684	8.9689	0.0041	-0.0395	0.0295	0.0495	0.0295	Z
	27	39.8576	5.4898	9.2376	39.8424	5.4532	9.2553	0.0152	0.0366	-0.0177	0.0434	-0.0177	Z
	28	39.7664	10.5440	9.2266	39.7368	10.4832	9.2627	0.0296	0.0608	-0.0361	0.0767	-0.0361	Z
	29	39.6307	14.2367	9.3853	39.5881	14.2028	9.4071	0.0426	0.0339	-0.0218	0.0586	-0.0218	Z
	30	39.5079	18.6549	9.3136	39.4933	18.6406	9.2400	0.0146	0.0143	0.0736	0.0764	0.0736	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-13. Floor Pan Deformation – Set 1, Right, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE FLOOR PAN - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	61.3187	5.2292	6.2274	60.9815	4.9466	5.7928	0.3372	0.2826	0.4346	0.6184	0.5501	X, Z
	2	61.4955	0.6672	6.0984	61.2648	0.3454	5.5785	0.2307	0.3218	0.5199	0.6535	0.5688	X, Z
	3	61.7885	-2.6075	6.0214	61.5132	-2.8734	5.5018	0.2753	-0.2659	0.5196	0.6454	0.5880	X, Z
	4	61.7820	-4.7789	5.7623	61.5009	-5.1028	5.2814	0.2811	-0.3239	0.4809	0.6444	0.5570	X, Z
	5	61.9490	-7.4742	6.0183	61.6461	-7.7964	5.5628	0.3029	-0.3222	0.4555	0.6349	0.5470	X, Z
	6	59.3240	4.9901	7.4429	59.1870	4.7204	6.9300	0.1370	0.2697	0.5129	0.5955	0.5309	X, Z
	7	59.1417	0.2778	7.5187	58.8982	0.0558	7.0740	0.2435	0.2220	0.4447	0.5535	0.5070	X, Z
	8	59.2858	-2.1784	7.4863	59.0543	-2.4903	7.0340	0.2315	-0.3119	0.4523	0.5962	0.5081	X, Z
	9	59.1226	-5.5965	7.6151	58.8458	-5.9053	7.2311	0.2768	-0.3088	0.3840	0.5652	0.4734	X, Z
	10	59.0946	-7.8188	7.7552	58.8533	-8.1633	7.3913	0.2413	-0.3445	0.3639	0.5562	0.4366	X, Z
FLOOR PAN (Z)	11	54.0835	4.2904	8.1406	53.9158	4.0341	7.7216	0.1677	0.2563	0.4190	0.5190	0.4190	Z
	12	54.2806	0.8377	8.3448	54.0978	0.5546	7.8819	0.1828	0.2831	0.4629	0.5726	0.4629	Z
	13	53.9544	-2.1999	8.3644	53.7640	-2.4375	7.9882	0.1904	-0.2376	0.3762	0.4840	0.3762	Z
	14	54.0708	-6.2987	8.3599	53.8900	-6.6157	8.0044	0.1808	-0.3170	0.3555	0.5095	0.3555	Z
	15	53.9106	-11.0428	8.4991	53.6168	-11.2867	8.1413	0.2938	-0.2439	0.3578	0.5233	0.3578	Z
	16	50.8016	4.9447	8.7387	50.6471	4.7182	8.3465	0.1545	0.2265	0.3922	0.4785	0.3922	Z
	17	50.6882	1.2252	8.8040	50.4444	1.0173	8.4099	0.2438	0.2079	0.3941	0.5079	0.3941	Z
	18	50.6678	-2.3771	8.3974	50.4350	-2.6267	8.0840	0.2328	-0.2496	0.3134	0.4634	0.3134	Z
	19	50.5503	-8.0802	8.6690	50.3675	-8.3532	8.3308	0.1828	-0.2730	0.3382	0.4715	0.3382	Z
	20	50.0574	-12.3002	8.8434	49.8876	-12.5591	8.5305	0.1698	-0.2589	0.3129	0.4402	0.3129	Z
	21	45.5954	4.8546	8.9213	45.4854	4.5721	8.6121	0.1100	0.2825	0.3092	0.4330	0.3092	Z
	22	45.4148	1.0372	8.9850	45.2187	0.7896	8.6915	0.1961	0.2476	0.2935	0.4312	0.2935	Z
	23	45.3611	-2.2868	8.4423	45.1646	-2.5437	8.1766	0.1965	-0.2569	0.2657	0.4186	0.2657	Z
	24	45.6055	-6.8692	8.4646	45.3473	-7.1512	8.2178	0.2582	-0.2820	0.2468	0.4551	0.2468	Z
	25	45.8076	-12.3192	8.9771	45.6469	-12.5809	8.6362	0.1607	-0.2617	0.3409	0.4588	0.3409	Z
	26	40.9253	4.4218	8.7308	40.7052	4.2780	8.4488	0.2201	0.1438	0.2820	0.3855	0.2820	Z
	27	40.6895	0.5426	8.6592	40.5177	0.2875	8.4329	0.1718	0.2551	0.2263	0.3818	0.2263	Z
	28	40.5922	-3.7360	8.3821	40.3975	-3.9936	8.1543	0.1947	-0.2576	0.2278	0.3952	0.2278	Z
	29	40.5060	-7.5927	8.5305	40.3281	-7.8656	8.3272	0.1779	-0.2729	0.2033	0.3840	0.2033	Z
	30	40.5098	-10.9901	8.7274	40.2944	-11.2785	8.4589	0.2154	-0.2884	0.2685	0.4491	0.2685	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-14. Floor Pan Deformation – Set 2, Left, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE FLOOR PAN - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	60.8586	17.9115	6.3637	60.8433	17.8197	5.7592	0.0153	0.0918	0.6045	0.6116	0.6047	X, Z
	2	60.7451	22.2381	6.2435	60.6416	22.1296	5.5834	0.1035	0.1085	0.6601	0.6769	0.6682	X, Z
	3	60.4905	25.7433	6.3609	60.4053	25.6296	5.7363	0.0852	0.1137	0.6246	0.6406	0.6304	X, Z
	4	60.3428	29.4245	6.3875	60.2989	29.3289	5.7757	0.0439	0.0956	0.6118	0.6208	0.6134	X, Z
	5	59.9891	33.5150	6.0129	59.9112	33.4301	5.5526	0.0779	0.0849	0.4603	0.4745	0.4668	X, Z
	6	58.5795	17.9402	7.7168	58.5643	17.8397	7.2006	0.0152	0.1005	0.5162	0.5261	0.5164	X, Z
	7	58.9432	22.3469	7.2972	58.8744	22.2421	6.7038	0.0688	0.1048	0.5934	0.6065	0.5974	X, Z
	8	59.1116	25.9794	7.1759	59.0633	25.8791	6.6346	0.0483	0.1003	0.5413	0.5526	0.5435	X, Z
	9	58.8702	29.5168	7.2637	58.8572	29.4459	6.7393	0.0130	0.0709	0.5244	0.5293	0.5246	X, Z
	10	58.7934	35.0787	7.1432	58.6189	34.8831	6.6070	0.1745	0.1956	0.5362	0.5968	0.5639	X, Z
FLOOR PAN (Z)	11	53.8533	17.8441	8.1559	53.8810	17.7254	7.6745	-0.0277	0.1187	0.4814	0.4966	0.4814	Z
	12	53.8152	22.2742	8.3451	53.8683	22.1504	7.8344	-0.0531	0.1238	0.5107	0.5282	0.5107	Z
	13	53.9232	27.5434	8.1197	53.9914	27.4466	7.7052	-0.0682	0.0968	0.4145	0.4311	0.4145	Z
	14	53.8112	31.7663	8.3467	53.8952	31.6949	7.8446	-0.0840	0.0714	0.5021	0.5141	0.5021	Z
	15	53.7500	36.0061	8.3406	53.8775	35.9397	7.9137	-0.1275	0.0664	0.4269	0.4505	0.4269	Z
	16	49.5049	18.0615	8.8951	49.5356	17.9596	8.4616	-0.0307	0.1019	0.4335	0.4464	0.4335	Z
	17	49.1072	22.0470	8.7487	49.1377	21.9902	8.2868	-0.0305	0.0568	0.4619	0.4664	0.4619	Z
	18	49.1290	26.4652	8.3077	49.1402	26.4071	8.0142	-0.0112	0.0581	0.2935	0.2994	0.2935	Z
	19	48.5245	30.5523	8.5907	48.6074	30.4782	8.2336	-0.0829	0.0741	0.3571	0.3740	0.3571	Z
	20	48.3794	35.6041	8.6514	48.4880	35.5445	8.2722	-0.1086	0.0596	0.3792	0.3989	0.3792	Z
	21	43.7152	17.9521	8.9843	43.7764	17.9138	8.6177	-0.0612	0.0383	0.3666	0.3736	0.3666	Z
	22	43.4874	22.5038	8.6793	43.5113	22.4196	8.3817	-0.0239	0.0842	0.2976	0.3102	0.2976	Z
	23	43.3779	26.3945	8.3683	43.4156	26.3059	8.0670	-0.0377	0.0886	0.3013	0.3163	0.3013	Z
	24	43.4311	31.1142	8.8548	43.5129	31.0766	8.5943	-0.0818	0.0376	0.2605	0.2756	0.2605	Z
	25	43.5099	35.8115	8.5777	43.5570	35.7821	8.1767	-0.0471	0.0294	0.4010	0.4048	0.4010	Z
	26	39.2983	17.4971	8.3364	39.3760	17.5064	8.0496	-0.0777	-0.0093	0.2868	0.2973	0.2868	Z
	27	39.4362	22.5599	8.5196	39.5088	22.4937	8.2745	-0.0726	0.0662	0.2451	0.2641	0.2451	Z
	28	39.3593	27.6139	8.4561	39.4216	27.5238	8.2250	-0.0623	0.0901	0.2311	0.2557	0.2311	Z
	29	39.2369	31.3085	8.5776	39.2897	31.2454	8.3290	-0.0528	0.0631	0.2486	0.2619	0.2486	Z
	30	39.1257	35.7261	8.4608	39.2070	35.6812	8.1117	-0.0813	0.0449	0.3491	0.3612	0.3491	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-15. Floor Pan Deformation – Set 2, Right, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE INTERIOR CRUSH - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	52.3345	-25.5844	-19.4977	52.6824	-25.7208	-19.0128	-0.3479	-0.1364	0.4849	0.6122	0.6122	X, Y, Z
	2	49.9890	-16.6143	-21.9096	50.3394	-16.7864	-21.4315	-0.3504	-0.1721	0.4781	0.6172	0.6172	X, Y, Z
	3	49.9856	-4.4809	-19.5073	50.3793	-4.5335	-18.9384	-0.3937	-0.0526	0.5689	0.6938	0.6938	X, Y, Z
	4	49.4523	-27.0716	-8.3126	49.5760	-27.3473	-7.8964	-0.1237	-0.2757	0.4162	0.5143	0.5143	X, Y, Z
	5	49.9161	-15.6394	-6.6920	50.1217	-15.9208	-6.1496	-0.2056	-0.2814	0.5424	0.6447	0.6447	X, Y, Z
	6	44.4463	-5.1622	-10.2790	44.6931	-5.3823	-9.8172	-0.2468	-0.2201	0.4618	0.5680	0.5680	X, Y, Z
SIDE PANEL (Y)	7	54.8920	-31.9154	0.7363	54.7786	-32.2306	1.2846	0.1134	-0.3152	0.5483	0.6425	-0.3152	Y
	8	54.1939	-32.7120	4.8234	53.9981	-33.0263	5.1764	0.1958	-0.3143	0.3530	0.5116	-0.3143	Y
	9	58.0176	-32.5932	4.8433	57.8481	-32.9380	5.2713	0.1695	-0.3448	0.4280	0.5752	-0.3448	Y
IMPACT SIDE DOOR (Y)	10	47.1386	-33.5016	-15.1915	47.4177	-33.6486	-14.7953	-0.2791	-0.1470	0.3962	0.5064	-0.1470	Y
	11	36.1237	-33.7442	-15.9698	36.3519	-33.8903	-15.7652	-0.2282	-0.1461	0.2046	0.3395	-0.1461	Y
	12	24.9869	-34.1006	-17.1744	25.1454	-34.2115	-17.2240	-0.1585	-0.1109	-0.0496	0.1997	-0.1109	Y
	13	45.1583	-33.6936	-2.6472	45.1433	-33.9788	-2.3160	0.0150	-0.2852	0.3312	0.4373	-0.2852	Y
	14	38.9961	-34.3521	-1.0037	38.9586	-34.6363	-0.8292	0.0375	-0.2842	0.1745	0.3356	-0.2842	Y
	15	30.8182	-34.2588	-0.0790	30.8186	-34.5543	-0.0448	-0.0004	-0.2955	0.0342	0.2975	-0.2955	Y
ROOF - (Z)	16	29.4121	-21.9732	-37.3041	29.9891	-21.9141	-37.1480	-0.5770	0.0591	0.1561	0.6007	0.1561	Z
	17	29.9321	-17.8484	-37.4995	30.5055	-17.7930	-37.3005	-0.5734	0.0554	0.1990	0.6095	0.1990	Z
	18	30.4712	-14.0282	-37.5734	31.0919	-14.0446	-37.3201	-0.6207	-0.0164	0.2533	0.6706	0.2533	Z
	19	30.0319	-10.4142	-37.7582	30.6289	-10.3894	-37.4913	-0.5970	0.0248	0.2669	0.6544	0.2669	Z
	20	30.4370	-5.5816	-37.6874	31.0250	-5.5193	-37.3745	-0.5880	0.0623	0.3129	0.6690	0.3129	Z
	21	26.6054	-22.0848	-37.7854	27.0490	-22.0313	-37.6925	-0.4436	0.0535	0.0929	0.4564	0.0929	Z
	22	26.9664	-18.0106	-38.0215	27.4707	-17.8852	-37.8806	-0.5043	0.1254	0.1409	0.5384	0.1409	Z
	23	27.4752	-13.4482	-38.1510	28.0534	-13.4039	-37.9480	-0.5782	0.0443	0.2030	0.6144	0.2030	Z
	24	28.0241	-9.1286	-38.1519	28.5925	-9.0513	-37.9059	-0.5684	0.0773	0.2460	0.6242	0.2460	Z
	25	27.7544	-5.7154	-38.1947	28.4273	-5.6768	-37.9070	-0.6729	0.0386	0.2877	0.7328	0.2877	Z
	26	23.7124	-21.7644	-38.1941	24.2825	-21.6706	-38.1192	-0.5701	0.0938	0.0749	0.5826	0.0749	Z
	27	23.8134	-18.0600	-38.4351	24.3869	-18.0370	-38.3232	-0.5735	0.0230	0.1119	0.5848	0.1119	Z
	28	23.9528	-13.7600	-38.6195	24.5441	-13.7265	-38.4674	-0.5913	0.0335	0.1521	0.6115	0.1521	Z
	29	24.5587	-9.5893	-38.6448	25.1712	-9.5459	-38.4471	-0.6125	0.0434	0.1977	0.6451	0.1977	Z
	30	24.5409	-6.1142	-38.6535	25.2090	-6.0433	-38.4211	-0.6681	0.0709	0.2324	0.7109	0.2324	Z
A-PILLAR Maximum (X, Y, Z)	31	54.5282	-30.5774	-21.8223	54.8690	-30.6595	-21.3289	-0.3408	-0.0821	0.4934	0.6053	0.4934	Z
	32	52.1743	-30.1232	-23.7347	52.5548	-30.1877	-23.2802	-0.3805	-0.0645	0.4545	0.5962	0.4545	Z
	33	48.2265	-29.3938	-26.3439	48.6562	-29.4449	-25.9033	-0.4297	-0.0511	0.4406	0.6176	0.4406	Z
	34	43.9863	-28.6645	-28.5997	44.5243	-28.6884	-28.2446	-0.5380	-0.0239	0.3551	0.6451	0.3551	Z
	35	40.8972	-28.0989	-30.2108	41.4602	-28.0913	-29.9334	-0.5630	0.0076	0.2774	0.6277	0.2775	Y, Z
	36	38.2808	-27.6452	-31.4316	38.8747	-27.6172	-31.2084	-0.5939	0.0280	0.2232	0.6351	0.2249	Y, Z
A-PILLAR Lateral (Y)	31	54.5282	-30.5774	-21.8223	54.8690	-30.6595	-21.3289	-0.3408	-0.0821	0.4934	0.6053	-0.0821	Y
	32	52.1743	-30.1232	-23.7347	52.5548	-30.1877	-23.2802	-0.3805	-0.0645	0.4545	0.5962	-0.0645	Y
	33	48.2265	-29.3938	-26.3439	48.6562	-29.4449	-25.9033	-0.4297	-0.0511	0.4406	0.6176	-0.0511	Y
	34	43.9863	-28.6645	-28.5997	44.5243	-28.6884	-28.2446	-0.5380	-0.0239	0.3551	0.6451	-0.0239	Y
	35	40.8972	-28.0989	-30.2108	41.4602	-28.0913	-29.9334	-0.5630	0.0076	0.2774	0.6277	0.0076	Y
	36	38.2808	-27.6452	-31.4316	38.8747	-27.6172	-31.2084	-0.5939	0.0280	0.2232	0.6351	0.0280	Y
B-PILLAR Maximum (X, Y, Z)	37	16.3593	-28.5836	-32.1831	16.7881	-28.5304	-32.2864	-0.4288	0.0532	-0.1033	0.4443	0.0532	Y
	38	14.0856	-30.6103	-27.8454	14.4324	-30.6067	-27.9784	-0.3468	0.0036	-0.1330	0.3714	0.0036	Y
	39	18.3262	-31.8062	-23.5464	18.6721	-31.8570	-23.5878	-0.3459	-0.0508	-0.0414	0.3521	0.0000	NA
	40	14.5262	-32.2752	-22.1591	14.9302	-32.3079	-22.3295	-0.4040	-0.0327	-0.1704	0.4397	0.0000	NA
B-PILLAR Lateral (Y)	37	16.3593	-28.5836	-32.1831	16.7881	-28.5304	-32.2864	-0.4288	0.0532	-0.1033	0.4443	0.0532	Y
	38	14.0856	-30.6103	-27.8454	14.4324	-30.6067	-27.9784	-0.3468	0.0036	-0.1330	0.3714	0.0036	Y
	39	18.3262	-31.8062	-23.5464	18.6721	-31.8570	-23.5878	-0.3459	-0.0508	-0.0414	0.3521	-0.0508	Y
	40	14.5262	-32.2752	-22.1591	14.9302	-32.3079	-22.3295	-0.4040	-0.0327	-0.1704	0.4397	-0.0327	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-16. Occupant Compartment Deformation – Set 1, Left, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE INTERIOR CRUSH - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	50.8602	15.6851	-19.1651	51.2089	15.8288	-18.3964	-0.3487	-0.1437	0.7687	0.8562	0.8562	X, Y, Z
	2	50.1755	3.5757	-19.7011	50.5051	3.6823	-19.1006	-0.3296	-0.1066	0.6005	0.6933	0.6933	X, Y, Z
	3	50.0242	-4.4182	-19.5098	50.2652	-4.2575	-18.9741	-0.2410	0.1607	0.5357	0.6090	0.6090	X, Y, Z
	4	47.1318	18.9671	-9.8523	47.2936	19.0517	-9.1058	-0.1618	-0.0846	0.7465	0.7685	0.7685	X, Y, Z
	5	47.4144	3.1703	-8.5000	47.6715	3.2522	-7.9688	-0.2571	-0.0819	0.5312	0.5958	0.5958	X, Y, Z
	6	44.4479	-5.2044	-10.2469	44.6649	-5.0623	-9.8403	-0.2170	0.1421	0.4066	0.4823	0.4823	X, Y, Z
SIDE PANEL (Y)	7	53.5037	21.3375	0.8845	53.5539	21.2931	1.8579	-0.0502	0.0444	0.9734	0.9757	0.0444	Y
	8	53.2564	22.1499	4.6052	53.1832	22.0601	5.4962	0.0732	0.0898	0.8910	0.8985	0.0898	Y
	9	58.6838	21.7484	4.7541	58.6383	21.6709	5.6992	0.0455	0.0775	0.9451	0.9494	0.0775	Y
IMPACT SIDE DOOR (Y)	10	45.1896	22.6742	-15.6691	45.4215	22.8142	-14.8446	-0.2319	-0.1400	0.8245	0.8679	-0.1400	Y
	11	34.8578	22.3901	-16.1131	35.1271	22.5399	-15.4671	-0.2693	-0.1498	0.6460	0.7157	-0.1498	Y
	12	23.0779	22.1754	-16.8263	23.3261	22.3306	-16.3343	-0.2482	-0.1552	0.4920	0.5725	-0.1552	Y
	13	43.0680	22.6205	-1.7184	43.1353	22.6109	-0.9022	-0.0673	0.0096	0.8162	0.8190	0.0096	Y
	14	35.2511	22.6773	0.4817	35.2217	22.6454	1.1239	0.0294	0.0319	0.6422	0.6437	0.0319	Y
	15	28.5484	22.5319	-0.1182	28.5391	22.4868	0.4228	0.0093	0.0451	0.5410	0.5430	0.0451	Y
ROOF - (Z)	16	28.6801	10.4500	-37.0984	29.2532	10.8619	-36.6659	-0.5731	-0.4119	0.4325	0.8277	0.4325	Z
	17	29.2485	7.4404	-37.2891	29.8579	7.7641	-36.8785	-0.6094	-0.3237	0.4106	0.8030	0.4106	Z
	18	30.1288	3.2673	-37.4285	30.5843	3.6494	-37.0734	-0.4555	-0.3821	0.3551	0.6925	0.3551	Z
	19	30.1668	-1.2689	-37.6433	30.8201	-0.9393	-37.2944	-0.6533	0.3296	0.3489	0.8107	0.3489	Z
	20	30.4008	-5.5789	-37.6974	31.0034	-5.2139	-37.3954	-0.6026	0.3650	0.3020	0.7665	0.3020	Z
	21	25.7356	10.7449	-37.5737	26.3691	11.1137	-37.1779	-0.6335	-0.3688	0.3958	0.8331	0.3958	Z
	22	26.3426	7.0863	-37.8279	26.8310	7.4836	-37.4807	-0.4884	-0.3973	0.3472	0.7190	0.3472	Z
	23	26.8175	2.7825	-38.0591	27.3751	3.2128	-37.7346	-0.5576	-0.4303	0.3245	0.7755	0.3245	Z
	24	27.5371	-2.0285	-38.1573	28.1132	-1.6115	-37.8678	-0.5761	0.4170	0.2895	0.7678	0.2895	Z
	25	27.7923	-5.7813	-38.1886	28.2980	-5.3985	-37.9455	-0.5057	0.3828	0.2431	0.6792	0.2431	Z
	26	23.1977	10.6424	-37.9103	23.7219	10.9862	-37.5769	-0.5242	-0.3438	0.3334	0.7100	0.3334	Z
	27	23.5971	6.7823	-38.2129	24.0693	7.1733	-37.9117	-0.4722	-0.3910	0.3012	0.6831	0.3012	Z
	28	23.9723	2.5880	-38.4521	24.5680	2.9555	-38.1728	-0.5957	-0.3675	0.2793	0.7536	0.2793	Z
	29	24.4327	-2.6764	-38.6061	24.9250	-2.2778	-38.3843	-0.4923	0.3986	0.2218	0.6711	0.2218	Z
	30	24.6074	-6.0140	-38.6417	25.1797	-5.7152	-38.4382	-0.5723	0.2988	0.2035	0.6769	0.2035	Z
A-PILLAR Maximum (X, Y, Z)	31	53.6298	20.3037	-21.5199	54.0353	20.4876	-20.5863	-0.4055	-0.1839	0.9336	1.0343	0.9336	Z
	32	51.6781	19.8843	-22.8938	52.0996	20.0863	-22.0066	-0.4215	-0.2020	0.8872	1.0028	0.8872	Z
	33	49.0743	19.3128	-24.6000	49.5459	19.5383	-23.7495	-0.4716	-0.2255	0.8505	0.9983	0.8505	Z
	34	46.5485	18.6675	-26.3734	47.0332	18.9115	-25.5666	-0.4847	-0.2440	0.8068	0.9723	0.8068	Z
	35	44.2998	18.1192	-27.6872	44.7871	18.3578	-26.9829	-0.4873	-0.2386	0.7043	0.8891	0.7043	Z
	36	41.6576	17.4975	-29.1628	42.1059	17.7438	-28.5019	-0.4483	-0.2463	0.6609	0.8357	0.6609	Z
A-PILLAR Lateral (Y)	31	53.6298	20.3037	-21.5199	54.0353	20.4876	-20.5863	-0.4055	-0.1839	0.9336	1.0343	-0.1839	Y
	32	51.6781	19.8843	-22.8938	52.0996	20.0863	-22.0066	-0.4215	-0.2020	0.8872	1.0028	-0.2020	Y
	33	49.0743	19.3128	-24.6000	49.5459	19.5383	-23.7495	-0.4716	-0.2255	0.8505	0.9983	-0.2255	Y
	34	46.5485	18.6675	-26.3734	47.0332	18.9115	-25.5666	-0.4847	-0.2440	0.8068	0.9723	-0.2440	Y
	35	44.2998	18.1192	-27.6872	44.7871	18.3578	-26.9829	-0.4873	-0.2386	0.7043	0.8891	-0.2386	Y
	36	41.6576	17.4975	-29.1628	42.1059	17.7438	-28.5019	-0.4483	-0.2463	0.6609	0.8357	-0.2463	Y
B-PILLAR Maximum (X, Y, Z)	37	12.6091	16.9816	-30.5211	13.0508	17.2718	-30.2704	-0.4417	-0.2902	0.2507	0.5849	0.2507	Z
	38	16.3084	18.5546	-26.7202	16.6902	18.8143	-26.4167	-0.3818	-0.2597	0.3035	0.5526	0.3035	Z
	39	13.2448	19.5158	-22.9631	13.6610	19.7510	-22.6685	-0.4162	-0.2352	0.2946	0.5615	0.2946	Z
	40	17.6087	20.1318	-20.2235	17.8736	20.3201	-19.9244	-0.2649	-0.1883	0.2991	0.4417	0.2991	Z
B-PILLAR Lateral (Y)	37	12.6091	16.9816	-30.5211	13.0508	17.2718	-30.2704	-0.4417	-0.2902	0.2507	0.5849	-0.2902	Y
	38	16.3084	18.5546	-26.7202	16.6902	18.8143	-26.4167	-0.3818	-0.2597	0.3035	0.5526	-0.2597	Y
	39	13.2448	19.5158	-22.9631	13.6610	19.7510	-22.6685	-0.4162	-0.2352	0.2946	0.5615	-0.2352	Y
	40	17.6087	20.1318	-20.2235	17.8736	20.3201	-19.9244	-0.2649	-0.1883	0.2991	0.4417	-0.1883	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-17. Occupant Compartment Deformation – Set 1, Right, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE INTERIOR CRUSH - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	51.4170	-9.0622	-20.0276	51.3975	-9.3724	-20.3449	0.0195	-0.3102	-0.3173	0.4442	0.4442	X, Y, Z
	2	49.0655	-0.1063	-22.4861	48.9572	-0.4092	-22.8401	0.1083	-0.3029	-0.3540	0.4783	0.4783	X, Y, Z
	3	49.1321	12.0477	-20.1914	49.0936	11.7927	-20.5655	0.0385	0.2550	-0.3741	0.4544	0.4544	X, Y, Z
	4	48.6859	-10.4418	-8.7909	48.6630	-10.7634	-9.0805	0.0229	-0.3216	-0.2896	0.4334	0.4334	X, Y, Z
	5	49.2067	1.0027	-7.2782	49.3194	0.6684	-7.5679	-0.1127	0.3343	-0.2897	0.4565	0.4565	X, Y, Z
	6	43.7195	11.4652	-10.8817	43.7600	11.1874	-11.1775	-0.0405	0.2778	-0.2958	0.4078	0.4078	X, Y, Z
SIDE PANEL (Y)	7	54.2359	-15.2228	0.2243	54.2669	-15.4888	-0.0916	-0.0310	-0.2660	-0.3159	0.4141	-0.2660	Y
	8	53.5922	-15.9811	4.3276	53.5797	-16.2308	3.9678	0.0125	-0.2497	-0.3598	0.4381	-0.2497	Y
	9	57.4161	-15.8742	4.2934	57.2930	-16.1475	3.9471	0.1231	-0.2733	-0.3463	0.4580	-0.2733	Y
IMPACT SIDE DOOR (Y)	10	46.2574	-16.9247	-15.5800	46.2240	-17.1921	-15.8241	0.0334	-0.2674	-0.2441	0.3636	-0.2674	Y
	11	35.2321	-17.1394	-16.2035	35.0953	-17.4221	-16.3906	0.1368	-0.2827	-0.1871	0.3656	-0.2827	Y
	12	24.0787	-17.4713	-17.2505	23.8898	-17.7327	-17.4074	0.1889	-0.2614	-0.1569	0.3587	-0.2614	Y
	13	44.4508	-17.0000	-3.0082	44.4412	-17.2739	-3.2773	0.0096	-0.2739	-0.2691	0.3841	-0.2739	Y
	14	38.3101	-17.6246	-1.2738	38.3732	-17.8675	-1.5805	-0.0631	-0.2429	-0.3067	0.3963	-0.2429	Y
	15	30.1461	-17.4973	-0.2368	30.1621	-17.7672	-0.4416	-0.0160	-0.2699	-0.2048	0.3392	-0.2699	Y
ROOF - (Z)	16	28.2608	-5.5357	-37.5461	28.0522	-5.8470	-37.7257	0.2086	-0.3113	-0.1796	0.4155	-0.1796	Z
	17	28.7905	-1.4144	-37.7852	28.5388	-1.7556	-37.9785	0.2517	-0.3412	-0.1933	0.4660	-0.1933	Z
	18	29.3401	2.4032	-37.9003	29.1181	2.0520	-38.0953	0.2220	0.3512	-0.1950	0.4590	-0.1950	Z
	19	28.9093	6.0169	-38.1110	28.6715	5.6719	-38.3132	0.2378	0.3450	-0.2022	0.4653	-0.2022	Z
	20	29.3299	10.8486	-38.0886	29.1232	10.5580	-38.2933	0.2067	0.2906	-0.2047	0.4112	-0.2047	Z
	21	25.4474	-5.6427	-37.9874	25.2121	-5.9522	-38.1526	0.2353	-0.3095	-0.1652	0.4224	-0.1652	Z
	22	25.8174	-1.5719	-38.2646	25.5251	-1.7626	-38.4488	0.2923	-0.1907	-0.1842	0.3946	-0.1842	Z
	23	26.3382	2.9875	-38.4415	26.1285	2.7017	-38.6150	0.2097	0.2858	-0.1735	0.3947	-0.1735	Z
	24	26.9001	7.3053	-38.4882	26.6422	7.0241	-38.6754	0.2579	0.2812	-0.1872	0.4250	-0.1872	Z
	25	26.6402	10.7188	-38.5575	26.4824	10.3790	-38.7315	0.1578	0.3398	-0.1740	0.4131	-0.1740	Z
	26	22.5500	-5.3168	-38.3589	22.3035	-5.6090	-38.5032	0.2465	-0.2922	-0.1443	0.4086	-0.1443	Z
	27	22.6588	-1.6150	-38.6341	22.4842	-1.9182	-38.7731	0.1746	-0.3032	-0.1390	0.3765	-0.1390	Z
	28	22.8086	2.6827	-38.8584	22.5579	2.3715	-39.0068	0.2507	0.3112	-0.1484	0.4263	-0.1484	Z
	29	23.4268	6.8512	-38.9290	23.2209	6.5518	-39.0829	0.2059	0.2994	-0.1539	0.3946	-0.1539	Z
	30	23.4194	10.3260	-38.9682	23.2768	10.1099	-39.1219	0.1426	0.2161	-0.1537	0.3011	-0.1537	Z
A-PILLAR Maximum (X, Y, Z)	31	53.5631	-14.0823	-22.3381	53.5618	-14.3529	-22.6221	0.0013	-0.2706	-0.2840	0.3923	0.0013	X
	32	51.1843	-13.6376	-24.2216	51.0522	-13.9133	-24.4525	0.1321	-0.2757	-0.2309	0.3831	0.1321	X
	33	47.2029	-12.9188	-26.7823	47.0997	-13.1914	-27.0337	0.1032	-0.2726	-0.2514	0.3849	0.1032	X
	34	42.9341	-12.1960	-28.9855	42.8265	-12.4577	-29.2468	0.1076	-0.2617	-0.2613	0.3852	0.1076	X
	35	39.8246	-11.6349	-30.5586	39.7181	-11.8943	-30.8084	0.1065	-0.2594	-0.2498	0.3755	0.1065	X
	36	37.1929	-11.1837	-31.7470	37.2099	-11.4334	-32.0051	-0.0170	-0.2497	-0.2581	0.3595	0.0000	NA
A-PILLAR Lateral (Y)	31	53.5631	-14.0823	-22.3381	53.5618	-14.3529	-22.6221	0.0013	-0.2706	-0.2840	0.3923	-0.2706	Y
	32	51.1843	-13.6376	-24.2216	51.0522	-13.9133	-24.4525	0.1321	-0.2757	-0.2309	0.3831	-0.2757	Y
	33	47.2029	-12.9188	-26.7823	47.0997	-13.1914	-27.0337	0.1032	-0.2726	-0.2514	0.3849	-0.2726	Y
	34	42.9341	-12.1960	-28.9855	42.8265	-12.4577	-29.2468	0.1076	-0.2617	-0.2613	0.3852	-0.2617	Y
	35	39.8246	-11.6349	-30.5586	39.7181	-11.8943	-30.8084	0.1065	-0.2594	-0.2498	0.3755	-0.2594	Y
	36	37.1929	-11.1837	-31.7470	37.2099	-11.4334	-32.0051	-0.0170	-0.2497	-0.2581	0.3595	-0.2497	Y
B-PILLAR Maximum (X, Y, Z)	37	15.2603	-12.0596	-32.1865	15.0222	-12.2952	-32.2917	0.2381	-0.2356	-0.1052	0.3511	0.2381	X
	38	13.0409	-14.0409	-27.8000	12.8644	-14.2831	-27.8738	0.1765	-0.2422	-0.0738	0.3086	0.1765	X
	39	17.3371	-15.2122	-23.5497	17.2479	-15.4565	-23.6262	0.0892	-0.2443	-0.0765	0.2711	0.0892	X
	40	13.5553	-15.6570	-22.1058	13.4620	-15.9025	-22.1820	0.0933	-0.2455	-0.0762	0.2735	0.0933	X
B-PILLAR Lateral (Y)	37	15.2603	-12.0596	-32.1865	15.0222	-12.2952	-32.2917	0.2381	-0.2356	-0.1052	0.3511	-0.2356	Y
	38	13.0409	-14.0409	-27.8000	12.8644	-14.2831	-27.8738	0.1765	-0.2422	-0.0738	0.3086	-0.2422	Y
	39	17.3371	-15.2122	-23.5497	17.2479	-15.4565	-23.6262	0.0892	-0.2443	-0.0765	0.2711	-0.2443	Y
	40	13.5553	-15.6570	-22.1058	13.4620	-15.9025	-22.1820	0.0933	-0.2455	-0.0762	0.2735	-0.2455	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-18. Occupant Compartment Deformation – Set 2, Left, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE INTERIOR CRUSH - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	50.0847	31.9643	-20.0406	50.1359	32.1494	-20.1980	-0.0512	-0.1851	-0.1574	0.2483	0.2483	X, Y, Z
	2	49.3533	19.8531	-20.4599	49.3989	19.9912	-20.6017	-0.0456	-0.1381	-0.1418	0.2031	0.2031	X, Y, Z
	3	49.1789	11.8617	-20.1958	49.1532	12.0569	-20.2851	0.0257	-0.1952	-0.0893	0.2162	0.2162	X, Y, Z
	4	46.4967	35.3407	-10.7064	46.4781	35.5931	-10.8817	0.0186	-0.2524	-0.1753	0.3079	0.3079	X, Y, Z
	5	46.7469	19.5555	-9.2184	46.8681	19.8234	-9.3902	-0.1212	-0.2679	-0.1718	0.3406	0.3406	X, Y, Z
	6	43.7293	11.1758	-10.8498	43.8020	11.4733	-10.9866	-0.0727	-0.2975	-0.1368	0.3354	0.3354	X, Y, Z
SIDE PANEL (Y)	7	53.0249	37.7841	-0.0804	53.0363	38.0759	-0.1466	-0.0114	-0.2918	-0.0662	0.2994	-0.2918	Y
	8	52.8320	38.6300	3.6360	52.7654	38.9273	3.4817	0.0666	-0.2973	-0.1543	0.3415	-0.2973	Y
	9	58.2597	38.2116	3.7132	58.2235	38.5331	3.5457	0.0362	-0.3215	-0.1675	0.3643	-0.3215	Y
IMPACT SIDE DOOR (Y)	10	44.4859	39.0030	-16.5283	44.4553	39.2255	-16.6532	0.0306	-0.2225	-0.1249	0.2570	-0.2225	Y
	11	34.1481	38.7497	-16.8264	34.1474	38.9554	-16.9899	0.0007	-0.2057	-0.1635	0.2628	-0.2057	Y
	12	22.3587	38.5683	-17.3742	22.3270	38.7474	-17.5317	0.0317	-0.1791	-0.1575	0.2406	-0.1791	Y
	13	42.5583	39.0792	-2.5495	42.5482	39.3484	-2.6529	0.0101	-0.2692	-0.1034	0.2886	-0.2692	Y
	14	34.7729	39.1816	-0.2418	34.6925	39.4439	-0.4143	0.0804	-0.2623	-0.1725	0.3241	-0.2623	Y
	15	28.0621	39.0535	-0.7474	27.9932	39.2812	-0.9301	0.0689	-0.2277	-0.1827	0.3000	-0.2277	Y
ROOF - (Z)	16	27.6406	26.6462	-37.6175	27.6865	26.8015	-37.7457	-0.0459	-0.1553	-0.1282	0.2065	-0.1282	Z
	17	28.1965	23.6331	-37.7894	28.2815	23.6985	-37.9029	-0.0850	-0.0654	-0.1135	0.1562	-0.1135	Z
	18	29.0613	19.4559	-37.9041	28.9976	19.5791	-38.0222	0.0637	-0.1232	-0.1181	0.1822	-0.1181	Z
	19	29.0816	14.9180	-38.0793	29.2218	14.9861	-38.1432	-0.1402	-0.0681	-0.0639	0.1685	-0.0639	Z
	20	29.3008	10.6068	-38.0985	29.3974	10.7100	-38.1503	-0.0966	-0.1032	-0.0518	0.1505	-0.0518	Z
	21	24.6908	26.9467	-38.0545	24.7899	27.0466	-38.1850	-0.0991	-0.0999	-0.1305	0.1919	-0.1305	Z
	22	25.2823	23.2840	-38.2847	25.2390	23.4097	-38.4161	0.0433	-0.1257	-0.1314	0.1869	-0.1314	Z
	23	25.7400	18.9767	-38.4844	25.7711	19.1332	-38.5858	-0.0311	-0.1565	-0.1014	0.1891	-0.1014	Z
	24	26.4426	14.1627	-38.5500	26.4996	14.3057	-38.6273	-0.0570	-0.1430	-0.0773	0.1723	-0.0773	Z
	25	26.6852	10.4089	-38.5516	26.6778	10.5176	-38.6224	0.0074	-0.1087	-0.0708	0.1299	-0.0708	Z
	26	22.1481	26.8498	-38.3549	22.1327	26.9147	-38.5090	0.0154	-0.0649	-0.1541	0.1679	-0.1541	Z
	27	22.5307	22.9858	-38.6289	22.4663	23.0945	-38.7649	0.0644	-0.1087	-0.1360	0.1856	-0.1360	Z
	28	22.8890	18.7884	-38.8361	22.9528	18.8709	-38.9417	-0.0638	-0.0825	-0.1056	0.1484	-0.1056	Z
	29	23.3301	13.5213	-38.9499	23.2977	13.6334	-39.0416	0.0324	-0.1121	-0.0917	0.1484	-0.0917	Z
	30	23.4935	10.1830	-38.9584	23.5469	10.1953	-39.0229	-0.0534	-0.0123	-0.0645	0.0846	-0.0645	Z
A-PILLAR Maximum (X, Y, Z)	31	52.8362	36.5526	-22.4743	52.9072	36.7513	-22.5710	-0.0710	-0.1987	-0.0967	0.2321	0.0000	NA
	32	50.8643	36.1278	-23.8173	50.9333	36.3208	-23.9285	-0.0690	-0.1930	-0.1112	0.2332	0.0000	NA
	33	48.2352	35.5500	-25.4821	48.3326	35.7373	-25.5885	-0.0974	-0.1873	-0.1064	0.2364	0.0000	NA
	34	45.6828	34.8976	-27.2146	45.7708	35.0732	-27.3217	-0.0880	-0.1756	-0.1071	0.2237	0.0000	NA
	35	43.4144	34.3454	-28.4921	43.4863	34.4910	-28.6634	-0.0719	-0.1456	-0.1713	0.2360	0.0000	NA
	36	40.7499	33.7195	-29.9253	40.7641	33.8470	-30.0946	-0.0142	-0.1275	-0.1693	0.2124	0.0000	NA
A-PILLAR Lateral (Y)	31	52.8362	36.5526	-22.4743	52.9072	36.7513	-22.5710	-0.0710	-0.1987	-0.0967	0.2321	-0.1987	Y
	32	50.8643	36.1278	-23.8173	50.9333	36.3208	-23.9285	-0.0690	-0.1930	-0.1112	0.2332	-0.1930	Y
	33	48.2352	35.5500	-25.4821	48.3326	35.7373	-25.5885	-0.0974	-0.1873	-0.1064	0.2364	-0.1873	Y
	34	45.6828	34.8976	-27.2146	45.7708	35.0732	-27.3217	-0.0880	-0.1756	-0.1071	0.2237	-0.1756	Y
	35	43.4144	34.3454	-28.4921	43.4863	34.4910	-28.6634	-0.0719	-0.1456	-0.1713	0.2360	-0.1456	Y
	36	40.7499	33.7195	-29.9253	40.7641	33.8470	-30.0946	-0.0142	-0.1275	-0.1693	0.2124	-0.1275	Y
B-PILLAR Maximum (X, Y, Z)	37	11.6838	33.2894	-30.8759	11.6712	33.3866	-31.0634	0.0126	-0.0972	-0.1875	0.2116	0.0126	X
	38	15.4407	34.8833	-27.1408	15.4158	35.0111	-27.3464	0.0249	-0.1278	-0.2056	0.2434	0.0249	X
	39	12.4327	35.8879	-23.3502	12.4905	36.0396	-23.5402	-0.0578	-0.1517	-0.1900	0.2499	0.0000	NA
	40	16.8362	36.5133	-20.6769	16.7767	36.6643	-20.9252	0.0595	-0.1510	-0.2483	0.2966	0.0595	X
B-PILLAR Lateral (Y)	37	11.6838	33.2894	-30.8759	11.6712	33.3866	-31.0634	0.0126	-0.0972	-0.1875	0.2116	-0.0972	Y
	38	15.4407	34.8833	-27.1408	15.4158	35.0111	-27.3464	0.0249	-0.1278	-0.2056	0.2434	-0.1278	Y
	39	12.4327	35.8879	-23.3502	12.4905	36.0396	-23.5402	-0.0578	-0.1517	-0.1900	0.2499	-0.1517	Y
	40	16.8362	36.5133	-20.6769	16.7767	36.6643	-20.9252	0.0595	-0.1510	-0.2483	0.2966	-0.1510	Y

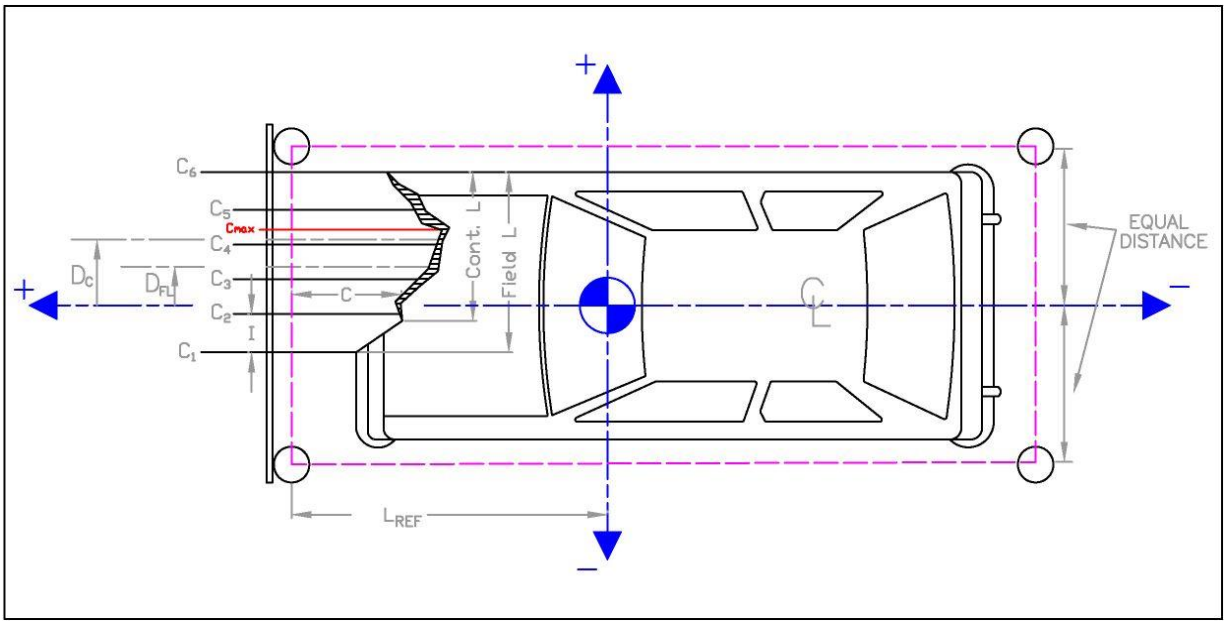
[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-19. Occupant Compartment Deformation – Set 2, Right, Test No. MOS-6

Date:	6/12/2019	**Test Name:**	MOS-6	**VIN:**	KNADE223296512940
Year:	2009	**Make:**	Kia	**Model:**	Rio



	in.	(mm)
Distance from C.G. to reference line - L_{REF}:	67 1/4	(1708)
Total Width of Vehicle:	66 1/4	(1683)
Width of contact and induced crush - Field L:	66 1/4	(1683)
Crush measurement spacing interval (L/5) - I:	13 1/4	(337)
Distance from center of vehicle to center of Field L - D_{FL}:	0	()
Width of Contact Damage:	34	(864)
Distance from center of vehicle to center of contact damage - D_C:	0	()

NOTE: Enter "NA" for crush measurement if distance can not be measured (i.e., side of vehicle has been pushed inward)
NOTE: All values must be filled out above before crush measurements are filled out.

	Crush Measurement		Lateral Location		Original Profile Measurement		Dist. Between Ref. Lines		Actual Crush	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
C_1	N/A	NA	-33 1/8	-(841)	24	(610)	-7 7/8	-(200)	NA	NA
C_2	3 3/4	(95)	-19 7/8	-(505)	8 1/2	(216)			3 1/8	(79)
C_3	3 5/8	(92)	-6 5/8	-(168)	6 1/8	(156)			5 3/8	(137)
C_4	4 1/8	(105)	6 5/8	(168)	6 1/8	(156)			5 7/8	(149)
C_5	5 1/8	(130)	19 7/8	(505)	8 1/2	(216)			4 1/2	(114)
C_6	N/A	NA	33 1/8	(841)	24	(610)			NA	NA
C_{MAX}	5 1/2	(140)	14	(356)	7 1/8	(181)			6 1/4	(159)

Figure D-20. Exterior Vehicle Crush (NASS) – Front, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

Driver Side Maximum Deformations

Reference Set 1				Reference Set 2			
Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]	Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]
Roof	0.3	≤ 4	Z	Roof	-0.1	≤ 4	Z
Windshield[D]	0.0	≤ 3	X, Z	Windshield[D]	NA	≤ 3	X, Z
A-Pillar Maximum	0.5	≤ 5	Z	A-Pillar Maximum	0.1	≤ 5	X
A-Pillar Lateral	0.0	≤ 3	Y	A-Pillar Lateral	-0.2	≤ 3	Y
B-Pillar Maximum	0.1	≤ 5	Y	B-Pillar Maximum	0.2	≤ 5	X
B-Pillar Lateral	0.1	≤ 3	Y	B-Pillar Lateral	-0.2	≤ 3	Y
Toe Pan - Wheel Well	0.2	≤ 9	X, Z	Toe Pan - Wheel Well	0.6	≤ 9	X, Z
Side Front Panel	-0.3	≤ 12	Y	Side Front Panel	-0.2	≤ 12	Y
Side Door (above seat)	-0.1	≤ 9	Y	Side Door (above seat)	-0.3	≤ 9	Y
Side Door (below seat)	-0.3	≤ 12	Y	Side Door (below seat)	-0.2	≤ 12	Y
Floor Pan	0.2	≤ 12	Z	Floor Pan	0.5	≤ 12	Z
Dash - no MASH requirement	0.7	NA	X, Y, Z	Dash - no MASH requirement	0.7	NA	X, Y, Z

[A] Items highlighted in red do not meet MASH allowable deformations.

[B] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[C] For Toe Pan - Wheel Well the direction of defromation may include X and Z direction. For A-Pillar Maximum and B-Pillar Maximum the direction of deformation may include X, Y, and Z directions. The direction of deformation for Toe Pan -Wheel Well, A-Pillar Maximum, and B-Pillar Maximum only include components where the deformation is positive and intruding into the occupant compartment. If direction of deformation is "NA" then no intrusion is recorded and deformation will be 0.

[D] If deformation is observered for the windshield then the windshield deformation is measured posttest with an examplar vehicle, therefore only one set of reference is measured and recorded.

Notes on vehicle interior crush:

Figure D-21. Maximum Occupant Compartment Deformation, Left, Test No. MOS-6

Date: 6/12/2019 Test Name: MOS-6 VIN: KNADE223296512940
Year: 2009 Make: Kia Model: Rio

Passenger Side Maximum Deformations

Reference Set 1				Reference Set 2			
Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]	Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]
Roof	0.4	≤ 4	Z	Roof	-0.1	≤ 4	Z
Windshield[D]	0.0	≤ 3	X, Z	Windshield[D]	NA	≤ 3	X, Z
A-Pillar Maximum	0.9	≤ 5	Z	A-Pillar Maximum	0.0	≤ 5	NA
A-Pillar Lateral	-0.2	≤ 3	Y	A-Pillar Lateral	-0.1	≤ 3	Y
B-Pillar Maximum	0.3	≤ 5	Z	B-Pillar Maximum	0.1	≤ 5	X
B-Pillar Lateral	-0.2	≤ 3	Y	B-Pillar Lateral	-0.1	≤ 3	Y
Toe Pan - Wheel Well	0.3	≤ 9	X, Z	Toe Pan - Wheel Well	0.7	≤ 9	X, Z
Side Front Panel	0.1	≤ 12	Y	Side Front Panel	-0.3	≤ 12	Y
Side Door (above seat)	-0.1	≤ 9	Y	Side Door (above seat)	-0.2	≤ 9	Y
Side Door (below seat)	0.0	≤ 12	Y	Side Door (below seat)	-0.2	≤ 12	Y
Floor Pan	0.2	≤ 12	Z	Floor Pan	0.5	≤ 12	Z
Dash - no MASH requirement	0.9	NA	X, Y, Z	Dash - no MASH requirement	0.9	NA	X, Y, Z

[A] Items highlighted in red do not meet MASH allowable deformations.

[B] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[C] For Toe Pan - Wheel Well the direction of defromation may include X and Z direction. For A-Pillar Maximum and B-Pillar Maximum the direction of deformation may include X, Y, and Z directions. The direction of deformation for Toe Pan -Wheel Well, A-Pillar Maximum, and B-Pillar Maximum only include components where the deformation is positive and intruding into the occupant compartment. If direction of deformation is "NA" then no intrusion is recorded and deformation will be 0.

[D] If deformation is observered for the windshield then the windshield deformation is measured posttest with an examplar vehicle, therefore only one set of reference is measured and recorded.

Notes on vehicle interior crush:

Figure D-22. Maximum Occupant Compartment Deformation, Right, Test No. MOS-6

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE FLOOR PAN - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	61.1909	-28.4860	4.5783	61.1870	-28.5136	4.7017	0.0039	-0.0276	-0.1234	0.1265	0.0039	X
	2	61.6807	-23.3711	6.0481	61.6469	-23.3903	6.2276	0.0338	-0.0192	-0.1795	0.1837	0.0338	X
	3	61.2850	-17.4446	6.1176	61.2433	-17.3741	6.3085	0.0417	0.0705	-0.1909	0.2077	0.0417	X
	4	60.5833	-11.4799	6.3429	60.5790	-11.4855	6.5230	0.0043	-0.0056	-0.1801	0.1802	0.0043	X
	5	58.5788	-7.9013	5.3805	58.6094	-7.8938	5.5619	-0.0306	0.0075	-0.1814	0.1841	0.0000	NA
	6	58.7630	-28.2712	7.7132	58.6933	-28.3044	7.8865	0.0697	-0.0332	-0.1733	0.1897	0.0697	X
	7	58.0239	-23.6108	7.8377	57.9761	-23.6411	8.0046	0.0478	-0.0303	-0.1669	0.1762	0.0478	X
	8	57.5583	-17.8989	7.7502	57.4785	-17.8717	7.9299	0.0798	0.0272	-0.1797	0.1985	0.0798	X
	9	56.7553	-12.2504	7.8188	56.7487	-12.2380	7.9937	0.0066	0.0124	-0.1749	0.1755	0.0066	X
	10	55.5706	-8.1527	5.3965	55.5687	-8.1403	5.5581	0.0019	0.0124	-0.1616	0.1621	0.0019	X
FLOOR PAN (Z)	11	54.4274	-28.5697	7.9601	54.3795	-28.5988	8.1001	0.0479	-0.0291	-0.1400	0.1508	-0.1400	Z
	12	53.7818	-23.8555	8.1013	53.7160	-23.8761	8.2523	0.0658	-0.0206	-0.1510	0.1660	-0.1510	Z
	13	52.8816	-18.0998	7.9552	52.8346	-18.0608	8.1081	0.0470	0.0390	-0.1529	0.1646	-0.1529	Z
	14	52.2219	-12.4914	8.3433	52.2034	-12.4562	8.4963	0.0185	0.0352	-0.1530	0.1581	-0.1530	Z
	15	51.5646	-8.2823	5.7883	51.5167	-8.2748	5.9356	0.0479	0.0075	-0.1473	0.1551	-0.1473	Z
	16	50.7900	-28.6721	8.1837	50.7553	-28.7047	8.3020	0.0347	-0.0326	-0.1183	0.1275	-0.1183	Z
	17	50.3641	-23.9360	8.3456	50.3691	-23.9833	8.4938	-0.0050	-0.0473	-0.1482	0.1556	-0.1482	Z
	18	49.7640	-17.8825	7.9992	49.6956	-17.8827	8.1421	0.0684	-0.0002	-0.1429	0.1584	-0.1429	Z
	19	49.4687	-12.6148	8.6554	49.4256	-12.6035	8.8052	0.0431	0.0113	-0.1498	0.1563	-0.1498	Z
	20	49.5898	-8.4968	5.5697	49.5899	-8.5067	5.7516	-0.0001	-0.0099	-0.1819	0.1822	-0.1819	Z
	21	47.9240	-28.7991	8.2817	47.8932	-28.8337	8.3804	0.0308	-0.0346	-0.0987	0.1090	-0.0987	Z
	22	47.4639	-23.9090	8.4373	47.4337	-23.8905	8.5517	0.0302	0.0185	-0.1144	0.1198	-0.1144	Z
	23	47.1490	-18.3623	8.0599	47.0943	-18.3910	8.1922	0.0547	-0.0287	-0.1323	0.1460	-0.1323	Z
	24	46.6393	-11.6437	8.7436	46.5823	-11.6084	8.8741	0.0570	0.0353	-0.1305	0.1467	-0.1305	Z
	25	46.6958	-8.6699	5.6516	46.6707	-8.6619	5.7813	0.0251	0.0080	-0.1297	0.1323	-0.1297	Z
	26	40.5278	-27.6576	8.2916	40.5199	-27.6641	8.3831	0.0079	-0.0065	-0.0915	0.0921	-0.0915	Z
	27	40.6480	-23.9530	8.2500	40.6488	-23.9093	8.3459	-0.0008	0.0437	-0.0959	0.1054	-0.0959	Z
	28	40.9227	-18.7769	8.1618	40.8591	-18.7243	8.2697	0.0636	0.0526	-0.1079	0.1358	-0.1079	Z
	29	41.0541	-11.6562	8.3419	40.9816	-11.6445	8.4376	0.0725	0.0117	-0.0957	0.1206	-0.0957	Z
	30	41.0901	-8.9378	5.7064	41.0390	-8.9915	5.9246	0.0511	-0.0537	-0.2182	0.2304	-0.2182	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-23. Floor Pan Deformation Data – Set 1, Left, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE FLOOR PAN - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	60.8908	0.4812	4.6952	60.8867	0.2687	4.8235	0.0041	0.2125	-0.1283	0.2483	0.0041	X
	2	62.4413	4.6320	4.7716	62.4610	4.4170	4.8944	-0.0197	0.2150	-0.1228	0.2484	0.0000	NA
	3	62.7127	10.1059	4.4184	62.7208	9.8639	4.5593	-0.0081	0.2420	-0.1409	0.2801	0.0000	NA
	4	62.6186	15.1764	4.2348	62.6074	14.9447	4.4025	0.0112	0.2317	-0.1677	0.2862	0.0112	X
	5	59.9892	20.4465	3.1160	60.0228	20.1829	3.2286	-0.0336	0.2636	-0.1126	0.2886	0.0000	NA
	6	57.3062	0.5074	5.0477	57.3564	0.2933	5.1705	-0.0502	0.2141	-0.1228	0.2519	0.0000	NA
	7	58.1558	4.6134	7.3294	58.1322	4.4644	7.4620	0.0236	0.1490	-0.1326	0.2008	0.0236	X
	8	58.3633	10.1321	7.0261	58.3345	9.9004	7.1750	0.0288	0.2317	-0.1489	0.2769	0.0288	X
	9	59.0312	15.6591	6.5442	59.0044	15.4161	6.7050	0.0268	0.2430	-0.1608	0.2926	0.0268	X
	10	58.6885	20.3799	5.9569	58.6863	20.1498	6.1071	0.0022	0.2301	-0.1502	0.2748	0.0022	X
FLOOR PAN (Z)	11	53.7249	0.4336	5.1423	53.7630	0.2058	5.2316	-0.0381	0.2278	-0.0893	0.2476	-0.0893	Z
	12	54.6945	4.7356	7.8404	54.7249	4.5049	7.9645	-0.0304	0.2307	-0.1241	0.2637	-0.1241	Z
	13	54.7731	10.0997	7.8113	54.7516	9.8985	7.9479	0.0215	0.2012	-0.1366	0.2441	-0.1366	Z
	14	54.5897	15.3792	7.8329	54.5752	15.1435	7.9795	0.0145	0.2357	-0.1466	0.2780	-0.1466	Z
	15	54.0839	19.9188	7.8462	54.0558	19.6810	8.0011	0.0281	0.2378	-0.1549	0.2852	-0.1549	Z
	16	50.3887	0.3382	5.3544	50.3819	0.1105	5.4500	0.0068	0.2277	-0.0956	0.2470	-0.0956	Z
	17	50.7972	4.3595	8.4662	50.7972	4.1297	8.5804	0.0000	0.2298	-0.1142	0.2566	-0.1142	Z
	18	51.0304	10.3483	7.9187	51.0333	10.0707	8.0467	-0.0029	0.2776	-0.1280	0.3057	-0.1280	Z
	19	50.9991	15.7422	8.0899	50.9913	15.5407	8.2329	0.0078	0.2015	-0.1430	0.2472	-0.1430	Z
	20	51.0782	19.8263	8.1679	51.0594	19.6096	8.3141	0.0188	0.2167	-0.1462	0.2621	-0.1462	Z
	21	46.3665	0.3836	5.8320	46.3565	0.1404	5.9041	0.0100	0.2432	-0.0721	0.2539	-0.0721	Z
	22	45.1620	4.0334	8.7674	45.1531	3.8027	8.8676	0.0089	0.2307	-0.1002	0.2517	-0.1002	Z
	23	46.0294	9.3260	7.9967	45.9777	9.1000	8.1113	0.0517	0.2260	-0.1146	0.2586	-0.1146	Z
	24	46.7676	15.8290	8.4400	46.7580	15.6110	8.5744	0.0096	0.2180	-0.1344	0.2563	-0.1344	Z
	25	47.0385	20.0861	8.3454	47.0053	19.8850	8.4767	0.0332	0.2011	-0.1313	0.2425	-0.1313	Z
	26	38.8879	0.1025	5.9835	38.9575	-0.1275	6.0603	-0.0696	0.2300	-0.0768	0.2523	-0.0768	Z
	27	38.5333	3.9834	8.1528	38.5024	3.7445	8.2381	0.0309	0.2389	-0.0853	0.2555	-0.0853	Z
	28	38.3738	8.3317	8.1106	38.3726	8.0991	8.2036	0.0012	0.2326	-0.0930	0.2505	-0.0930	Z
	29	38.5273	14.4675	8.1305	38.4456	14.1860	8.2333	0.0817	0.2815	-0.1028	0.3106	-0.1028	Z
	30	38.5989	19.2469	8.1885	38.5745	18.9944	8.3012	0.0244	0.2525	-0.1127	0.2776	-0.1127	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.
[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.
[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-24. Floor Pan Deformation Data – Set 1, Right, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE FLOOR PAN - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	59.8434	-14.0344	4.4713	59.8485	-14.0695	4.4176	-0.0051	-0.0351	0.0537	0.0644	0.0537	Z
	2	60.7715	-8.9738	5.9174	60.7549	-8.9957	5.9087	0.0166	-0.0219	0.0087	0.0288	0.0187	X, Z
	3	60.8832	-3.0348	5.9616	60.8678	-2.9667	5.9545	0.0154	0.0681	0.0071	0.0702	0.0170	X, Z
	4	60.6936	2.9689	6.1620	60.7110	2.9583	6.1363	-0.0174	0.0106	0.0257	0.0328	0.0257	Z
	5	58.9995	6.7014	5.1881	59.0497	6.6998	5.1646	-0.0502	0.0016	0.0235	0.0555	0.0235	Z
	6	57.4505	-13.5999	7.6104	57.4026	-13.6295	7.6158	0.0479	-0.0296	-0.0054	0.0566	0.0479	X
	7	57.1121	-8.8929	7.7159	57.0877	-8.9214	7.7092	0.0244	-0.0285	0.0067	0.0381	0.0253	X, Z
	8	57.1355	-3.1626	7.6042	57.0849	-3.1311	7.6014	0.0506	0.0315	0.0028	0.0597	0.0507	X, Z
	9	56.8175	2.5341	7.6494	56.8401	2.5447	7.6345	-0.0226	-0.0106	0.0149	0.0291	0.0149	Z
	10	55.9808	6.7077	5.2116	55.9990	6.7144	5.1806	-0.0182	-0.0067	0.0310	0.0366	0.0310	Z
FLOOR PAN (Z)	11	53.1059	-13.5262	7.8678	53.0808	-13.5525	7.8570	0.0251	-0.0263	0.0108	0.0379	0.0108	Z
	12	52.8653	-8.7735	7.9896	52.8248	-8.7895	7.9838	0.0405	-0.0160	0.0058	0.0439	0.0058	Z
	13	52.4591	-2.9627	7.8199	52.4431	-2.9211	7.8086	0.0160	0.0416	0.0113	0.0460	0.0113	Z
	14	52.2814	2.6832	8.1847	52.2961	2.7191	8.1657	-0.0147	-0.0359	0.0190	0.0432	0.0190	Z
	15	51.9794	6.9221	5.6124	51.9529	6.9293	5.5830	0.0265	-0.0072	0.0294	0.0402	0.0294	Z
	16	49.4736	-13.3168	8.0996	49.4623	-13.3467	8.0812	0.0113	-0.0299	0.0184	0.0369	0.0184	Z
	17	49.4538	-8.5610	8.2415	49.4825	-8.6086	8.2459	-0.0287	-0.0476	-0.0044	0.0558	-0.0044	Z
	18	49.3716	-2.4799	7.8696	49.3311	-2.4748	7.8602	0.0405	0.0051	0.0094	0.0419	0.0094	Z
	19	49.5285	2.7965	8.5031	49.5180	2.8118	8.4920	0.0105	-0.0153	0.0111	0.0216	0.0111	Z
	20	49.9929	6.8761	5.3990	50.0122	6.8621	5.4120	-0.0193	0.0140	-0.0130	0.0272	-0.0130	Z
	21	46.6074	-13.1984	8.2042	46.6002	-13.2299	8.1774	0.0072	-0.0315	0.0268	0.0420	0.0268	Z
	22	46.5667	-8.2862	8.3391	46.5663	-8.2646	8.3207	0.0004	0.0216	0.0184	0.0284	0.0184	Z
	23	46.7253	-2.7345	7.9380	46.6962	-2.7584	7.9290	0.0291	-0.0239	0.0090	0.0387	0.0090	Z
	24	46.7926	4.0059	8.5930	46.7707	4.0469	8.5717	0.0219	-0.0410	0.0213	0.0511	0.0213	Z
	25	47.0950	6.9510	5.4878	47.0907	6.9574	5.4601	0.0043	-0.0064	0.0277	0.0288	0.0277	Z
	26	39.3357	-11.4298	8.2247	39.3541	-11.4337	8.2169	-0.0184	-0.0039	0.0078	0.0204	0.0078	Z
	27	39.7715	-7.7491	8.1666	39.8035	-7.7039	8.1556	-0.0320	0.0452	0.0110	0.0565	0.0110	Z
	28	40.4867	-2.6158	8.0549	40.4560	-2.5564	8.0458	0.0307	0.0594	0.0091	0.0675	0.0091	Z
	29	41.2257	4.4685	8.2033	41.1847	4.4878	8.1689	0.0410	-0.0193	0.0344	0.0569	0.0344	Z
	30	41.4870	7.1627	5.5557	41.4525	7.1117	5.6391	0.0345	0.0510	-0.0834	0.1037	-0.0834	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-25. Floor Pan Deformation Data – Set 2, Left, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE FLOOR PAN - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
TOE PAN - WHEEL WELL (X, Z)	1	62.0239	14.6136	4.3197	62.0165	14.6397	4.3268	0.0074	-0.0261	-0.0071	0.0280	0.0074	X
	2	63.9223	18.6174	4.3833	63.9397	18.6386	4.3653	-0.0174	-0.0212	0.0180	0.0328	0.0180	Z
	3	64.6567	24.0481	4.0227	64.6612	24.0418	4.0002	-0.0045	0.0063	0.0225	0.0238	0.0225	Z
	4	64.9936	29.1081	3.8341	64.9809	29.1130	3.8178	0.0127	-0.0049	0.0163	0.0212	0.0207	X, Z
	5	62.8163	34.5822	2.7236	62.8444	34.5473	2.6346	-0.0281	0.0349	0.0890	0.0996	0.0890	Z
	6	58.4565	14.9450	4.6913	58.5039	14.9673	4.6979	-0.0474	-0.0223	-0.0066	0.0528	0.0000	NA
	7	59.6647	18.9652	6.9639	59.6497	19.0673	6.9623	0.0150	-0.1021	0.0016	0.1032	0.0151	X, Z
	8	60.3396	24.4460	6.6535	60.3132	24.4648	6.6458	0.0264	-0.0188	0.0077	0.0333	0.0275	X, Z
	9	61.4729	29.8958	6.1620	61.4481	29.9009	6.1426	0.0248	-0.0051	0.0194	0.0319	0.0315	X, Z
	10	61.5301	34.6283	5.5714	61.5310	34.6417	5.5224	-0.0009	-0.0134	0.0490	0.0508	0.0490	Z
FLOOR PAN (Z)	11	54.8824	15.1764	4.8050	54.9167	15.1873	4.7841	-0.0343	-0.0109	0.0209	0.0416	0.0209	Z
	12	56.2292	19.3819	7.4932	56.2620	19.4010	7.4880	-0.0328	-0.0191	0.0052	0.0383	0.0052	Z
	13	56.7640	24.7199	7.4579	56.7489	24.7725	7.4433	0.0151	-0.0526	0.0146	0.0566	0.0146	Z
	14	57.0306	29.9958	7.4747	57.0213	30.0134	7.4489	0.0093	-0.0176	0.0258	0.0326	0.0258	Z
	15	56.9132	34.5619	7.4857	56.8913	34.5788	7.4505	0.0219	-0.0169	0.0352	0.0448	0.0352	Z
	16	51.5514	15.3654	5.0350	51.5414	15.3821	5.0263	0.0100	-0.0167	0.0087	0.0213	0.0087	Z
	17	52.3175	19.3393	8.1402	52.3212	19.3654	8.1328	-0.0037	-0.0261	0.0074	0.0274	0.0074	Z
	18	53.0566	25.2862	7.5850	53.0598	25.2621	7.5667	-0.0032	0.0241	0.0183	0.0304	0.0183	Z
	19	53.4854	30.6632	7.7505	53.4863	30.7165	7.7249	-0.0009	-0.0533	0.0256	0.0591	0.0256	Z
	20	53.9123	34.7258	7.8236	53.9021	34.7650	7.7845	0.0102	-0.0392	0.0391	0.0563	0.0391	Z
	21	47.5502	15.7533	5.5340	47.5367	15.7578	5.5078	0.0135	-0.0045	0.0262	0.0298	0.0262	Z
	22	46.6767	19.4942	8.4718	46.6721	19.5231	8.4605	0.0046	-0.0289	0.0113	0.0314	0.0113	Z
	23	47.9872	24.6933	7.6908	47.9404	24.7270	7.6711	0.0468	-0.0337	0.0197	0.0609	0.0197	Z
	24	49.2787	31.1102	8.1230	49.2771	31.1496	8.0951	0.0016	-0.0394	0.0279	0.0483	0.0279	Z
	25	49.9104	35.3287	8.0223	49.8877	35.3865	7.9735	0.0227	-0.0578	0.0488	0.0790	0.0488	Z
	26	40.0759	16.1099	5.7257	40.1432	16.1236	5.7163	-0.0673	-0.0137	0.0094	0.0693	0.0094	Z
	27	40.0646	20.0083	7.8926	40.0362	20.0302	7.8771	0.0284	-0.0219	0.0155	0.0391	0.0155	Z
	28	40.2755	24.3543	7.8466	40.2784	24.3798	7.8209	-0.0029	-0.0255	0.0257	0.0363	0.0257	Z
	29	40.9508	30.4548	7.8589	40.8710	30.4383	7.8186	0.0798	0.0165	0.0403	0.0909	0.0403	Z
	30	41.4292	35.2108	7.9114	41.4105	35.2183	7.8607	0.0187	-0.0075	0.0507	0.0546	0.0507	Z

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Pretest Floor Pan	Posttest Floor Pan
	

Figure D-26. Floor Pan Deformation Data – Set 2, Right, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE INTERIOR CRUSH - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	49.9781	-27.1457	-19.5214	50.0658	-27.2007	-19.3278	-0.0877	-0.0550	0.1936	0.2195	0.2195	X, Y, Z
	2	46.2136	-17.7226	-23.1970	46.2920	-17.7564	-22.9991	-0.0784	-0.0338	0.1979	0.2155	0.2155	X, Y, Z
	3	47.8538	-2.7893	-20.4733	47.9385	-2.7844	-20.2664	-0.0847	0.0049	0.2069	0.2236	0.2236	X, Y, Z
	4	49.0075	-27.3302	-9.3737	49.0919	-27.3338	-9.0982	-0.0844	-0.0036	0.2755	0.2882	0.2882	X, Y, Z
	5	48.0004	-16.6918	-8.8664	48.0944	-16.7141	-8.6718	-0.0940	-0.0223	0.1946	0.2173	0.2173	X, Y, Z
	6	43.7678	-3.6726	-13.2017	43.8192	-3.7086	-12.9632	-0.0514	-0.0360	0.2385	0.2466	0.2466	X, Y, Z
SIDE PANEL (Y)	7	54.6353	-30.3319	0.6572	54.6539	-30.3369	0.8586	-0.0186	-0.0050	0.2014	0.2023	-0.0050	Y
	8	58.9316	-30.1337	2.2282	58.8912	-30.1419	2.4734	0.0404	-0.0082	0.2452	0.2486	-0.0082	Y
	9	57.0739	-31.0388	3.2993	57.0640	-31.0579	3.4699	0.0099	-0.0191	0.1706	0.1720	-0.0191	Y
IMPACT SIDE DOOR (Y)	10	27.4095	-33.1816	-17.6781	27.4683	-33.1917	-17.5712	-0.0588	-0.0101	0.1069	0.1224	-0.0101	Y
	11	36.7714	-32.6348	-17.4466	36.8151	-32.6522	-17.2275	-0.0437	-0.0174	0.2191	0.2241	-0.0174	Y
	12	45.0835	-32.2875	-17.0477	45.1908	-32.3045	-16.8125	-0.1073	-0.0170	0.2352	0.2591	-0.0170	Y
	13	27.4127	-32.8553	-9.2744	27.4941	-32.8538	-9.0974	-0.0814	0.0015	0.1770	0.1948	0.0015	Y
	14	36.7391	-32.7280	-8.7396	36.8069	-32.7353	-8.5453	-0.0678	-0.0073	0.1943	0.2059	-0.0073	Y
	15	44.7896	-31.9861	-8.3146	44.8134	-32.0229	-8.1369	-0.0238	-0.0368	0.1777	0.1830	-0.0368	Y
ROOF - (Z)	16	34.4082	-5.8957	-35.5318	34.5514	-5.8971	-35.4054	-0.1432	-0.0014	0.1264	0.1910	0.1264	Z
	17	34.5640	-10.8159	-35.4514	34.7284	-10.8107	-35.3199	-0.1644	0.0052	0.1315	0.2106	0.1315	Z
	18	34.5165	-14.0491	-35.3665	34.7383	-14.0597	-35.2145	-0.2218	-0.0106	0.1520	0.2691	0.1520	Z
	19	34.2564	-17.3683	-35.2561	34.4123	-17.3974	-35.1248	-0.1559	-0.0291	0.1313	0.2059	0.1313	Z
	20	33.5090	-23.6913	-34.9826	33.6606	-23.7250	-34.8474	-0.1516	-0.0337	0.1352	0.2059	0.1352	Z
	21	28.7065	-6.4019	-38.3888	28.8125	-6.4251	-38.2939	-0.1060	-0.0232	0.0949	0.1442	0.0949	Z
	22	28.3724	-10.6546	-38.3979	28.6168	-10.6279	-38.2795	-0.2444	0.0267	0.1184	0.2729	0.1184	Z
	23	28.4729	-13.9069	-38.2717	28.6580	-13.8931	-38.1639	-0.1851	0.0138	0.1078	0.2146	0.1078	Z
	24	28.5866	-17.4148	-38.0676	28.7234	-17.4333	-37.9644	-0.1368	-0.0185	0.1032	0.1724	0.1032	Z
	25	27.9571	-22.2014	-37.7953	28.1282	-22.1490	-37.6956	-0.1711	0.0524	0.0997	0.2048	0.0997	Z
	26	21.4900	-6.2311	-39.2857	21.6730	-6.2478	-39.2078	-0.1830	-0.0167	0.0779	0.1996	0.0779	Z
	27	21.5840	-9.7755	-39.2357	21.7661	-9.7859	-39.1582	-0.1821	-0.0104	0.0775	0.1982	0.0775	Z
	28	21.6386	-13.3523	-39.1243	21.8392	-13.2865	-39.0483	-0.2006	0.0658	0.0760	0.2244	0.0760	Z
	29	21.9354	-17.5695	-38.8848	22.1716	-17.5541	-38.7992	-0.2362	0.0154	0.0856	0.2517	0.0856	Z
	30	22.1378	-21.8756	-38.5466	22.2764	-21.8595	-38.4708	-0.1386	0.0161	0.0758	0.1588	0.0758	Z
A-PILLAR Maximum (X, Y, Z)	31	56.1336	-29.3796	-21.6437	56.2190	-29.3969	-21.4143	-0.0854	-0.0173	0.2294	0.2454	0.2294	Z
	32	53.0777	-28.9922	-23.7685	53.2304	-29.0102	-23.5456	-0.1527	-0.0180	0.2229	0.2708	0.2229	Z
	33	49.2536	-28.4126	-26.2703	49.3897	-28.4368	-26.0403	-0.1361	-0.0242	0.2300	0.2683	0.2300	Z
	34	45.8288	-27.8120	-28.4201	45.9684	-27.8270	-28.2375	-0.1396	-0.0150	0.1826	0.2303	0.1826	Z
	35	41.2890	-27.1356	-30.6224	41.4495	-27.1569	-30.4500	-0.1605	-0.0213	0.1724	0.2365	0.1724	Z
	36	36.5227	-26.3452	-32.9684	37.0769	-26.6398	-32.0830	-0.5542	-0.2946	0.8854	1.0853	0.8854	Z
A-PILLAR Lateral (Y)	31	56.1336	-29.3796	-21.6437	56.2190	-29.3969	-21.4143	-0.0854	-0.0173	0.2294	0.2454	-0.0173	Y
	32	53.0777	-28.9922	-23.7685	53.2304	-29.0102	-23.5456	-0.1527	-0.0180	0.2229	0.2708	-0.0180	Y
	33	49.2536	-28.4126	-26.2703	49.3897	-28.4368	-26.0403	-0.1361	-0.0242	0.2300	0.2683	-0.0242	Y
	34	45.8288	-27.8120	-28.4201	45.9684	-27.8270	-28.2375	-0.1396	-0.0150	0.1826	0.2303	-0.0150	Y
	35	41.2890	-27.1356	-30.6224	41.4495	-27.1569	-30.4500	-0.1605	-0.0213	0.1724	0.2365	-0.0213	Y
	36	36.5227	-26.3452	-32.9684	37.0769	-26.6398	-32.0830	-0.5542	-0.2946	0.8854	1.0853	-0.2946	Y
B-PILLAR Maximum (X, Y, Z)	37	15.3038	-27.6250	-33.2039	15.4280	-27.6281	-33.1658	-0.1242	-0.0031	0.0381	0.1299	0.0381	Z
	38	13.1424	-29.3436	-29.7590	13.2303	-29.3418	-29.7412	-0.0879	0.0018	0.0178	0.0897	0.0179	Y, Z
	39	16.8613	-30.2946	-27.0941	16.9733	-30.2813	-27.0965	-0.1120	0.0133	-0.0024	0.1128	0.0133	Y
	40	14.6657	-31.7344	-22.9702	14.7500	-31.7399	-22.9474	-0.0843	-0.0055	0.0228	0.0875	0.0228	Z
B-PILLAR Lateral (Y)	37	15.3038	-27.6250	-33.2039	15.4280	-27.6281	-33.1658	-0.1242	-0.0031	0.0381	0.1299	-0.0031	Y
	38	13.1424	-29.3436	-29.7590	13.2303	-29.3418	-29.7412	-0.0879	0.0018	0.0178	0.0897	0.0018	Y
	39	16.8613	-30.2946	-27.0941	16.9733	-30.2813	-27.0965	-0.1120	0.0133	-0.0024	0.1128	0.0133	Y
	40	14.6657	-31.7344	-22.9702	14.7500	-31.7399	-22.9474	-0.0843	-0.0055	0.0228	0.0875	-0.0055	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-27. Occupant Compartment Deformation Data – Set 1, Left, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE INTERIOR CRUSH - SET 1

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	48.1650	17.1265	-19.7155	48.2564	16.8349	-19.5332	-0.0914	0.2916	0.1823	0.3558	0.3558	X, Y, Z
	2	47.8643	6.4355	-20.3371	47.9216	6.1505	-20.1455	-0.0573	0.2850	0.1916	0.3482	0.3482	X, Y, Z
	3	47.8417	-2.7650	-20.4676	47.9363	-3.0210	-20.3238	-0.0946	-0.2560	0.1438	0.3085	0.3085	X, Y, Z
	4	45.8207	17.1020	-13.5391	45.8737	16.9361	-13.3601	-0.0530	0.1659	0.1790	0.2497	0.2497	X, Y, Z
	5	46.2882	6.8041	-13.4074	46.3399	6.5145	-13.2338	-0.0517	0.2896	0.1736	0.3416	0.3416	X, Y, Z
	6	43.7695	-3.6664	-13.1960	43.8168	-3.9230	-13.0360	-0.0473	-0.2566	0.1600	0.3061	0.3061	X, Y, Z
SIDE PANEL (Y)	7	52.7950	22.8985	1.4795	52.7759	22.6402	1.6426	0.0191	0.2583	0.1631	0.3061	0.2583	Y
	8	53.6756	22.7836	-2.7972	53.7876	22.5329	-2.5705	-0.1120	0.2507	0.2267	0.3561	0.2507	Y
	9	56.7370	23.0338	-2.7487	56.7306	22.7770	-2.5939	0.0064	0.2568	0.1548	0.2999	0.2568	Y
IMPACT SIDE DOOR (Y)	10	24.0649	23.0759	-17.8256	24.1165	22.8303	-17.7259	-0.0516	0.2456	0.0997	0.2700	0.2456	Y
	11	34.8253	23.5157	-17.3251	34.9054	23.2935	-17.0794	-0.0801	0.2222	0.2457	0.3408	0.2222	Y
	12	41.9770	23.8524	-16.9827	42.0247	23.6171	-16.8152	-0.0477	0.2353	0.1675	0.2927	0.2353	Y
	13	24.6133	22.8354	-8.7752	24.6065	22.5913	-8.7095	0.0068	0.2441	0.0657	0.2529	0.2441	Y
	14	34.7442	23.5222	-8.4037	34.8026	23.2898	-8.3210	-0.0584	0.2324	0.0827	0.2535	0.2324	Y
	15	41.8497	23.5147	-8.7711	41.8828	23.2730	-8.6619	-0.0331	0.2417	0.1092	0.2673	0.2417	Y
ROOF - (Z)	16	34.1989	-3.9061	-35.5550	34.3584	-4.1196	-35.4530	-0.1595	-0.2135	0.1020	0.2854	0.1020	Z
	17	33.8923	0.9682	-35.4932	33.9947	0.7703	-35.4019	-0.1024	0.1979	0.0913	0.2408	0.0913	Z
	18	33.4808	4.2521	-35.4217	33.5474	4.0749	-35.3389	-0.0666	0.1772	0.0828	0.2066	0.0828	Z
	19	32.5787	8.3025	-35.3475	32.7058	8.1019	-35.2512	-0.1271	0.2006	0.0963	0.2563	0.0963	Z
	20	31.4740	13.6942	-35.0940	31.5817	13.4657	-35.0057	-0.1077	0.2285	0.0883	0.2676	0.0883	Z
	21	28.4846	-3.4751	-38.4037	28.6582	-3.7197	-38.3138	-0.1736	-0.2446	0.0899	0.3131	0.0899	Z
	22	27.5921	0.6040	-38.4415	27.7215	0.4374	-38.3576	-0.1294	0.1666	0.0839	0.2270	0.0839	Z
	23	26.9257	3.4783	-38.4110	27.0190	3.2424	-38.3373	-0.0933	0.2359	0.0737	0.2642	0.0737	Z
	24	26.3882	7.0892	-38.2518	26.5547	6.8139	-38.1701	-0.1665	0.2753	0.0817	0.3319	0.0817	Z
	25	25.4585	11.7586	-37.9574	25.6194	11.5721	-37.8704	-0.1609	0.1865	0.0870	0.2612	0.0870	Z
	26	22.3866	-3.4358	-39.1906	22.4907	-3.6653	-39.1321	-0.1041	-0.2295	0.0585	0.2587	0.0585	Z
	27	21.5769	0.0090	-39.1763	21.7641	-0.1712	-39.1104	-0.1872	0.1802	0.0659	0.2681	0.0659	Z
	28	21.0833	3.1995	-39.0856	21.2445	2.9097	-39.0258	-0.1612	0.2898	0.0598	0.3370	0.0598	Z
	29	20.8357	6.9736	-38.8807	20.9541	6.7115	-38.8197	-0.1184	0.2621	0.0610	0.2940	0.0610	Z
	30	20.7232	10.7279	-38.5761	20.8785	10.4753	-38.5135	-0.1553	0.2526	0.0626	0.3031	0.0626	Z
A-PILLAR Maximum (X, Y, Z)	31	54.0218	22.0766	-21.4204	54.0297	21.8266	-21.2402	-0.0079	0.2500	0.1802	0.3083	0.3082	Y, Z
	32	50.6290	21.3171	-23.8678	50.7491	21.0836	-23.6611	-0.1201	0.2335	0.2067	0.3342	0.3118	Y, Z
	33	47.3501	20.4548	-26.1790	47.4720	20.2255	-25.9777	-0.1219	0.2293	0.2013	0.3286	0.3051	Y, Z
	34	45.0472	19.8265	-27.6446	45.1451	19.5885	-27.4820	-0.0979	0.2380	0.1626	0.3044	0.2882	Y, Z
	35	40.5785	18.6107	-30.1577	40.7822	18.3981	-29.9736	-0.2037	0.2126	0.1841	0.3473	0.2812	Y, Z
	36	35.9541	17.4252	-32.3624	36.1119	17.2001	-32.2274	-0.1578	0.2251	0.1350	0.3063	0.2625	Y, Z
A-PILLAR Lateral (Y)	31	54.0218	22.0766	-21.4204	54.0297	21.8266	-21.2402	-0.0079	0.2500	0.1802	0.3083	0.2500	Y
	32	50.6290	21.3171	-23.8678	50.7491	21.0836	-23.6611	-0.1201	0.2335	0.2067	0.3342	0.2335	Y
	33	47.3501	20.4548	-26.1790	47.4720	20.2255	-25.9777	-0.1219	0.2293	0.2013	0.3286	0.2293	Y
	34	45.0472	19.8265	-27.6446	45.1451	19.5885	-27.4820	-0.0979	0.2380	0.1626	0.3044	0.2380	Y
	35	40.5785	18.6107	-30.1577	40.7822	18.3981	-29.9736	-0.2037	0.2126	0.1841	0.3473	0.2126	Y
	36	35.9541	17.4252	-32.3624	36.1119	17.2001	-32.2274	-0.1578	0.2251	0.1350	0.3063	0.2251	Y
B-PILLAR Maximum (X, Y, Z)	37	13.0133	15.4885	-34.4132	13.1617	15.2633	-34.3772	-0.1484	0.2252	0.0360	0.2721	0.2281	Y, Z
	38	11.2119	17.7715	-30.1715	11.2693	17.5741	-30.0838	-0.0574	0.1974	0.0877	0.2235	0.2160	Y, Z
	39	14.5450	19.4341	-26.5486	14.6937	19.1851	-26.5552	-0.1487	0.2490	-0.0066	0.2901	0.2490	Y
	40	12.4592	20.7048	-21.9000	12.5492	20.4712	-21.8513	-0.0900	0.2336	0.0487	0.2550	0.2386	Y, Z
B-PILLAR Lateral (Y)	37	13.0133	15.4885	-34.4132	13.1617	15.2633	-34.3772	-0.1484	0.2252	0.0360	0.2721	0.2252	Y
	38	11.2119	17.7715	-30.1715	11.2693	17.5741	-30.0838	-0.0574	0.1974	0.0877	0.2235	0.1974	Y
	39	14.5450	19.4341	-26.5486	14.6937	19.1851	-26.5552	-0.1487	0.2490	-0.0066	0.2901	0.2490	Y
	40	12.4592	20.7048	-21.9000	12.5492	20.4712	-21.8513	-0.0900	0.2336	0.0487	0.2550	0.2336	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-28. Occupant Compartment Deformation Data – Set 1, Right, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
DRIVER SIDE INTERIOR CRUSH - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	48.7052	-12.1032	-19.5846	48.7674	-12.1736	-19.4592	-0.0622	-0.0704	0.1254	0.1567	0.1567	X, Y, Z
	2	45.7541	-2.4088	-23.2975	45.7923	-2.4695	-23.1869	-0.0382	-0.0607	0.1106	0.1318	0.1318	X, Y, Z
	3	48.6739	12.3411	-20.6466	48.7134	12.3280	-20.5709	-0.0395	0.0131	0.0757	0.0864	0.0864	X, Y, Z
	4	47.7446	-12.1580	-9.4344	47.8285	-12.1512	-9.2255	-0.0839	0.0068	0.2089	0.2252	0.2252	X, Y, Z
	5	47.6539	-1.4703	-8.9750	47.7366	-1.4824	-8.8742	-0.0827	-0.0121	0.1008	0.1309	0.1309	X, Y, Z
	6	44.5432	11.8441	-13.3637	44.5611	11.8080	-13.2464	-0.0179	0.0361	0.1173	0.1240	0.1240	X, Y, Z
SIDE PANEL (Y)	7	53.1164	-15.5858	0.6003	53.1576	-15.5445	0.7333	-0.0412	0.0413	0.1330	0.1452	0.0413	Y
	8	57.4173	-15.7495	2.1626	57.4029	-15.6981	2.3315	0.0144	0.0514	0.1689	0.1771	0.0514	Y
	9	55.4912	-16.4872	3.2413	55.5089	-16.4488	3.3413	-0.0177	0.0384	0.1000	0.1086	0.0384	Y
IMPACT SIDE DOOR (Y)	10	25.7064	-16.1742	-17.6726	25.7510	-16.2144	-17.5775	-0.0446	-0.0402	0.0951	0.1125	-0.0402	Y
	11	35.0813	-16.4307	-17.4605	35.1112	-16.4669	-17.2713	-0.0299	-0.0362	0.1892	0.1949	-0.0362	Y
	12	43.3934	-16.7954	-17.0781	43.4879	-16.8276	-16.8888	-0.0945	-0.0322	0.1893	0.2140	-0.0322	Y
	13	25.7560	-15.8115	-9.2705	25.8408	-15.8199	-9.1066	-0.0848	-0.0084	0.1639	0.1847	-0.0084	Y
	14	35.0601	-16.4816	-8.7531	35.1324	-16.4876	-8.5887	-0.0723	-0.0060	0.1644	0.1797	-0.0060	Y
	15	43.1455	-16.4305	-8.3460	43.1721	-16.4538	-8.2142	-0.0266	-0.0233	0.1318	0.1365	-0.0233	Y
ROOF - (Z)	16	34.9786	10.3307	-35.6663	35.0473	10.2545	-35.6386	-0.0687	0.0762	0.0277	0.1063	0.0277	Z
	17	34.7124	5.4157	-35.5631	34.8076	5.3443	-35.5173	-0.0952	0.0714	0.0458	0.1275	0.0458	Z
	18	34.3882	2.1988	-35.4631	34.5425	2.1070	-35.3879	-0.1543	0.0918	0.0752	0.1947	0.0752	Z
	19	33.8448	-1.0853	-35.3366	33.9351	-1.1903	-35.2723	-0.0903	-0.1050	0.0643	0.1527	0.0643	Z
	20	32.5590	-7.3197	-35.0322	32.6509	-7.4293	-34.9455	-0.0919	-0.1096	0.0867	0.1673	0.0867	Z
	21	29.2483	10.3022	-38.5106	29.2722	10.1946	-38.5026	-0.0239	0.1076	0.0080	0.1105	0.0080	Z
	22	28.5510	6.0937	-38.4992	28.7211	6.0237	-38.4563	-0.1701	0.0700	0.0429	0.1889	0.0429	Z
	23	28.3726	2.8454	-38.3580	28.4859	2.7676	-38.3167	-0.1133	0.0778	0.0413	0.1435	0.0413	Z
	24	28.1857	-0.6583	-38.1378	28.2518	-0.7639	-38.0912	-0.0661	-0.1056	0.0466	0.1330	0.0466	Z
	25	27.1490	-5.3722	-37.8419	27.2601	-5.4101	-37.7854	-0.1111	-0.0379	0.0565	0.1303	0.0565	Z
	26	22.0711	11.0867	-39.3954	22.1697	10.9700	-39.3922	-0.0986	0.1167	0.0032	0.1528	0.0032	Z
	27	21.8610	7.5476	-39.3290	21.9628	7.4373	-39.3168	-0.1018	0.1103	0.0122	0.1506	0.0122	Z
	28	21.6092	3.9798	-39.2010	21.7394	3.9439	-39.1813	-0.1302	0.0359	0.0197	0.1365	0.0197	Z
	29	21.5440	-0.2462	-38.9422	21.7099	-0.3346	-38.9017	-0.1659	-0.0884	0.0405	0.1923	0.0405	Z
	30	21.3774	-4.5522	-38.5843	21.4508	-4.6310	-38.5418	-0.0734	-0.0788	0.0425	0.1158	0.0425	Z
A-PILLAR Maximum (X, Y, Z)	31	54.6420	-14.8660	-21.7074	54.7035	-14.8982	-21.5514	-0.0615	-0.0322	0.1560	0.1707	0.1560	Z
	32	51.6258	-14.2276	-23.8286	51.7496	-14.2746	-23.6748	-0.1238	-0.0470	0.1538	0.2030	0.1538	Z
	33	47.8600	-13.3337	-26.3262	47.9608	-13.3953	-26.1599	-0.1008	-0.0616	0.1663	0.2040	0.1663	Z
	34	44.4946	-12.4515	-28.4727	44.5944	-12.5132	-28.3493	-0.0998	-0.0617	0.1234	0.1703	0.1234	Z
	35	40.0247	-11.3985	-30.6699	40.1393	-11.4781	-30.5505	-0.1146	-0.0796	0.1194	0.1836	0.1194	Z
	36	35.3385	-10.2130	-33.0111	35.8194	-10.6037	-32.1717	-0.4809	-0.3907	0.8394	1.0433	0.8394	Z
A-PILLAR Lateral (Y)	31	54.6420	-14.8660	-21.7074	54.7035	-14.8982	-21.5514	-0.0615	-0.0322	0.1560	0.1707	-0.0322	Y
	32	51.6258	-14.2276	-23.8286	51.7496	-14.2746	-23.6748	-0.1238	-0.0470	0.1538	0.2030	-0.0470	Y
	33	47.8600	-13.3337	-26.3262	47.9608	-13.3953	-26.1599	-0.1008	-0.0616	0.1663	0.2040	-0.0616	Y
	34	44.4946	-12.4515	-28.4727	44.5944	-12.5132	-28.3493	-0.0998	-0.0617	0.1234	0.1703	-0.0617	Y
	35	40.0247	-11.3985	-30.6699	40.1393	-11.4781	-30.5505	-0.1146	-0.0796	0.1194	0.1836	-0.0796	Y
	36	35.3385	-10.2130	-33.0111	35.8194	-10.6037	-32.1717	-0.4809	-0.3907	0.8394	1.0433	-0.3907	Y
B-PILLAR Maximum (X, Y, Z)	37	14.0875	-9.6706	-33.2025	14.1604	-9.7605	-33.1698	-0.0729	-0.0899	0.0327	0.1203	0.0327	Z
	38	11.7943	-11.1821	-29.7457	11.8397	-11.2574	-29.7248	-0.0454	-0.0753	0.0209	0.0904	0.0209	Z
	39	15.4239	-12.4362	-27.0831	15.5006	-12.4921	-27.0866	-0.0767	-0.0559	-0.0035	0.0950	0.0000	NA
	40	13.1220	-13.6640	-22.9486	13.1791	-13.7276	-22.9189	-0.0571	-0.0636	0.0297	0.0905	0.0297	Z
B-PILLAR Lateral (Y)	37	14.0875	-9.6706	-33.2025	14.1604	-9.7605	-33.1698	-0.0729	-0.0899	0.0327	0.1203	-0.0899	Y
	38	11.7943	-11.1821	-29.7457	11.8397	-11.2574	-29.7248	-0.0454	-0.0753	0.0209	0.0904	-0.0753	Y
	39	15.4239	-12.4362	-27.0831	15.5006	-12.4921	-27.0866	-0.0767	-0.0559	-0.0035	0.0950	-0.0559	Y
	40	13.1220	-13.6640	-22.9486	13.1791	-13.7276	-22.9189	-0.0571	-0.0636	0.0297	0.0905	-0.0636	Y

[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-29. Occupant Compartment Deformation Data – Set 2, Left, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

VEHICLE DEFORMATION
PASSENGER SIDE INTERIOR CRUSH - SET 2

	POINT	Pretest X (in.)	Pretest Y (in.)	Pretest Z (in.)	Posttest X (in.)	Posttest Y (in.)	Posttest Z (in.)	ΔX[A] (in.)	ΔY[A] (in.)	ΔZ[A] (in.)	Total Δ (in.)	Crush[B] (in.)	Directions for Crush[C]
DASH (X, Y, Z)	1	50.6657	32.1856	-20.0062	50.6946	32.1031	-19.9895	-0.0289	0.0825	0.0167	0.0890	0.0890	X, Y, Z
	2	49.4438	21.5586	-20.5975	49.4464	21.4831	-20.5378	-0.0026	0.0755	0.0597	0.0963	0.0963	X, Y, Z
	3	48.6292	12.3939	-20.7029	48.6779	12.3429	-20.6629	-0.0487	0.0510	0.0400	0.0811	0.0811	X, Y, Z
	4	48.3542	32.3774	-13.8203	48.3656	32.4400	-13.8043	-0.0114	-0.0626	0.0160	0.0656	0.0656	X, Y, Z
	5	47.9347	22.0778	-13.6626	47.9423	22.0175	-13.6199	-0.0076	0.0603	0.0427	0.0743	0.0743	X, Y, Z
	6	44.5256	11.8634	-13.4125	44.5397	11.8344	-13.3477	-0.0141	0.0290	0.0648	0.0724	0.0724	X, Y, Z
SIDE PANEL (Y)	7	55.8651	37.5879	1.1542	55.8175	37.6145	1.1274	0.0476	-0.0266	-0.0268	0.0608	-0.0266	Y
	8	56.7143	37.3875	-3.1257	56.7915	37.3989	-3.0904	-0.0772	-0.0114	0.0353	0.0856	-0.0114	Y
	9	59.7861	37.3735	-3.0902	59.7444	37.3909	-3.1312	0.0417	-0.0174	-0.0410	0.0610	-0.0174	Y
IMPACT SIDE DOOR (Y)	10	27.1750	40.1908	-18.0353	27.1649	40.1453	-18.0863	0.0101	0.0455	-0.0510	0.0691	0.0455	Y
	11	37.9353	39.7044	-17.5795	37.9577	39.6899	-17.5009	-0.0224	0.0145	0.0786	0.0830	0.0145	Y
	12	45.0909	39.4253	-17.2668	45.0800	39.4065	-17.2772	0.0109	0.0188	-0.0104	0.0241	0.0188	Y
	13	27.7391	39.9253	-8.9866	27.6859	39.9134	-9.0714	0.0532	0.0119	-0.0848	0.1008	0.0119	Y
	14	37.8930	39.7389	-8.6578	37.9066	39.7417	-8.7423	-0.0136	-0.0028	-0.0845	0.0856	-0.0028	Y
	15	44.9699	39.1192	-9.0538	44.9574	39.1192	-9.1214	0.0125	0.0000	-0.0676	0.0687	0.0000	Y
ROOF - (Z)	16	34.8749	12.3951	-35.7320	34.9669	12.3259	-35.7116	-0.0920	0.0692	0.0204	0.1169	0.0204	Z
	17	34.9890	17.2779	-35.6823	35.0217	17.2292	-35.6869	-0.0327	0.0487	-0.0046	0.0588	-0.0046	Z
	18	34.8618	20.5852	-35.6180	34.8582	20.5602	-35.6408	0.0036	0.0250	-0.0228	0.0340	-0.0228	Z
	19	34.3118	24.6984	-35.5512	34.3636	24.6447	-35.5719	-0.0518	0.0537	-0.0207	0.0774	-0.0207	Z
	20	33.6761	30.1656	-35.3079	33.7023	30.0860	-35.3515	-0.0262	0.0796	-0.0436	0.0945	-0.0436	Z
	21	29.2068	13.3095	-38.5589	29.3047	13.1953	-38.5437	-0.0979	0.1142	0.0152	0.1512	0.0152	Z
	22	28.6684	17.4501	-38.6041	28.7256	17.4168	-38.6066	-0.0572	0.0333	-0.0025	0.0662	-0.0025	Z
	23	28.2518	20.3712	-38.5788	28.2650	20.2716	-38.5988	-0.0132	0.0996	-0.0200	0.1024	-0.0200	Z
	24	28.0276	24.0152	-38.4272	28.1080	23.8705	-38.4499	-0.0804	0.1447	-0.0227	0.1671	-0.0227	Z
	25	27.5043	28.7480	-38.1417	27.5835	28.6927	-38.1728	-0.0792	0.0553	-0.0311	0.1015	-0.0311	Z
	26	23.1315	13.8713	-39.3212	23.1596	13.7712	-39.3289	-0.0281	0.1001	-0.0077	0.1043	-0.0077	Z
	27	22.6212	17.3730	-39.3131	22.7337	17.3146	-39.3236	-0.1125	0.0584	-0.0105	0.1272	-0.0105	Z
	28	22.4043	20.5944	-39.2290	22.4792	20.4289	-39.2541	-0.0749	0.1655	-0.0251	0.1834	-0.0251	Z
	29	22.4831	24.3763	-39.0334	22.5153	24.2427	-39.0685	-0.0322	0.1336	-0.0351	0.1418	-0.0351	Z
	30	22.6953	28.1271	-38.7386	22.7627	28.0009	-38.7838	-0.0674	0.1262	-0.0452	0.1500	-0.0452	Z
A-PILLAR Maximum (X, Y, Z)	31	56.9193	36.6094	-21.7481	56.8624	36.5750	-21.7568	0.0569	0.0344	-0.0087	0.0671	0.0665	X, Y
	32	53.4634	36.1388	-24.1798	53.5161	36.1016	-24.1555	-0.0527	0.0372	0.0243	0.0689	0.0444	Y, Z
	33	50.1126	35.5563	-26.4753	50.1641	35.5138	-26.4493	-0.0515	0.0425	0.0260	0.0717	0.0498	Y, Z
	34	47.7580	35.1251	-27.9300	47.7825	35.0696	-27.9371	-0.0245	0.0555	-0.0071	0.0611	0.0555	Y
	35	43.1907	34.2923	-30.4217	43.3194	34.2424	-30.3981	-0.1287	0.0499	0.0236	0.1400	0.0552	Y, Z
	36	38.4722	33.5039	-32.6046	38.5508	33.4351	-32.6196	-0.0786	0.0688	-0.0150	0.1055	0.0688	Y
A-PILLAR Lateral (Y)	31	56.9193	36.6094	-21.7481	56.8624	36.5750	-21.7568	0.0569	0.0344	-0.0087	0.0671	0.0344	Y
	32	53.4634	36.1388	-24.1798	53.5161	36.1016	-24.1555	-0.0527	0.0372	0.0243	0.0689	0.0372	Y
	33	50.1126	35.5563	-26.4753	50.1641	35.5138	-26.4493	-0.0515	0.0425	0.0260	0.0717	0.0425	Y
	34	47.7580	35.1251	-27.9300	47.7825	35.0696	-27.9371	-0.0245	0.0555	-0.0071	0.0611	0.0555	Y
	35	43.1907	34.2923	-30.4217	43.3194	34.2424	-30.3981	-0.1287	0.0499	0.0236	0.1400	0.0499	Y
	36	38.4722	33.5039	-32.6046	38.5508	33.4351	-32.6196	-0.0786	0.0688	-0.0150	0.1055	0.0688	Y
B-PILLAR Maximum (X, Y, Z)	37	15.4413	33.5432	-34.5576	15.5068	33.4516	-34.6336	-0.0655	0.0916	-0.0760	0.1359	0.0916	Y
	38	13.8610	35.9827	-30.3149	13.8436	35.9383	-30.3435	0.0174	0.0444	-0.0286	0.0556	0.0477	X, Y
	39	17.3401	37.3609	-26.7099	17.4136	37.2701	-26.8429	-0.0735	0.0908	-0.1330	0.1770	0.0908	Y
	40	15.3911	38.8174	-22.0565	15.4144	38.7594	-22.1351	-0.0233	0.0580	-0.0786	0.1004	0.0580	Y
B-PILLAR Lateral (Y)	37	15.4413	33.5432	-34.5576	15.5068	33.4516	-34.6336	-0.0655	0.0916	-0.0760	0.1359	0.0916	Y
	38	13.8610	35.9827	-30.3149	13.8436	35.9383	-30.3435	0.0174	0.0444	-0.0286	0.0556	0.0444	Y
	39	17.3401	37.3609	-26.7099	17.4136	37.2701	-26.8429	-0.0735	0.0908	-0.1330	0.1770	0.0908	Y
	40	15.3911	38.8174	-22.0565	15.4144	38.7594	-22.1351	-0.0233	0.0580	-0.0786	0.1004	0.0580	Y

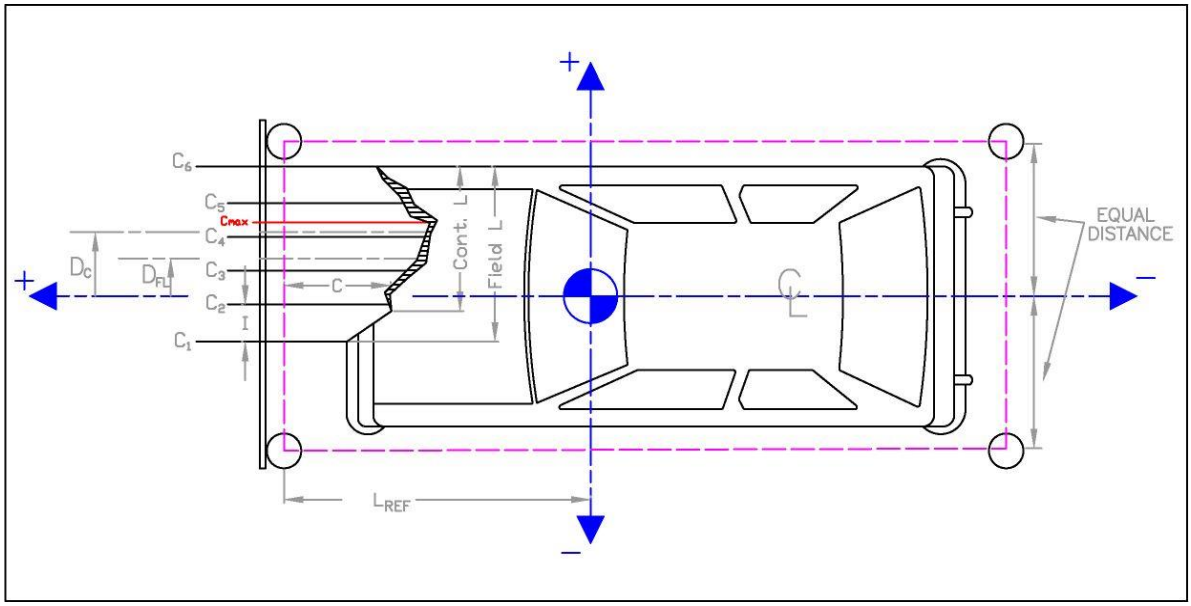
[A] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[B] Crush calculations that use multiple directional components will disregard components that are negative and only include positive values where the component is deforming inward toward the occupant compartment.

[C] Direction for Crush column denotes which directions are included in the crush calculations. If "NA" then no intrusion is recorded, and Crush will be 0.

Figure D-30. Occupant Compartment Deformation Data – Set 2, Right, Test No. MOS-7

Date:	6/28/2019	**Test Name:**	MOS-7	**VIN:**	KNADE223896580563
Year:	2009	**Make:**	Kia	**Model:**	Rio



	in.	(mm)
Distance from C.G. to reference line - L_{REF}:	76	(1930)
Total Width of Vehicle:	66 3/8	(1686)
Width of contact and induced crush - Field L:	66 3/8	(1686)
Crush measurement spacing interval (L/5) - I:	13 1/4	(337)
Distance from center of vehicle to center of Field L - D_{FL}:	0	()
Width of Contact Damage:	36	(914)
Distance from center of vehicle to center of contact damage - D_C:	0	()

NOTE: Enter "NA" for crush measurement if distance can not be measured (i.e., side of vehicle has been pushed inward)
NOTE: All values must be filled out above before crush measurements are filled out.

	Crush Measurement		Lateral Location		Original Profile Measurement		Dist. Between Ref. Lines		Actual Crush	
	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
C_1	N/a	NA	-33 1/4	-(845)	24	(610)	1	(27)	NA	NA
C_2	9 7/8	(251)	-20	-(508)	8 1/2	(216)			1/3	(8)
C_3	7 3/8	(187)	-6 3/4	-(171)	6 1/8	(156)			1/5	(5)
C_4	7 3/8	(187)	6 1/2	(165)	6 1/8	(156)			1/5	(5)
C_5	8 3/4	(222)	19 3/4	(502)	8 1/2	(216)			- 4/5	-(21)
C_6	N/a	NA	33	(838)	24	(610)			NA	NA
C_{MAX}	9 7/8	(251)	-20	-(508)	8 1/2	(216)			1/3	(8)

Figure D-31. Exterior Vehicle Crush (NASS) – Front, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

Driver Side Maximum Deformations

Reference Set 1				Reference Set 2			
Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]	Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]
Roof	0.2	≤ 4	Z	Roof	0.1	≤ 4	Z
Windshield[D]	0.0	≤ 3	X, Z	Windshield[D]	NA	≤ 3	X, Z
A-Pillar Maximum	0.9	≤ 5	Z	A-Pillar Maximum	0.8	≤ 5	Z
A-Pillar Lateral	-0.3	≤ 3	Y	A-Pillar Lateral	-0.4	≤ 3	Y
B-Pillar Maximum	0.0	≤ 5	Z	B-Pillar Maximum	0.0	≤ 5	Z
B-Pillar Lateral	-0.3	≤ 3	Y	B-Pillar Lateral	-0.1	≤ 3	Y
Toe Pan - Wheel Well	0.1	≤ 9	X	Toe Pan - Wheel Well	0.1	≤ 9	Z
Side Front Panel	0.0	≤ 12	Y	Side Front Panel	0.1	≤ 12	Y
Side Door (above seat)	0.0	≤ 9	Y	Side Door (above seat)	0.0	≤ 9	Y
Side Door (below seat)	0.0	≤ 12	Y	Side Door (below seat)	0.0	≤ 12	Y
Floor Pan	-0.2	≤ 12	Z	Floor Pan	0.0	≤ 12	Z
Dash - no MASH requirement	0.3	NA	X, Y, Z	Dash - no MASH requirement	0.3	NA	X, Y, Z

[A] Items highlighted in red do not meet MASH allowable deformations.

[B] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[C] For Toe Pan - Wheel Well the direction of defromation may include X and Z direction. For A-Pillar Maximum and B-Pillar Maximum the direction of deformation may include X, Y, and Z directions. The direction of deformation for Toe Pan -Wheel Well, A-Pillar Maximum, and B-Pillar Maximum only include components where the deformation is positive and intruding into the occupant compartment. If direction of deformation is "NA" then no intrusion is recorded and deformation will be 0.

[D] If deformation is observered for the windshield then the windshield deformation is measured posttest with an examplar vehicle, therefore only one set of reference is measured and recorded.

Notes on vehicle crush:

Figure D-32. Maximum Occupant Compartment Deformation, Left, Test No. MOS-7

Date: 6/28/2019 Test Name: MOS-7 VIN: KNADE223896580563
Year: 2009 Make: Kia Model: Rio

Passenger Side Maximum Deformations

Reference Set 1				Reference Set 2			
Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]	Location	Maximum Deformation[A,B] (in.)	MASH Allowable Deformation (in.)	Directions of Deformation[C]
Roof	0.1	≤ 4	Z	Roof	0.0	≤ 4	Z
Windshield[D]	0.0	≤ 3	X, Z	Windshield[D]	NA	≤ 3	X, Z
A-Pillar Maximum	0.3	≤ 5	Y, Z	A-Pillar Maximum	0.1	≤ 5	Y
A-Pillar Lateral	0.3	≤ 3	Y	A-Pillar Lateral	0.1	≤ 3	Y
B-Pillar Maximum	0.2	≤ 5	Y	B-Pillar Maximum	0.1	≤ 5	Y
B-Pillar Lateral	0.2	≤ 3	Y	B-Pillar Lateral	0.1	≤ 3	Y
Toe Pan - Wheel Well	0.0	≤ 9	X	Toe Pan - Wheel Well	0.1	≤ 9	Z
Side Front Panel	0.3	≤ 12	Y	Side Front Panel	0.0	≤ 12	Y
Side Door (above seat)	0.2	≤ 9	Y	Side Door (above seat)	0.0	≤ 9	Y
Side Door (below seat)	0.2	≤ 12	Y	Side Door (below seat)	0.0	≤ 12	Y
Floor Pan	-0.2	≤ 12	Z	Floor Pan	0.1	≤ 12	Z
Dash - no MASH requirement	0.4	NA	X, Y, Z	Dash - no MASH requirement	0.1	NA	X, Y, Z

[A] Items highlighted in red do not meet MASH allowable deformations.

[B] Positive values denote deformation as inward toward the occupant compartment, negative values denote deformations outward away from the occupant compartment.

[C] For Toe Pan - Wheel Well the direction of defromation may include X and Z direction. For A-Pillar Maximum and B-Pillar Maximum the direction of deformation may include X, Y, and Z directions. The direction of deformation for Toe Pan -Wheel Well, A-Pillar Maximum, and B-Pillar Maximum only include components where the deformation is positive and intruding into the occupant compartment. If direction of deformation is "NA" then no intrusion is recorded and deformation will be 0.

[D] If deformation is observered for the windshield then the windshield deformation is measured posttest with an examplar vehicle, therefore only one set of reference is measured and recorded.

Notes on vehicle crush:

Figure D-33. Maximum Occupant Compartment Deformation, Right, Test No. MOS-7

Appendix E. Accelerometer and Rate Transducer Data Plots, Test No. MOS-5

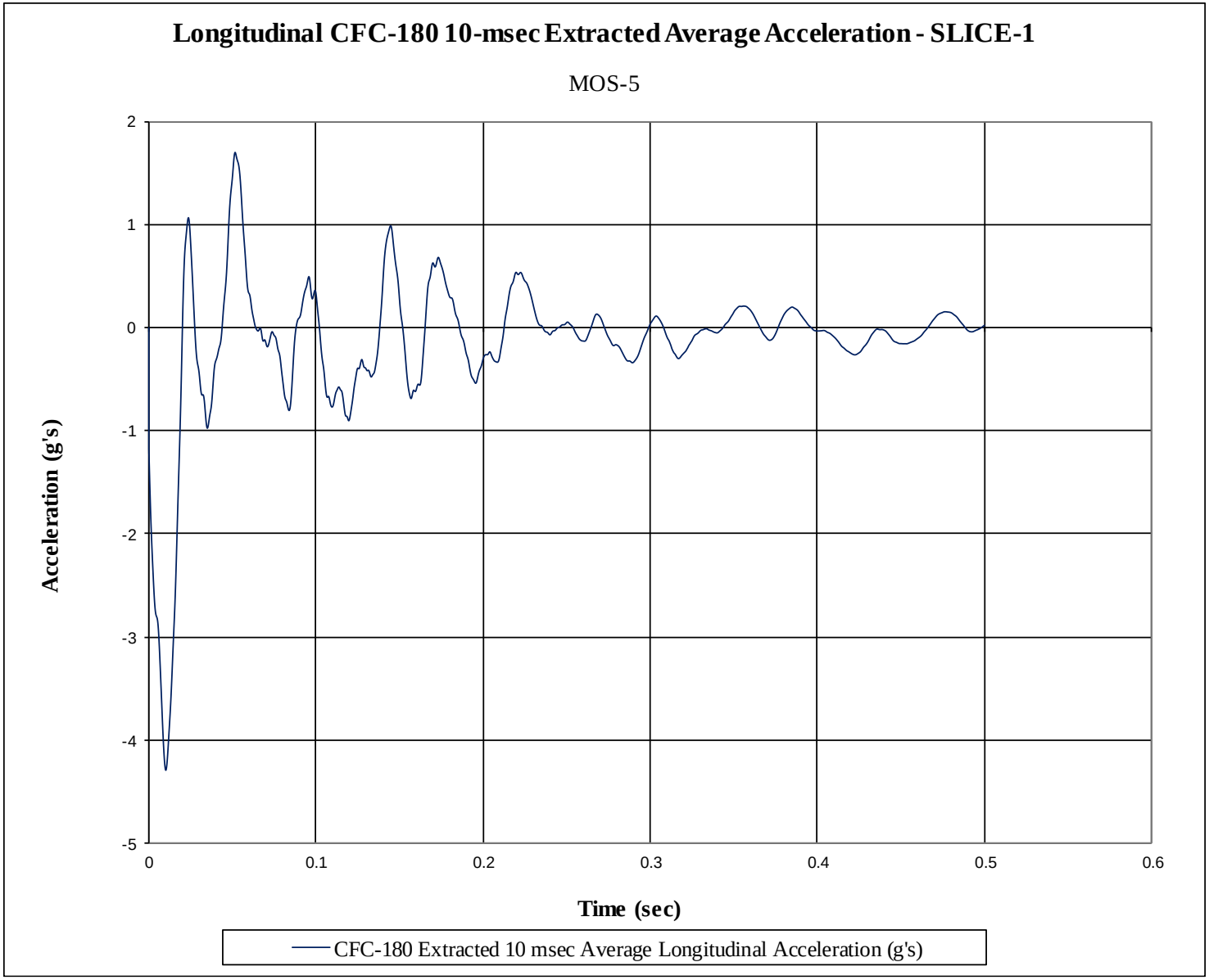


Figure E-1. 10-ms Average Longitudinal Deceleration (SLICE-1), Test No. MOS-5

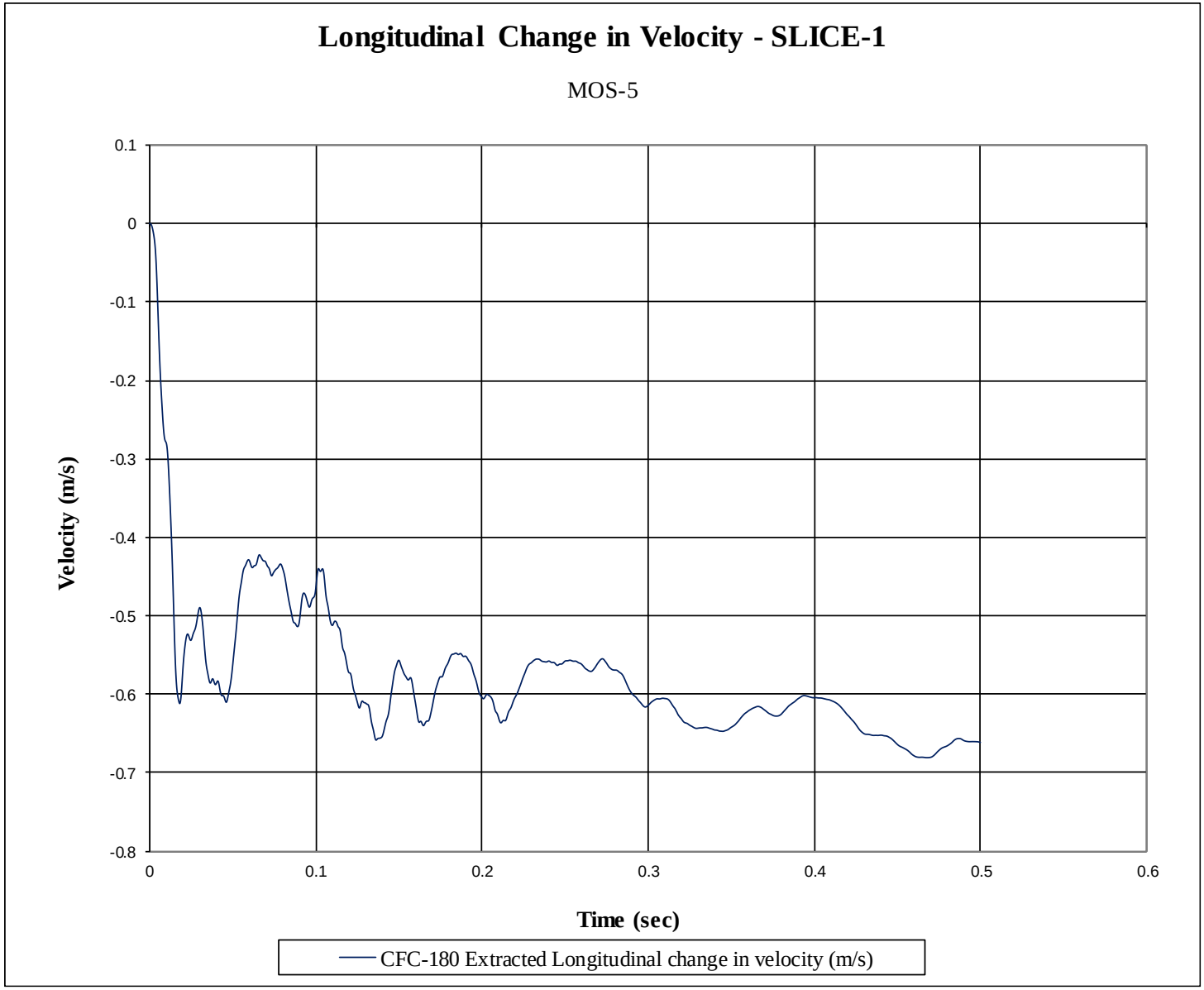


Figure E-2. Longitudinal Occupant Impact Velocity (SLICE-1), Test No. MOS-5

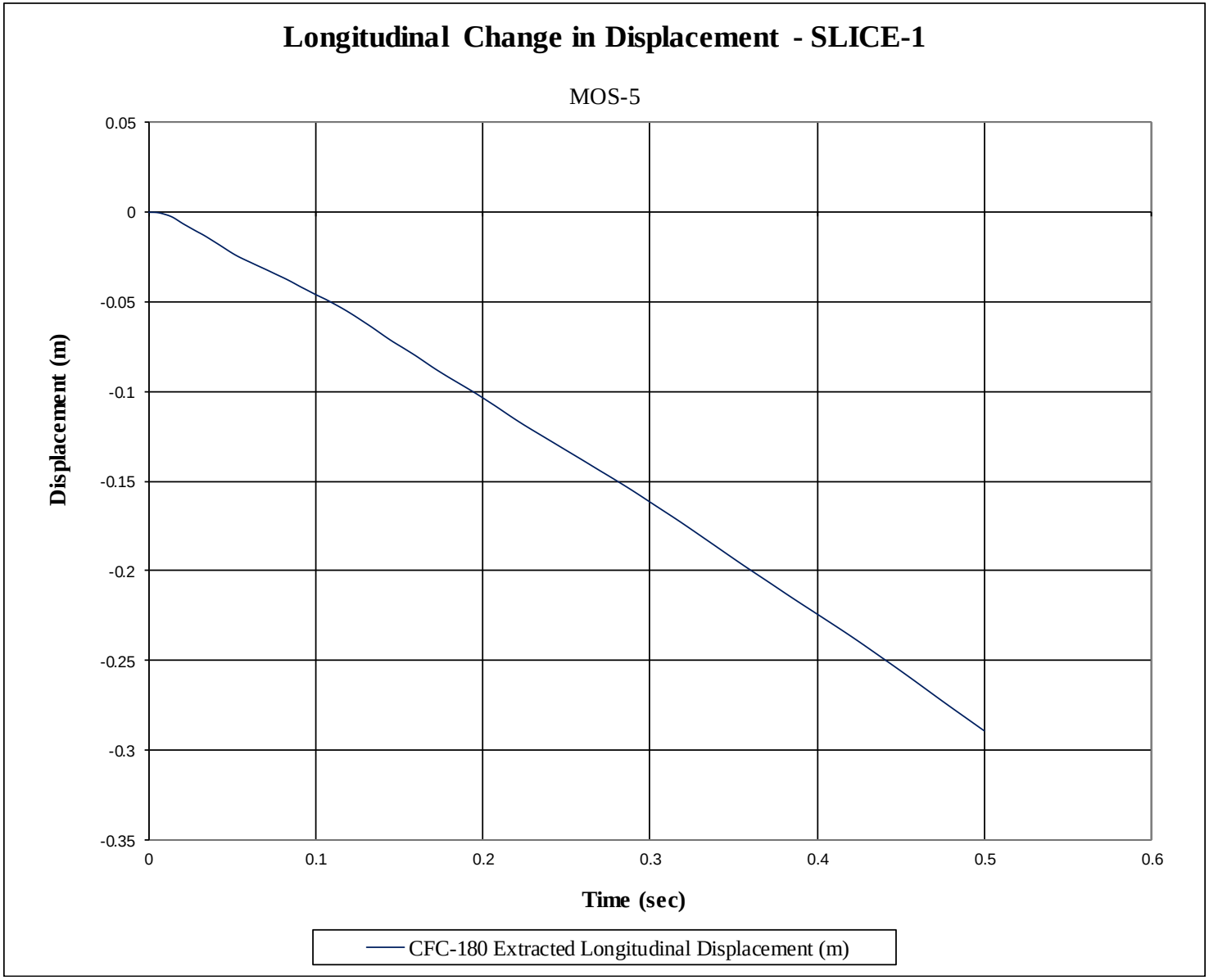


Figure E-3. Longitudinal Occupant Displacement (SLICE-1), Test No. MOS-5

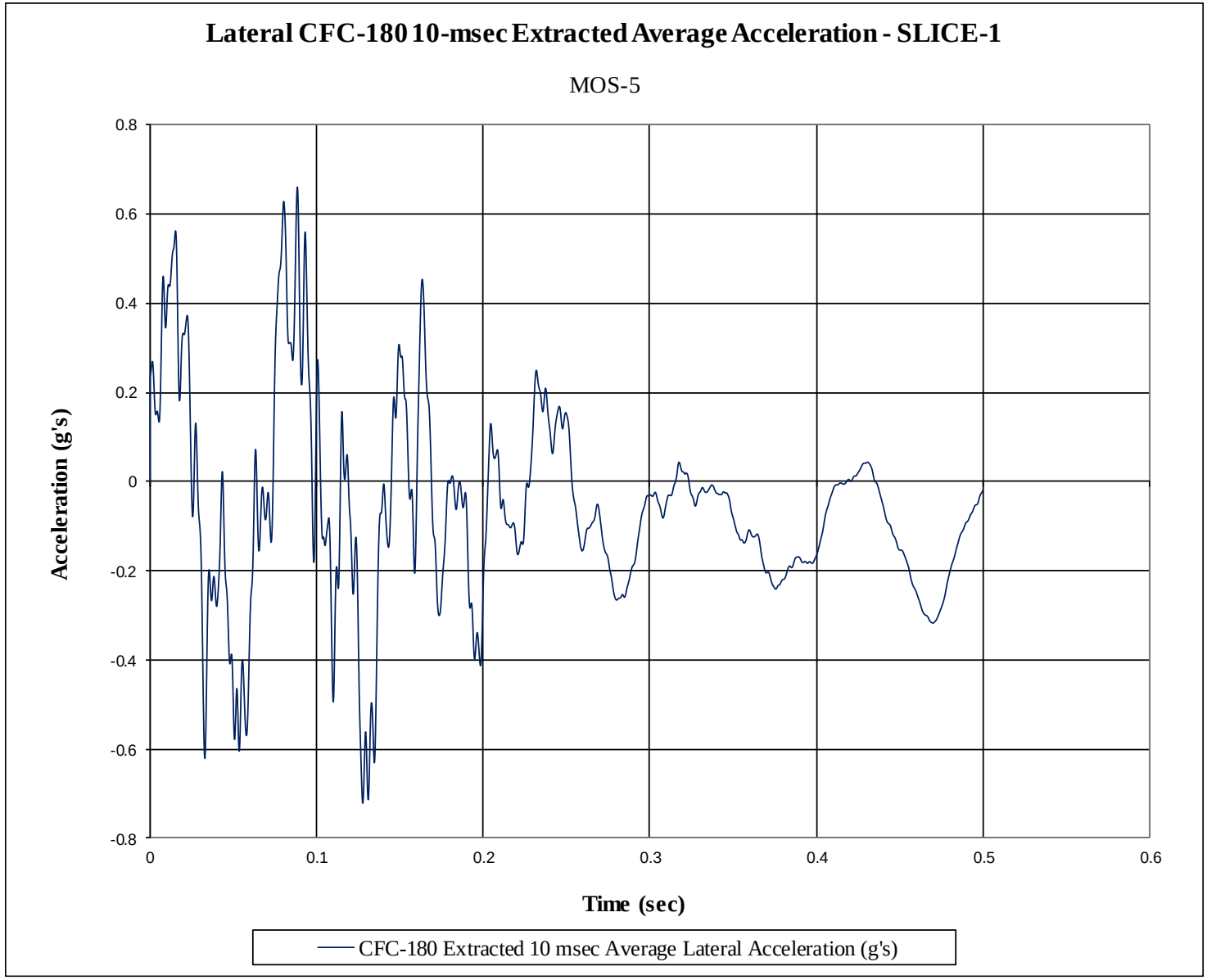


Figure E-4. 10-ms Average Lateral Deceleration (SLICE-1), Test No. MOS-5

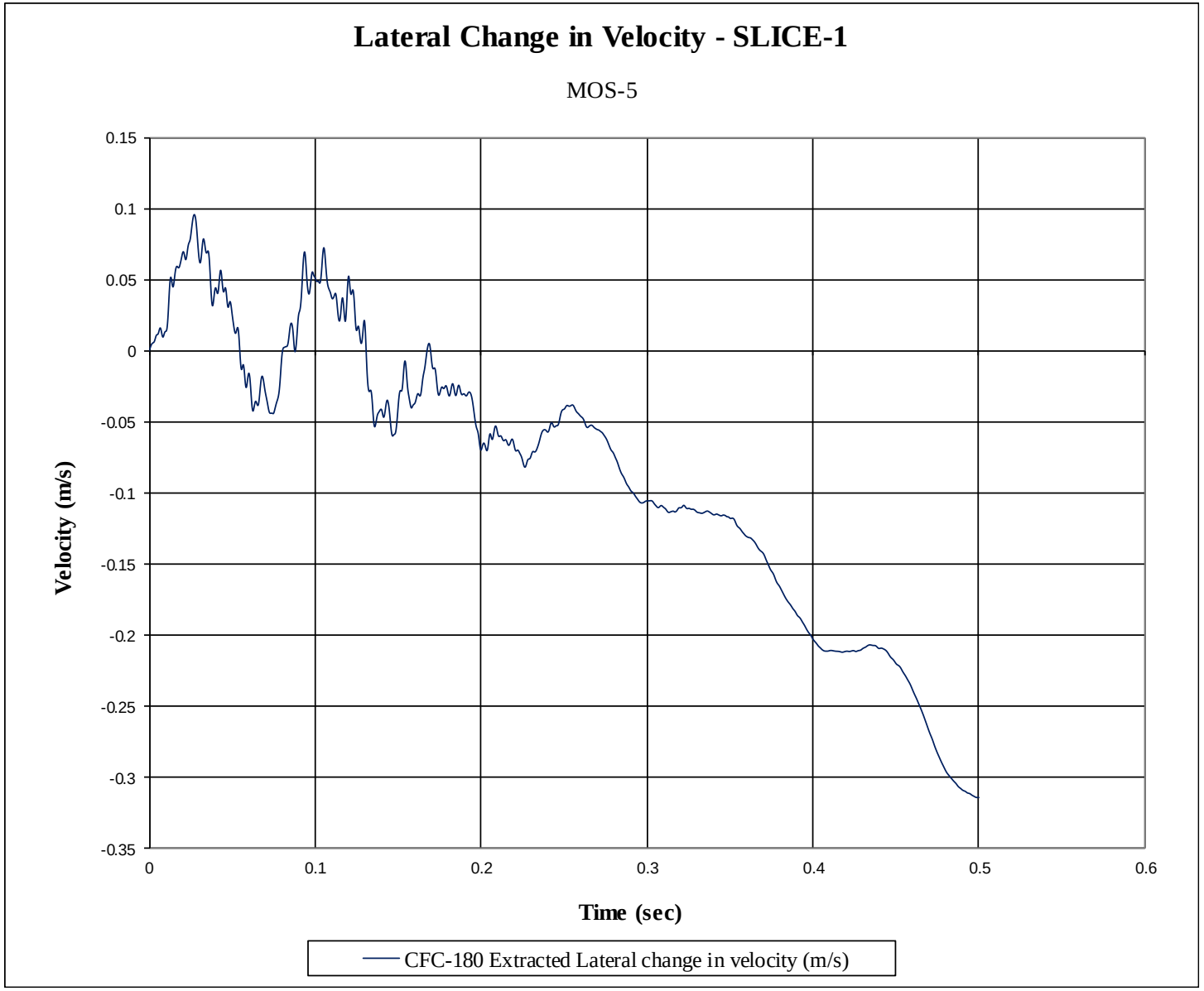


Figure E-5. Lateral Occupant Impact Velocity (SLICE-1), Test No. MOS-5

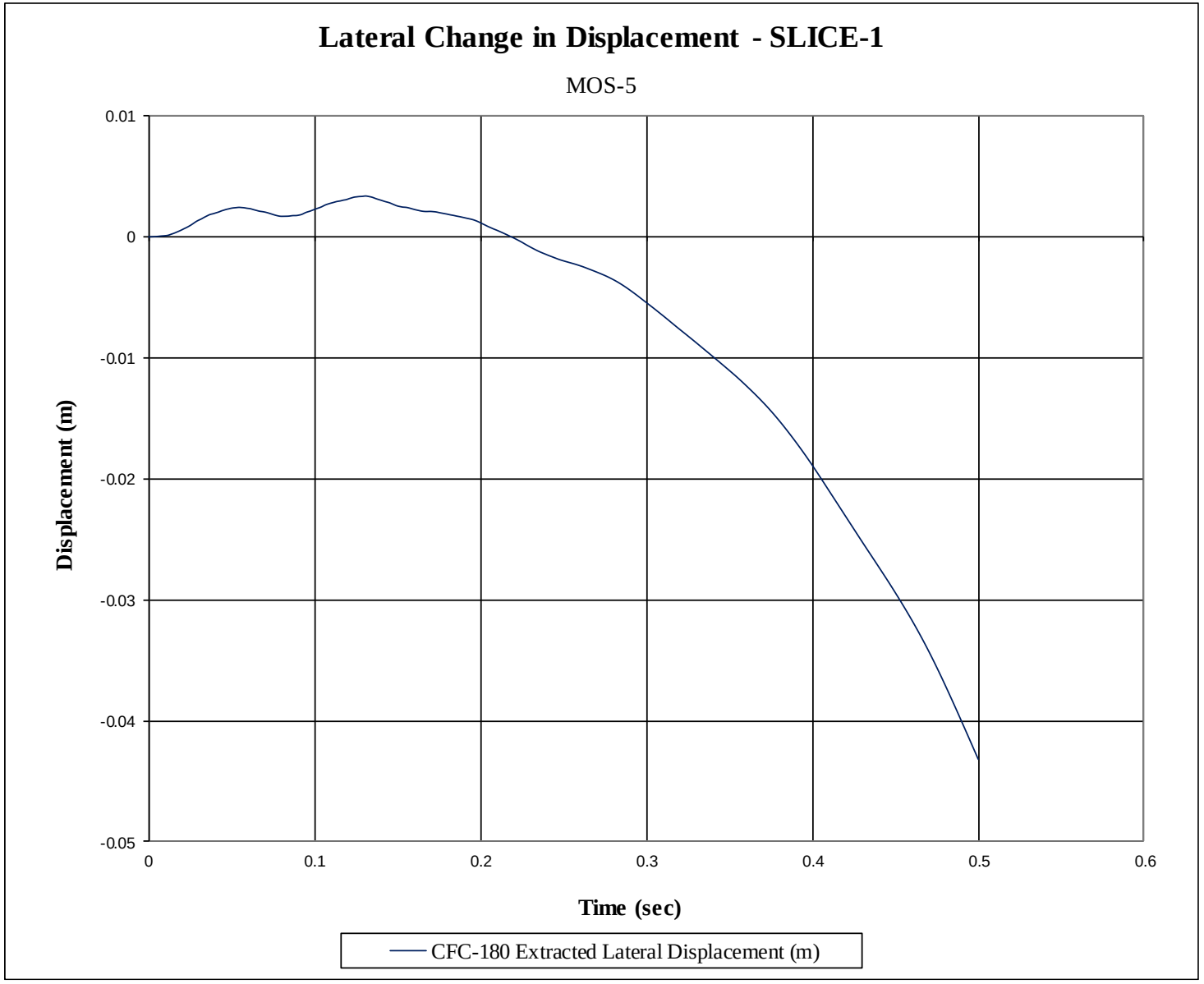


Figure E-6. Lateral Occupant Displacement (SLICE-1), Test No. MOS-5

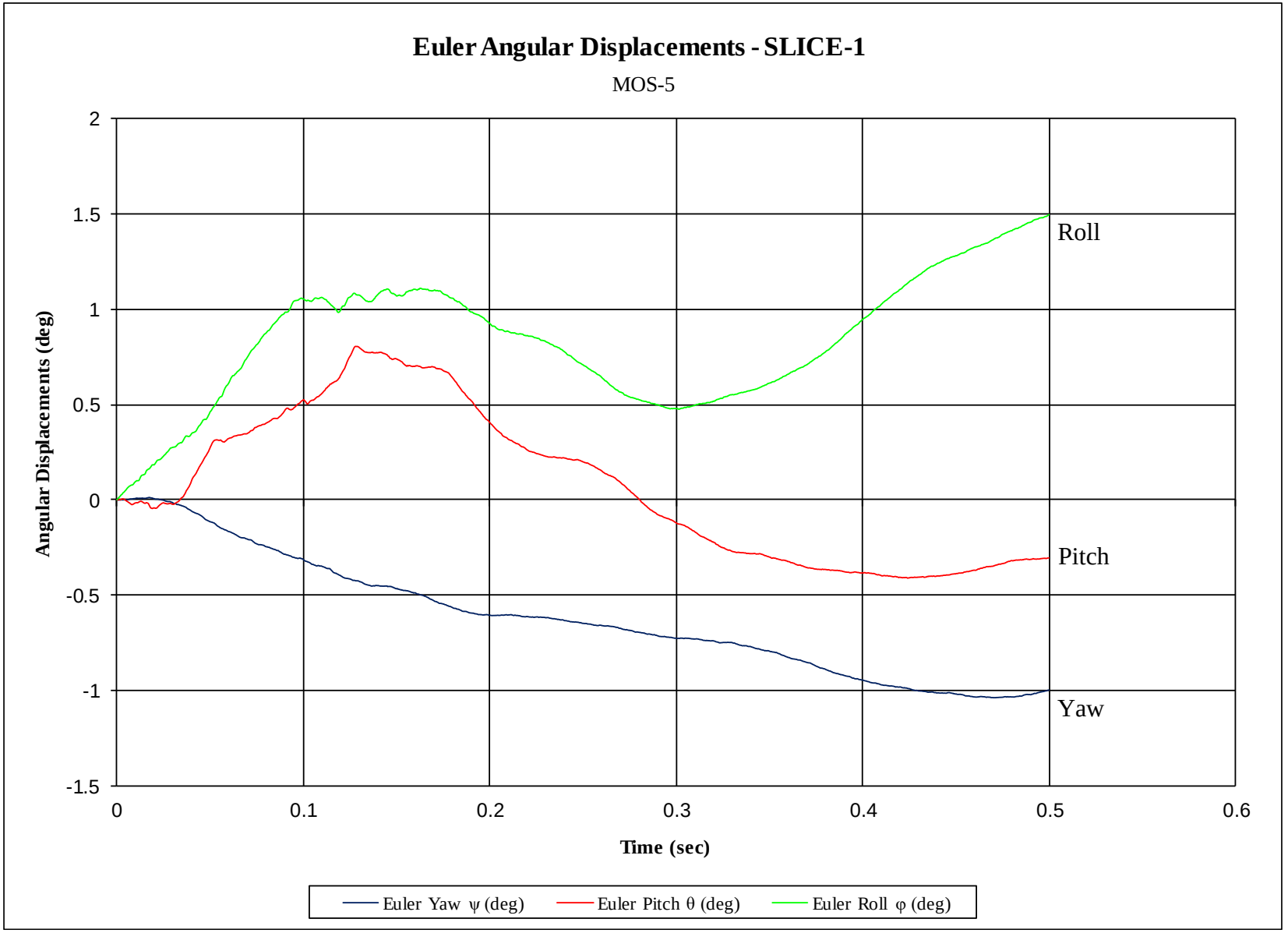


Figure E-7. Vehicle Angular Displacements (SLICE-1), Test No. MOS-5

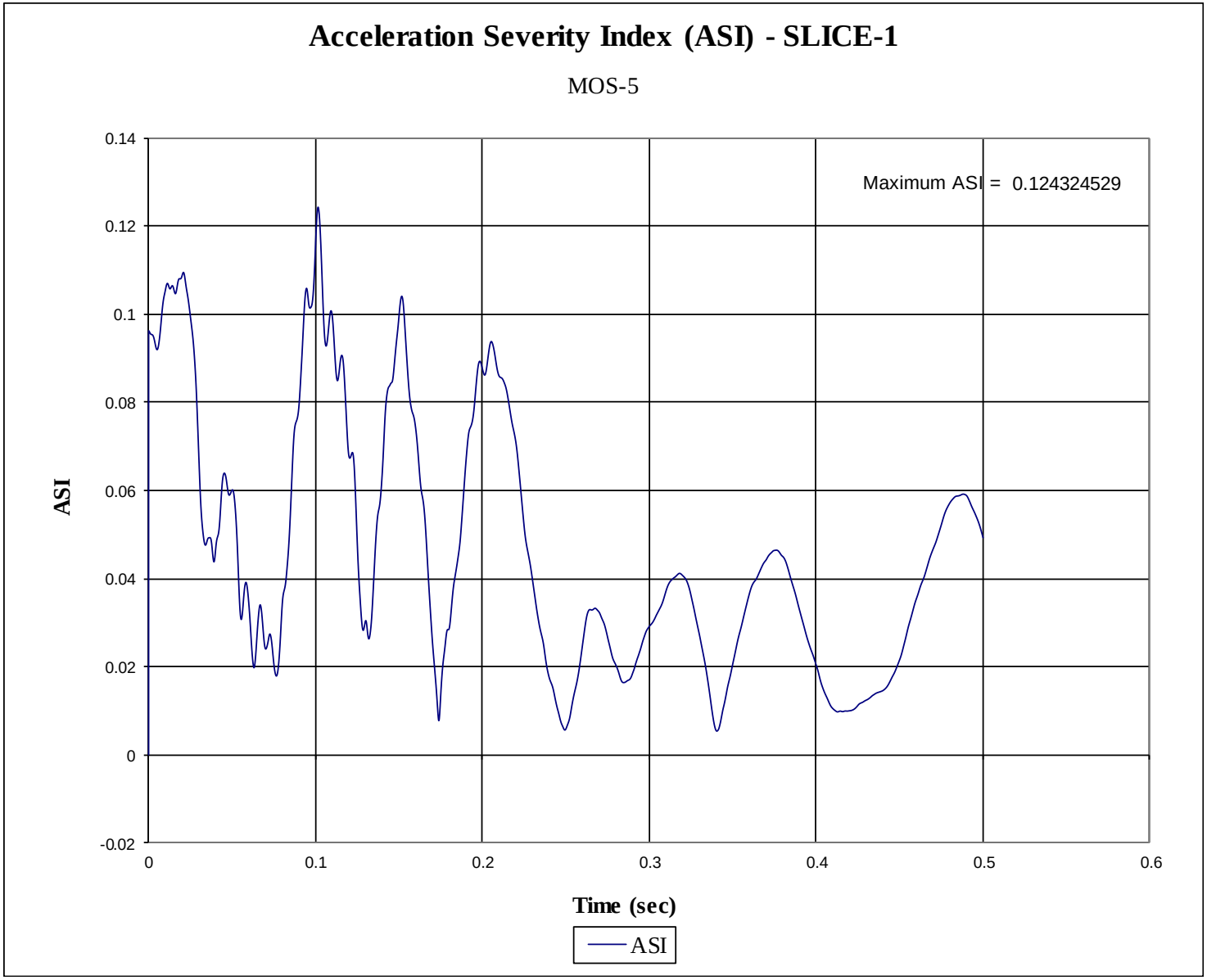


Figure E-8. Acceleration Severity Index (SLICE-1), Test No. MOS-5

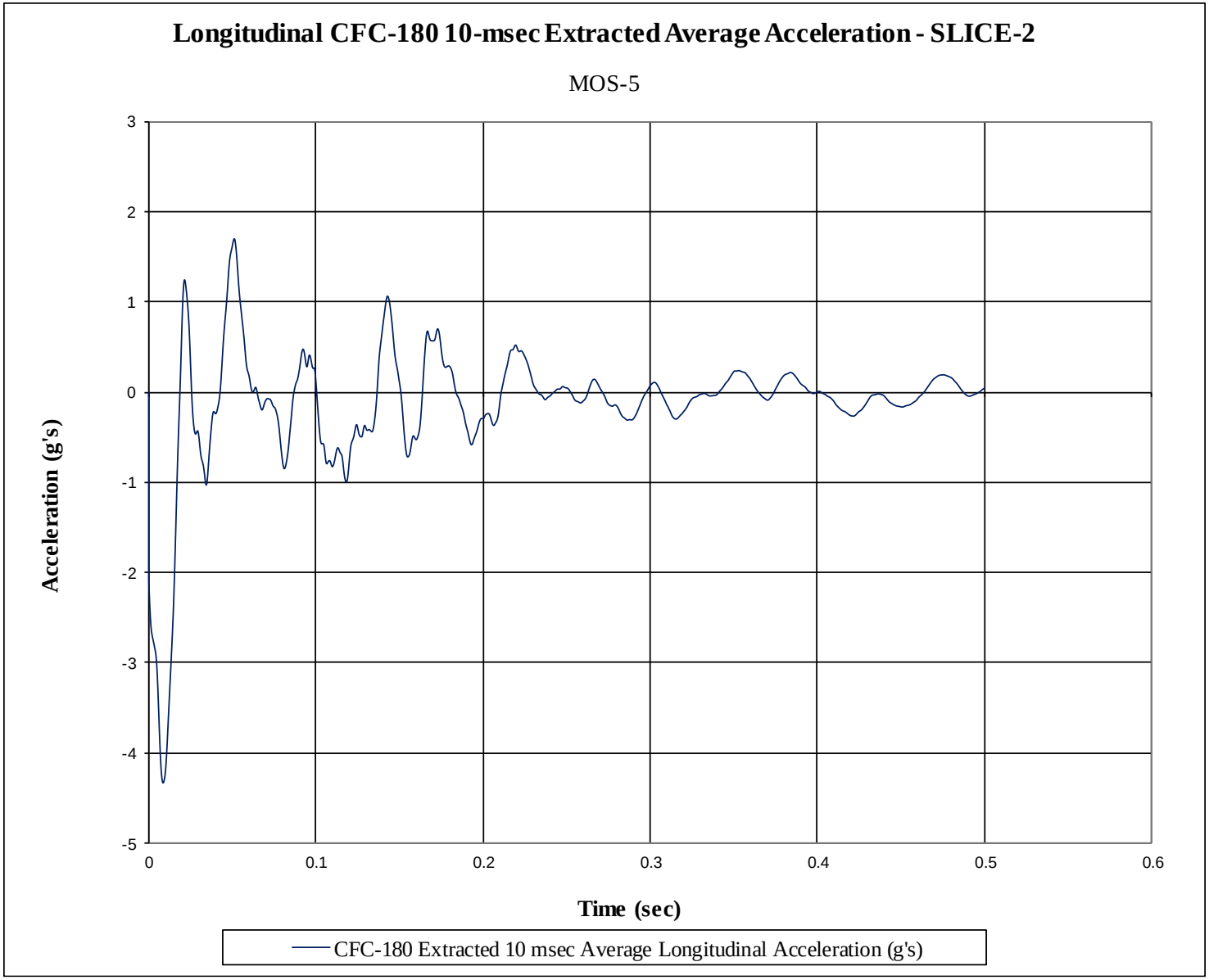


Figure E-9. 10-ms Average Longitudinal Deceleration (SLICE-2), Test No. MOS-5

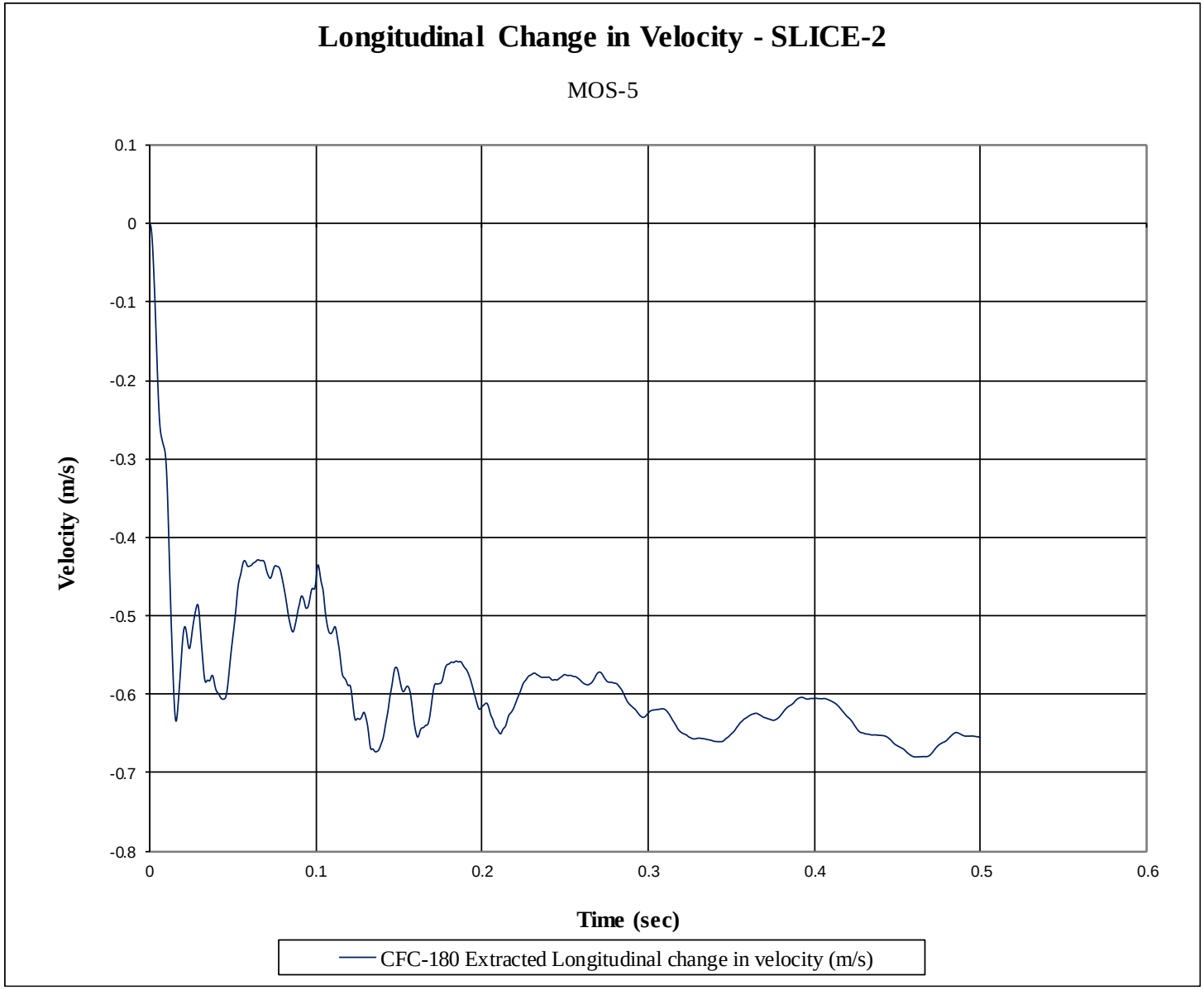


Figure E-10. Longitudinal Occupant Impact Velocity (SLICE-2), Test No. MOS-5

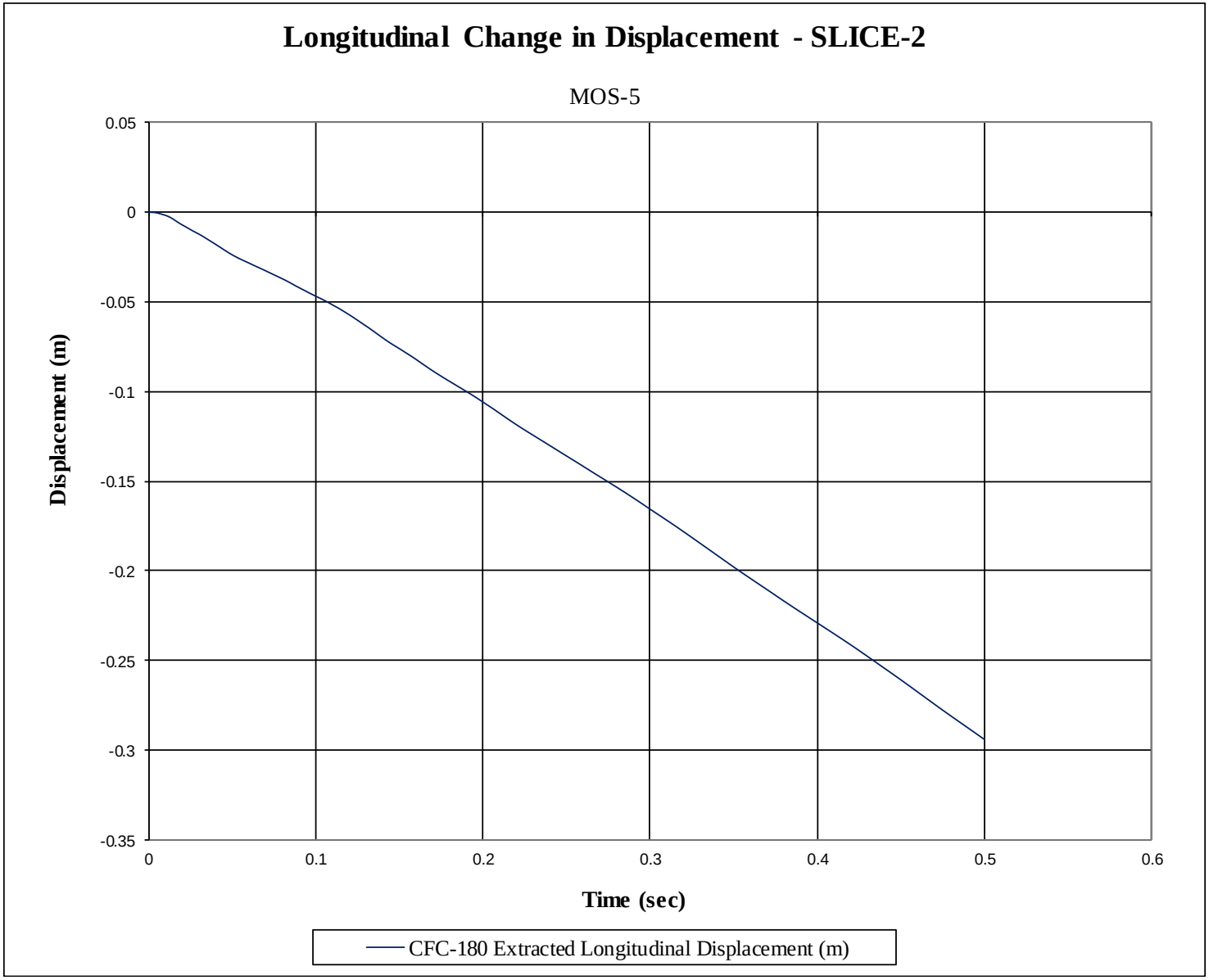


Figure E-11. Longitudinal Occupant Displacement (SLICE-2), Test No. MOS-5

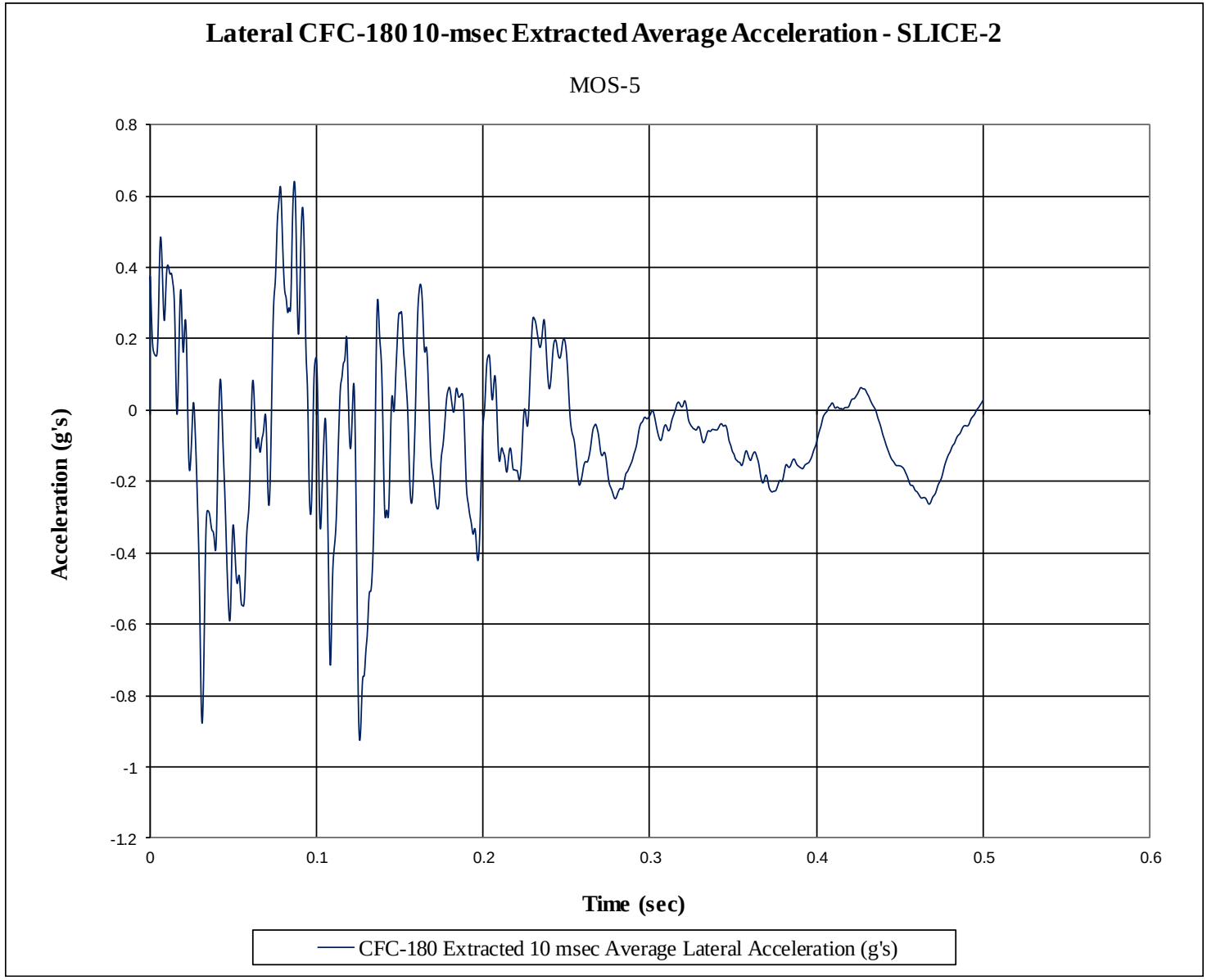


Figure E-12. 10-ms Average Lateral Deceleration (SLICE-2), Test No. MOS-5

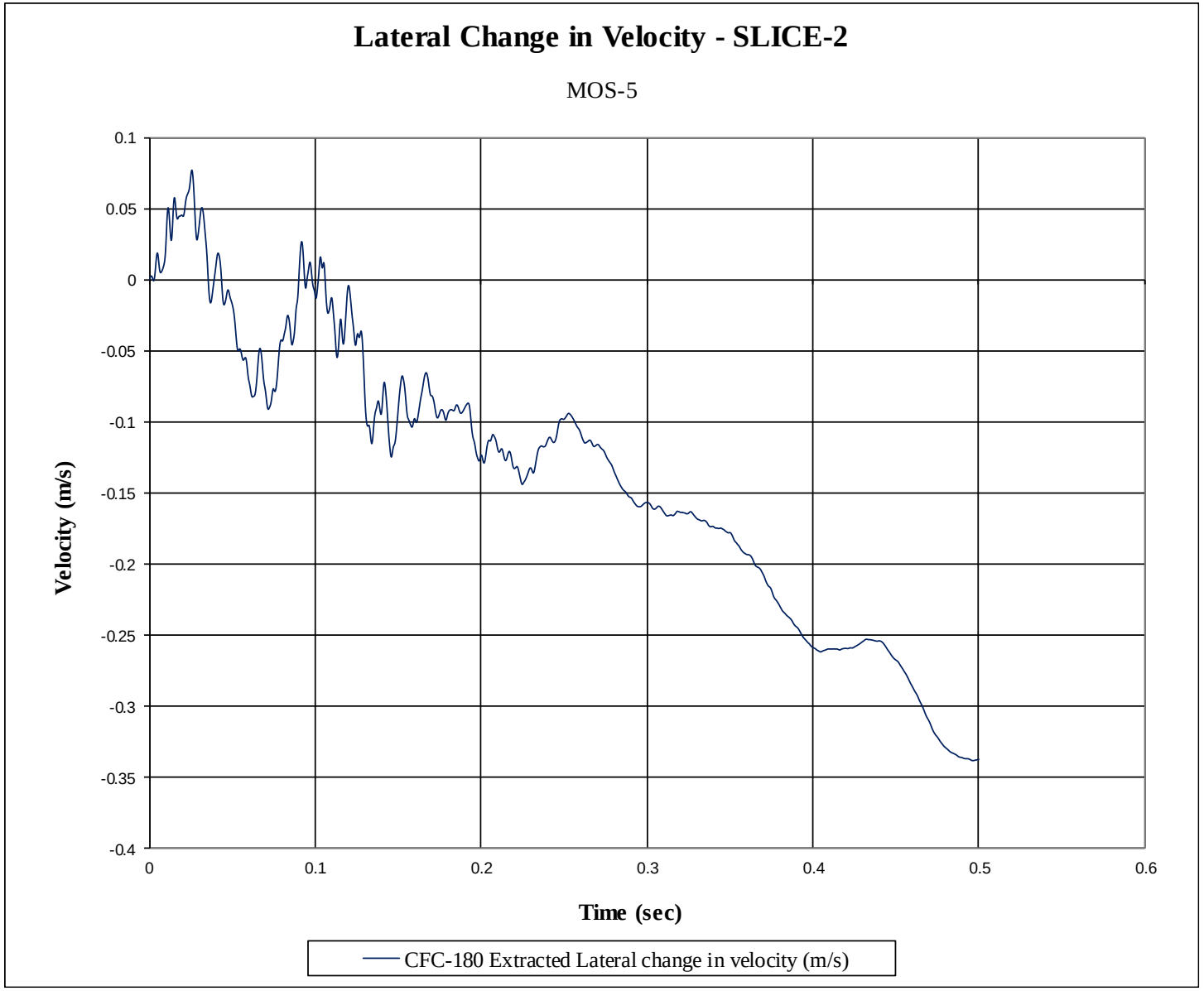


Figure E-13. Lateral Occupant Impact Velocity (SLICE-2), Test No. MOS-5

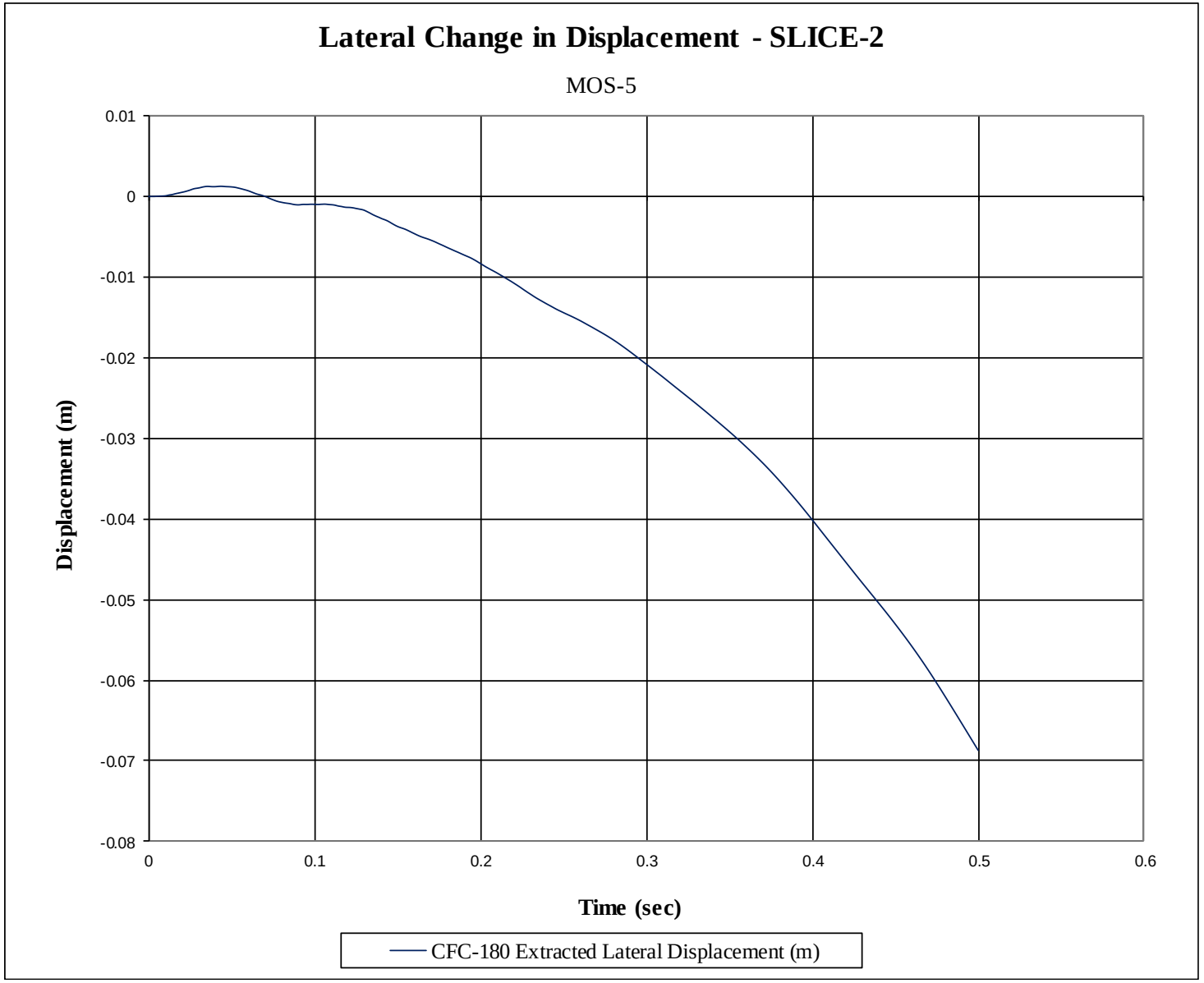


Figure E-14. Lateral Occupant Displacement (SLICE-2), Test No. MOS-5

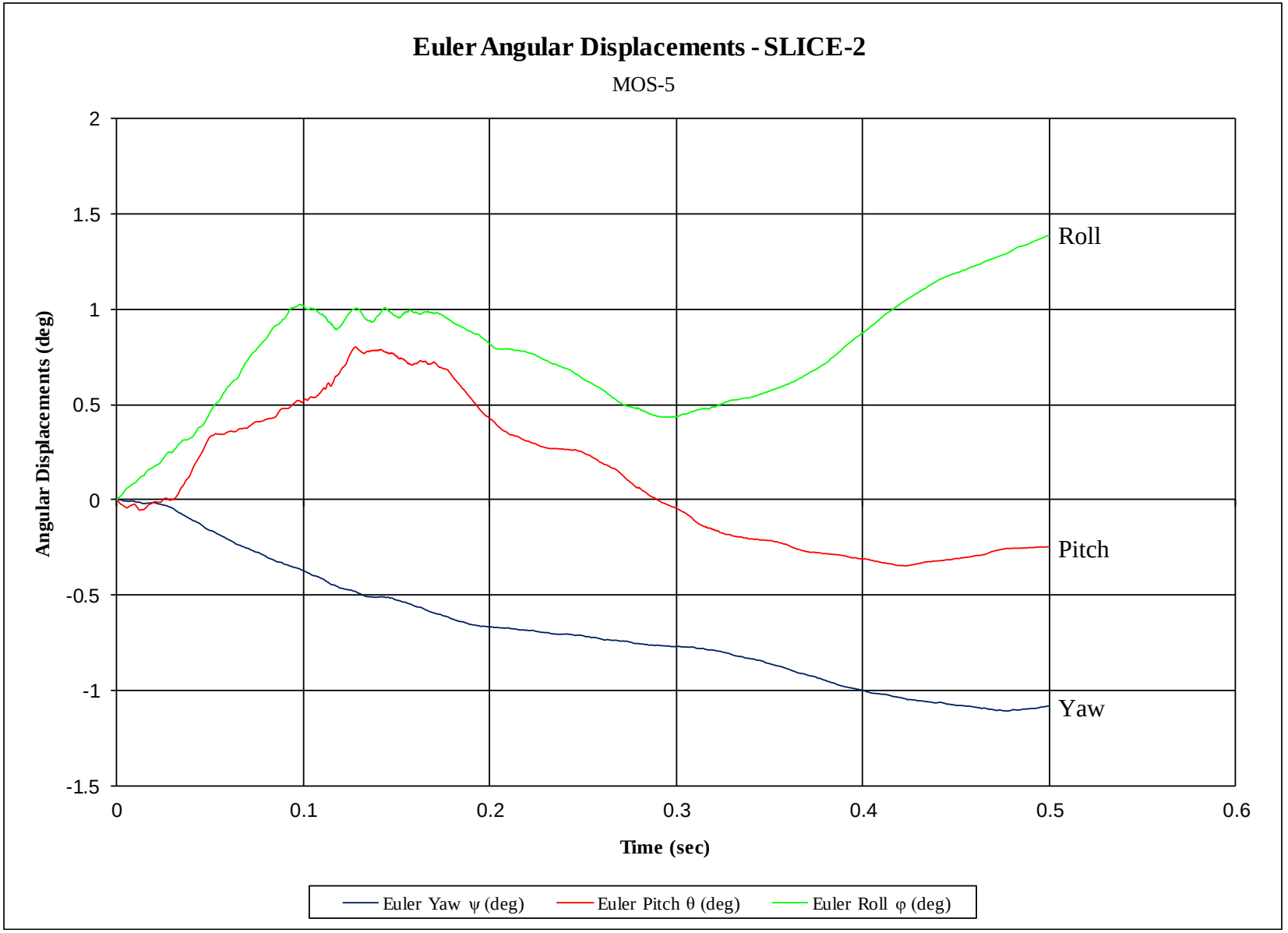


Figure E-15. Vehicle Angular Displacements (SLICE-2), Test No. MOS-5

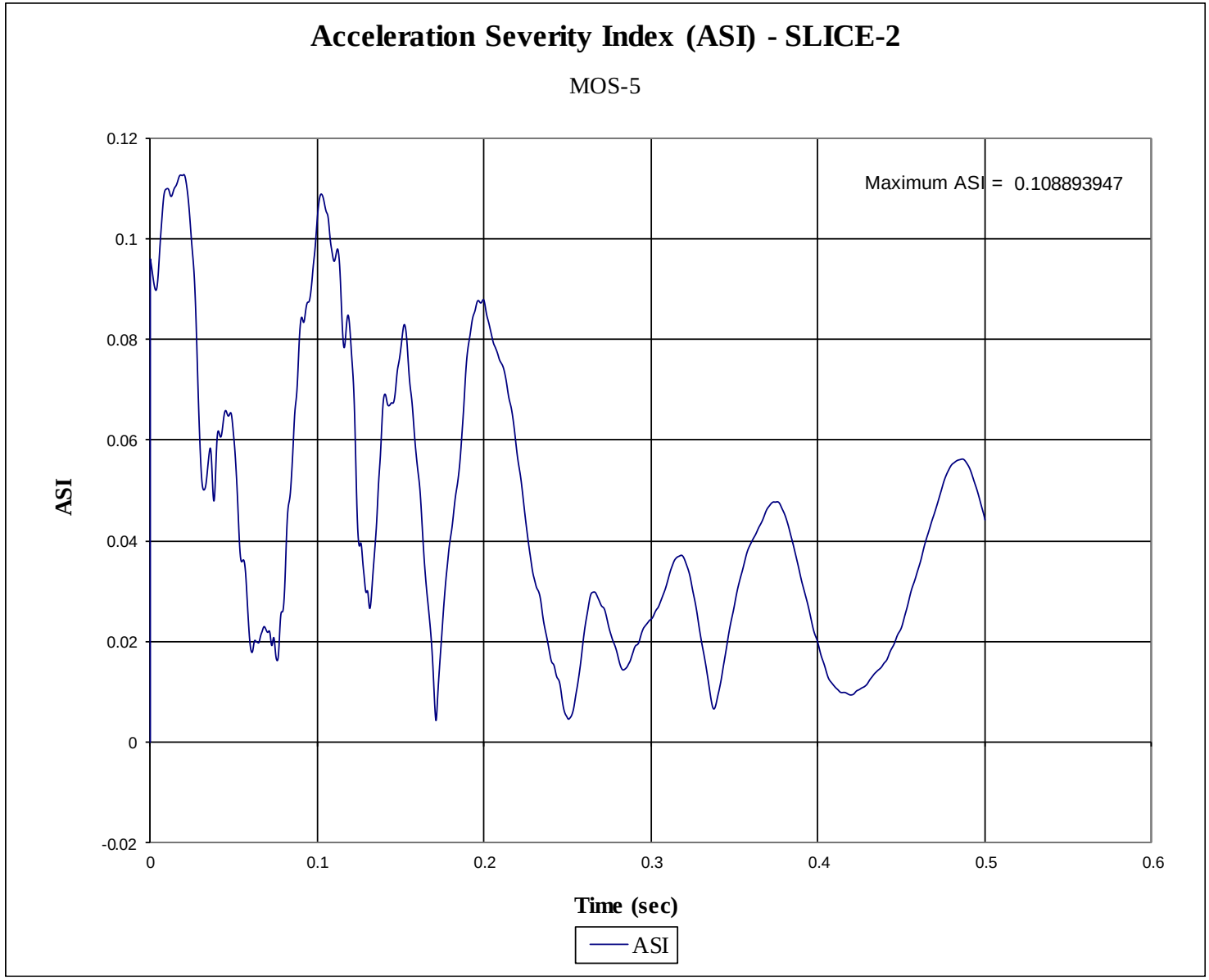


Figure E-16. Acceleration Severity Index (SLICE-2), Test No. MOS-5

Appendix F. Accelerometer and Rate Transducer Data Plots, Test No. MOS-6

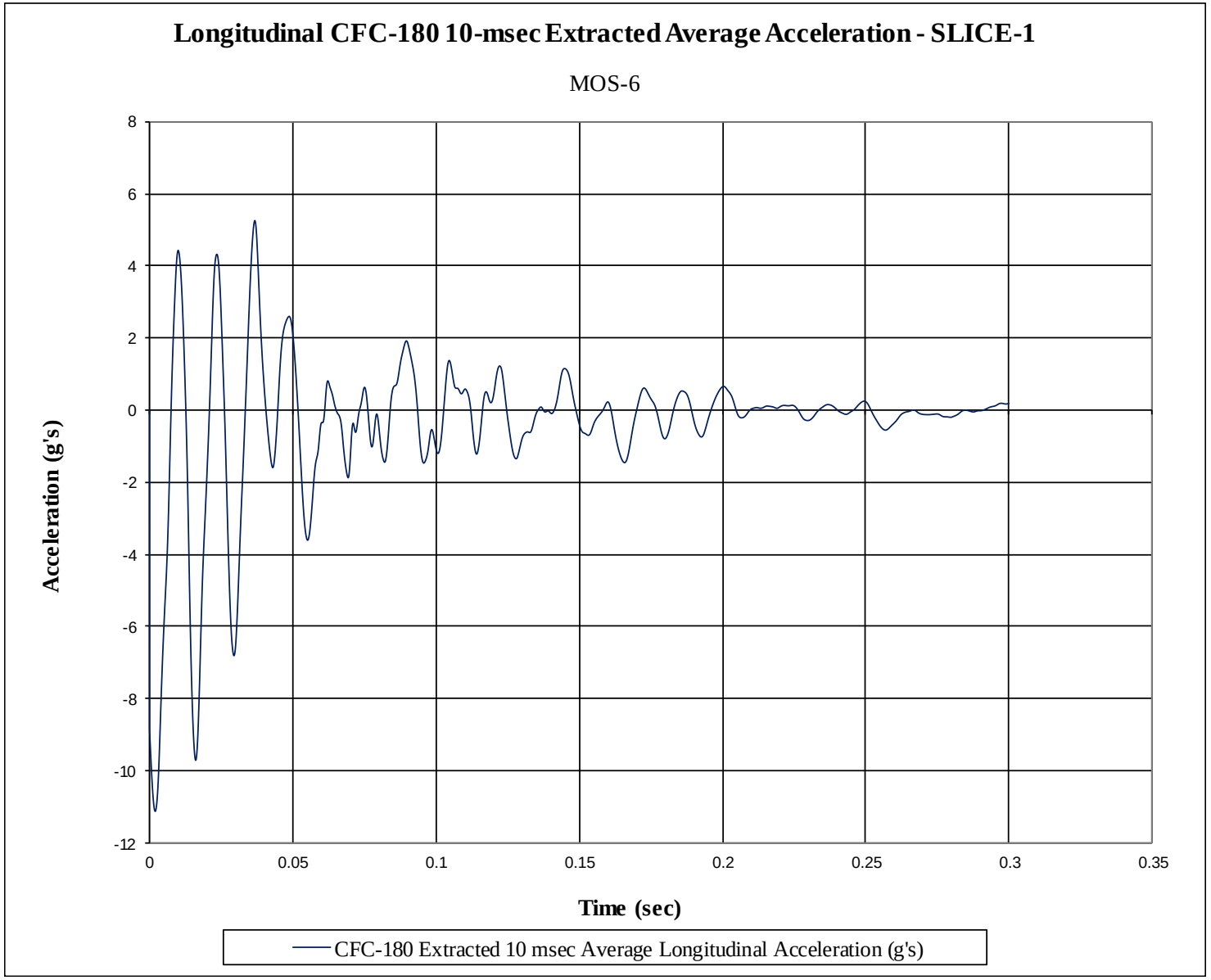


Figure F-1. 10-ms Average Longitudinal Deceleration (SLICE-1), Test No. MOS-6

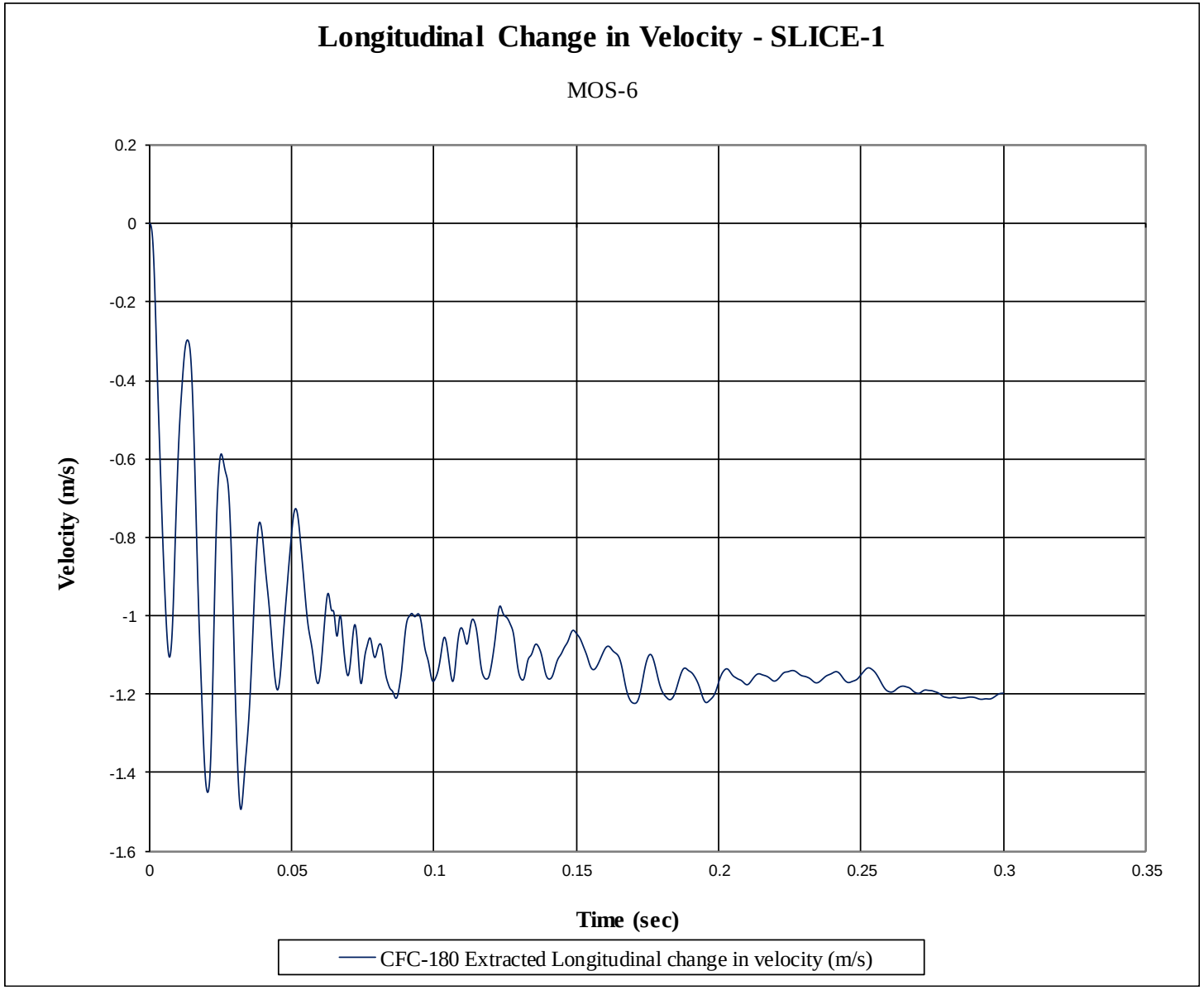


Figure F-2. Longitudinal Occupant Impact Velocity (SLICE-1), Test No. MOS-6

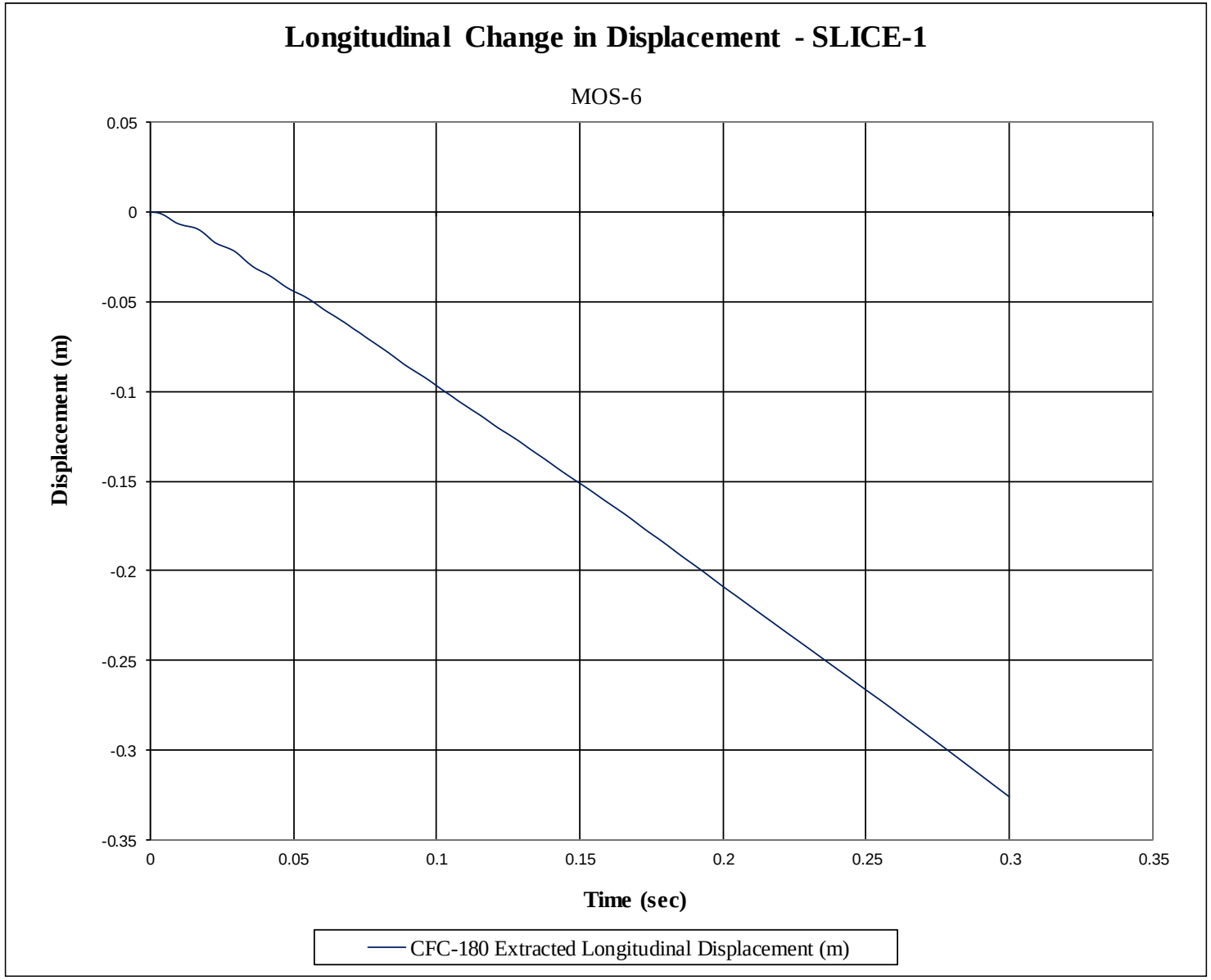


Figure F-3. Longitudinal Occupant Displacement (SLICE-1), Test No. MOS-6

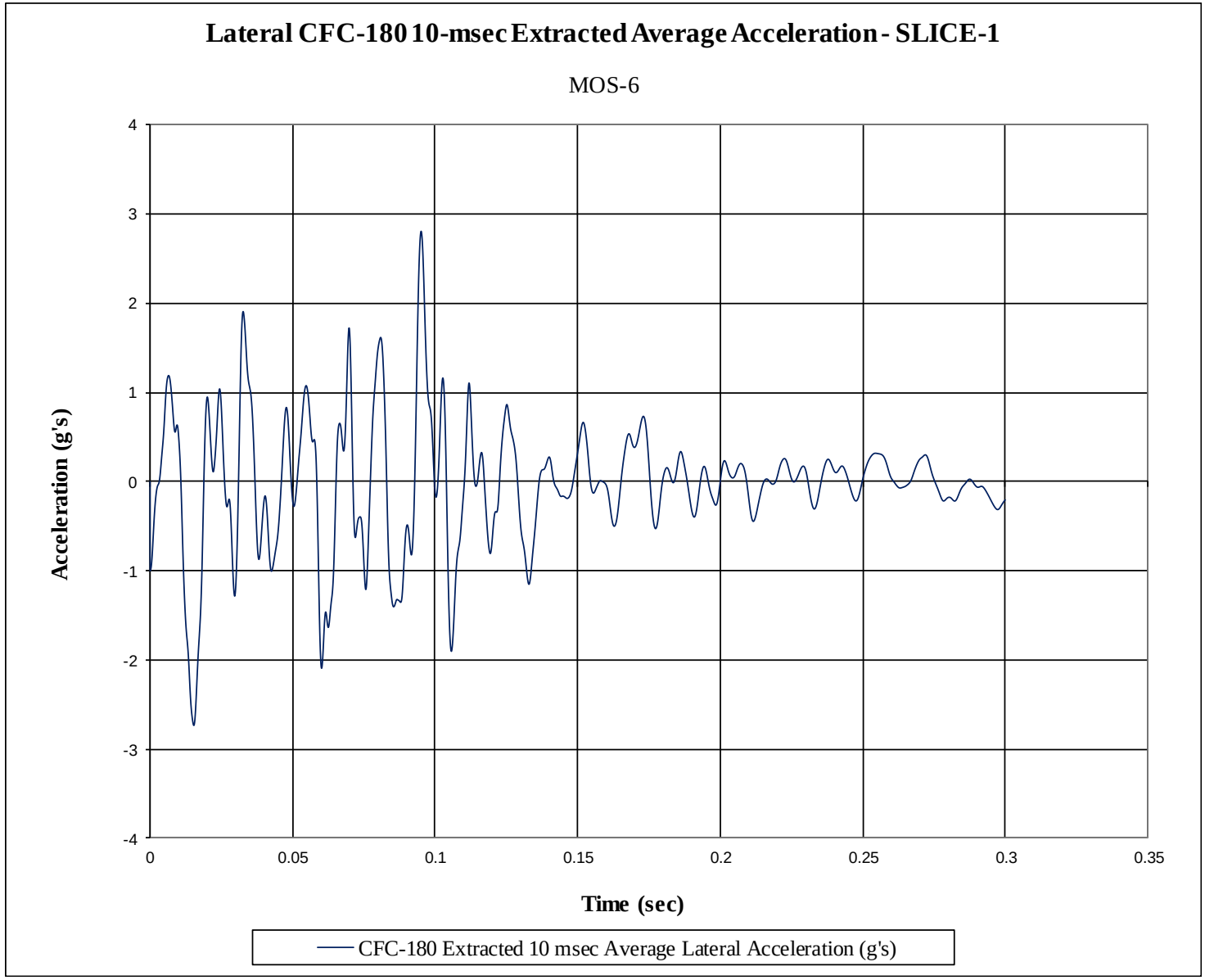


Figure F-4. 10-ms Average Lateral Deceleration (SLICE-1), Test No. MOS-6

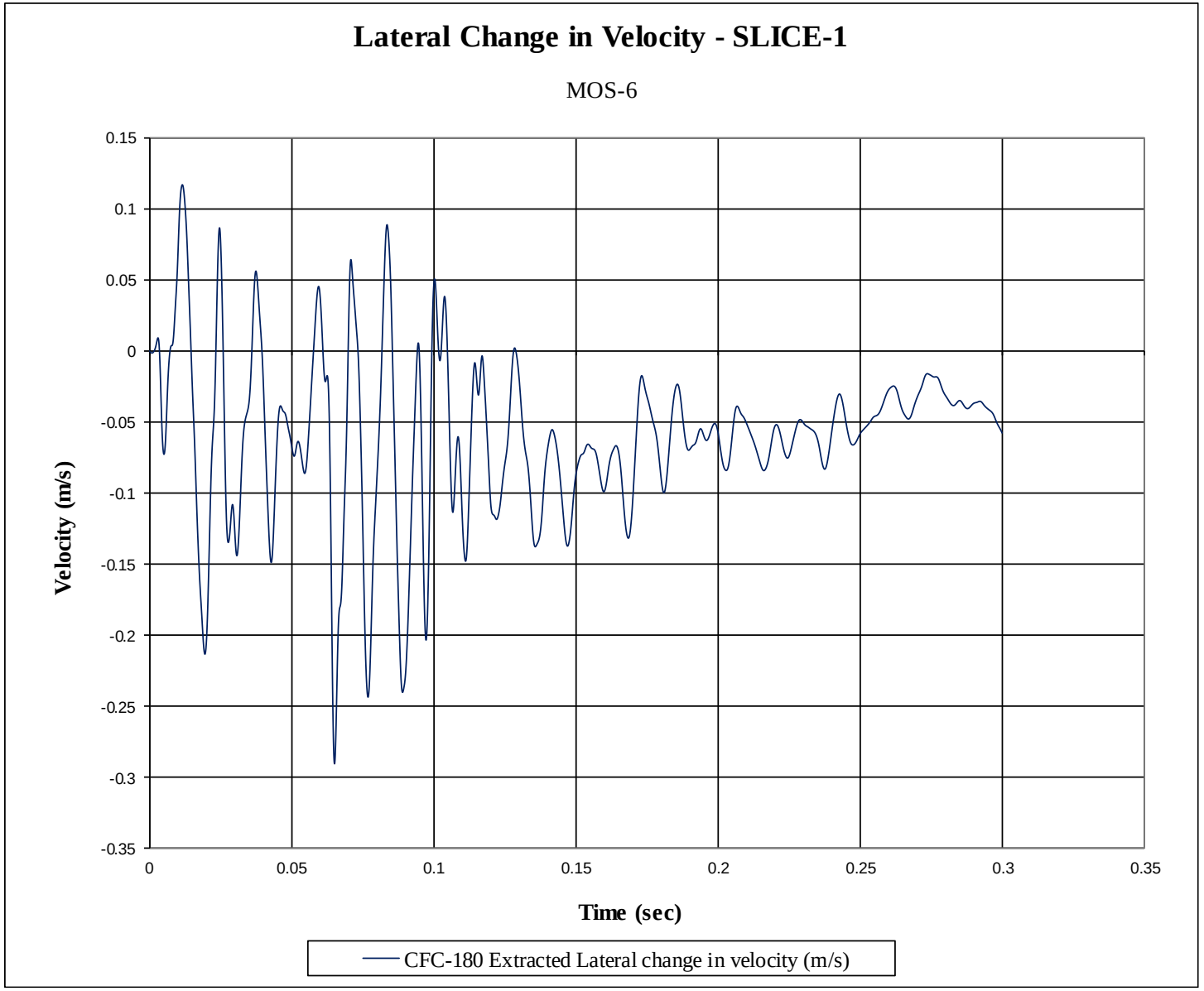


Figure F-5. Lateral Occupant Impact Velocity (SLICE-1), Test No. MOS-6

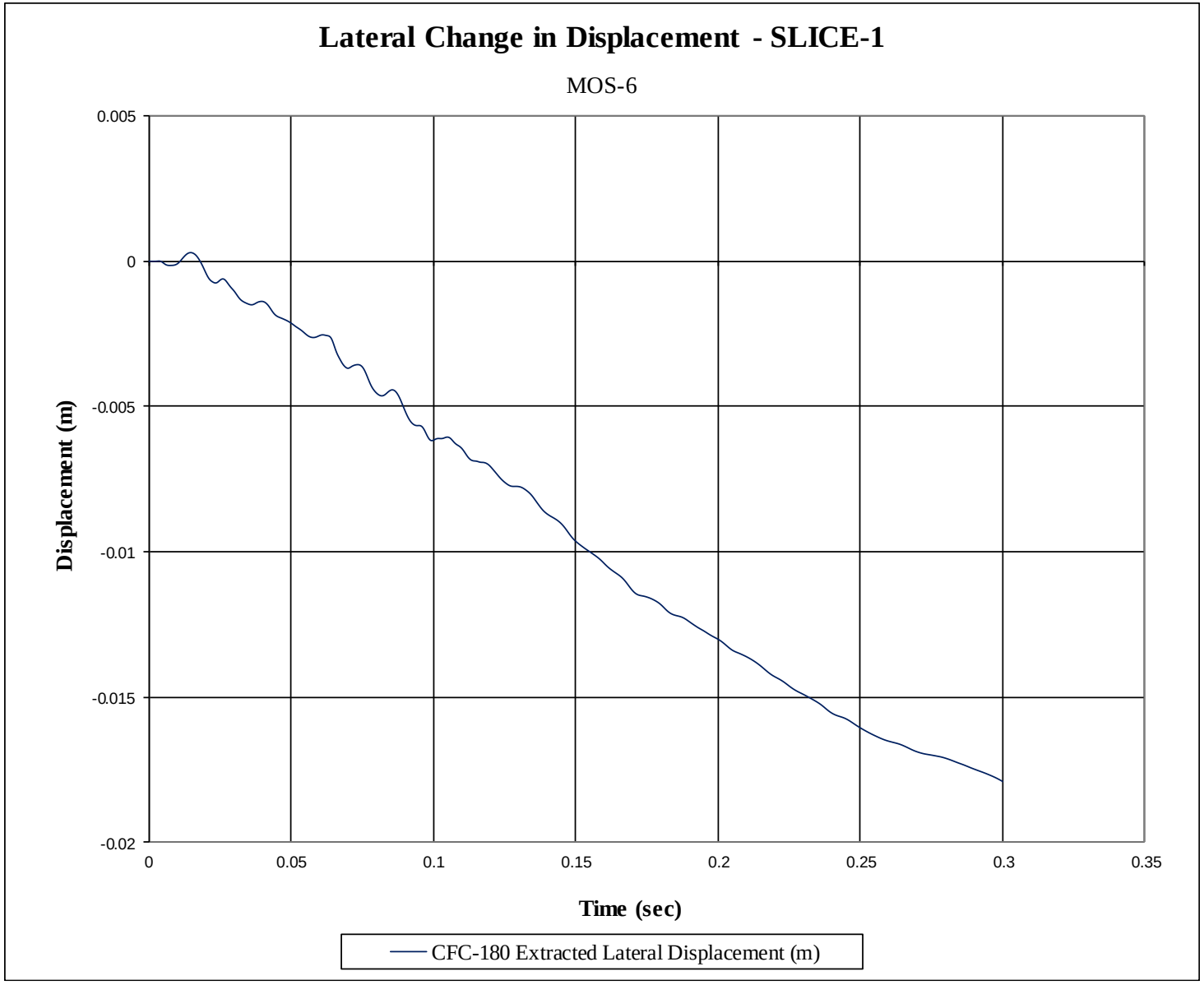


Figure F-6. Lateral Occupant Displacement (SLICE-1), Test No. MOS-6

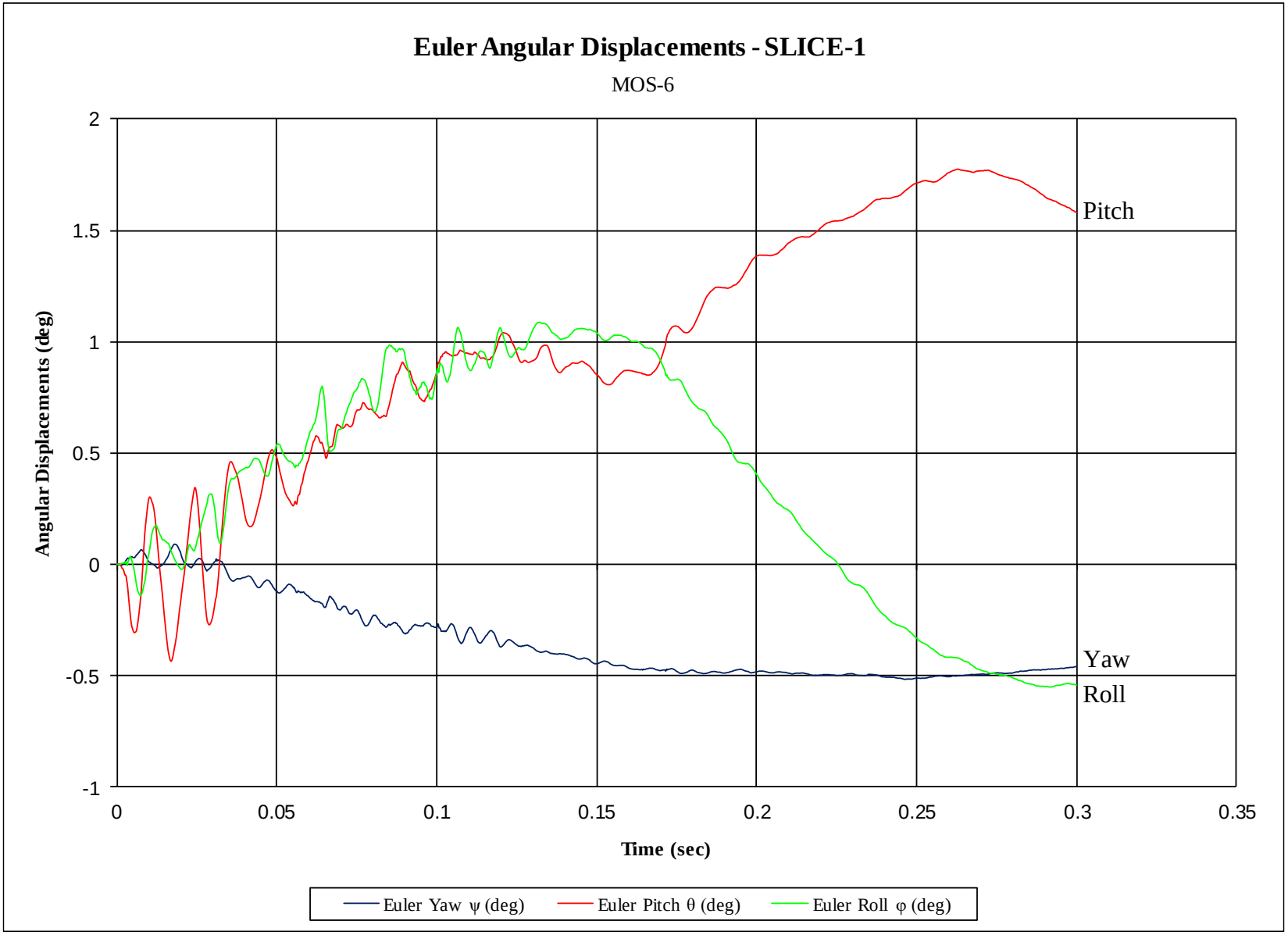


Figure F-7. Vehicle Angular Displacements (SLICE-1), Test No. MOS-6

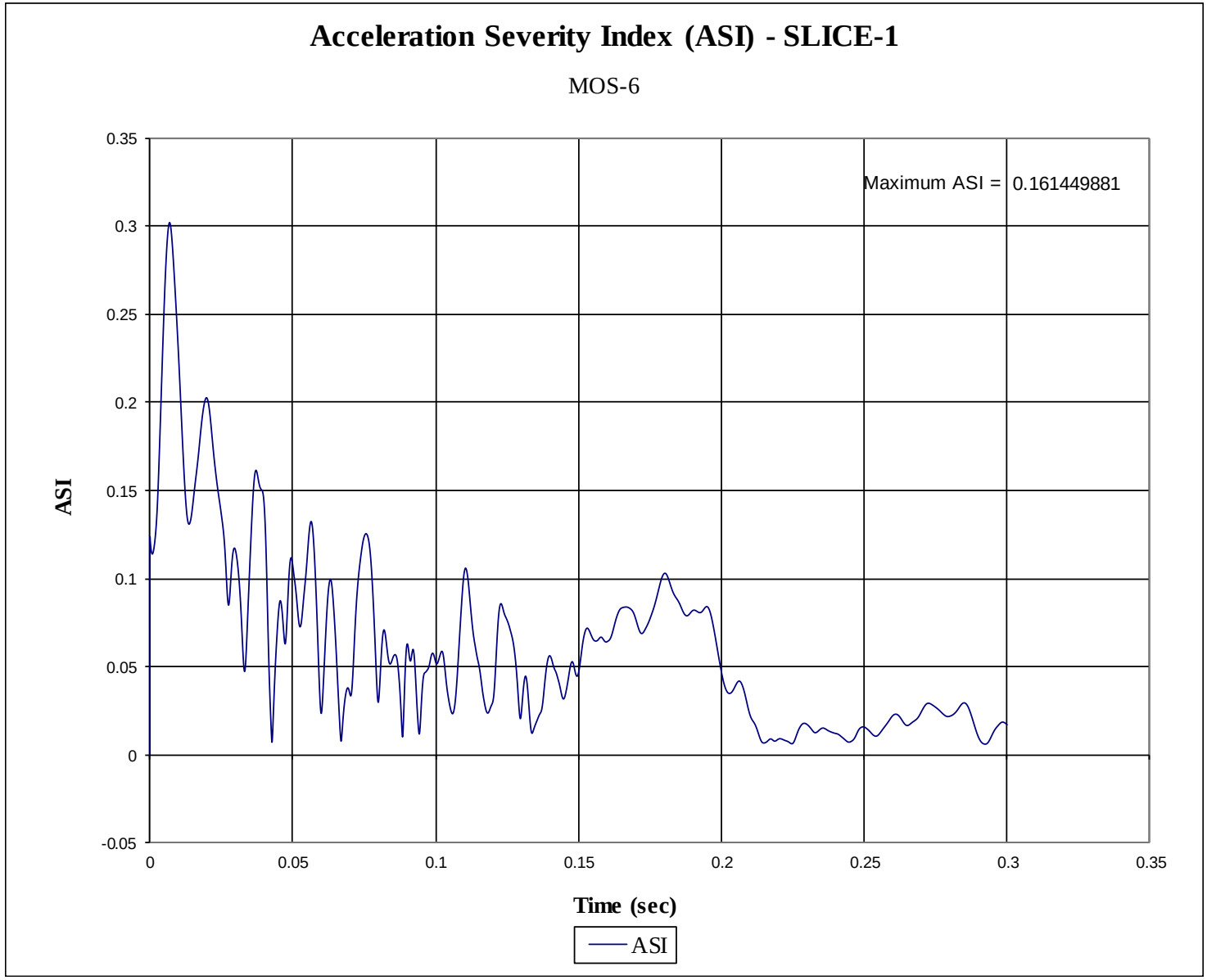


Figure F-8. Acceleration Severity Index (SLICE-1), Test No. MOS-6

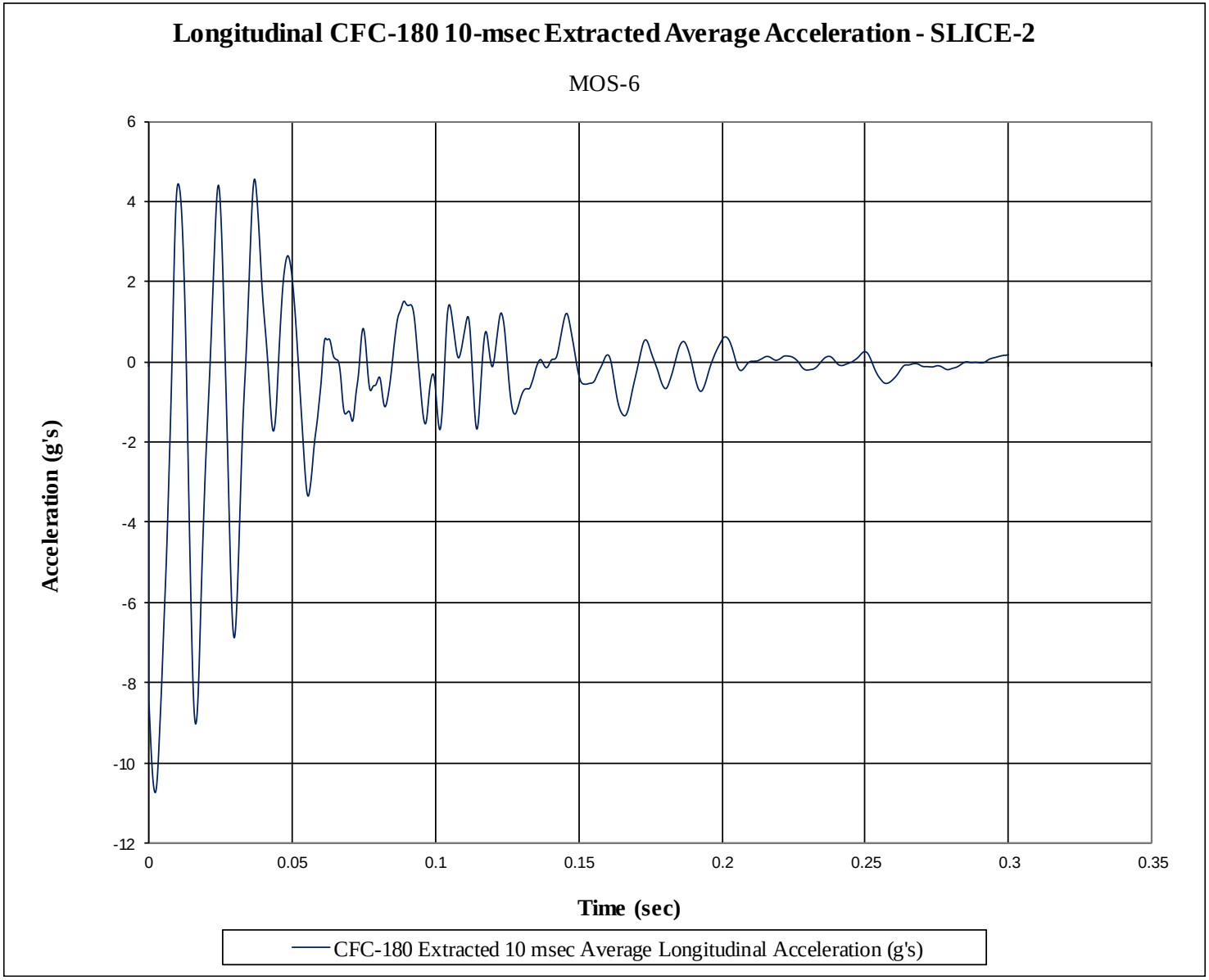


Figure F-9. 10-ms Average Longitudinal Deceleration (SLICE-2), Test No. MOS-6

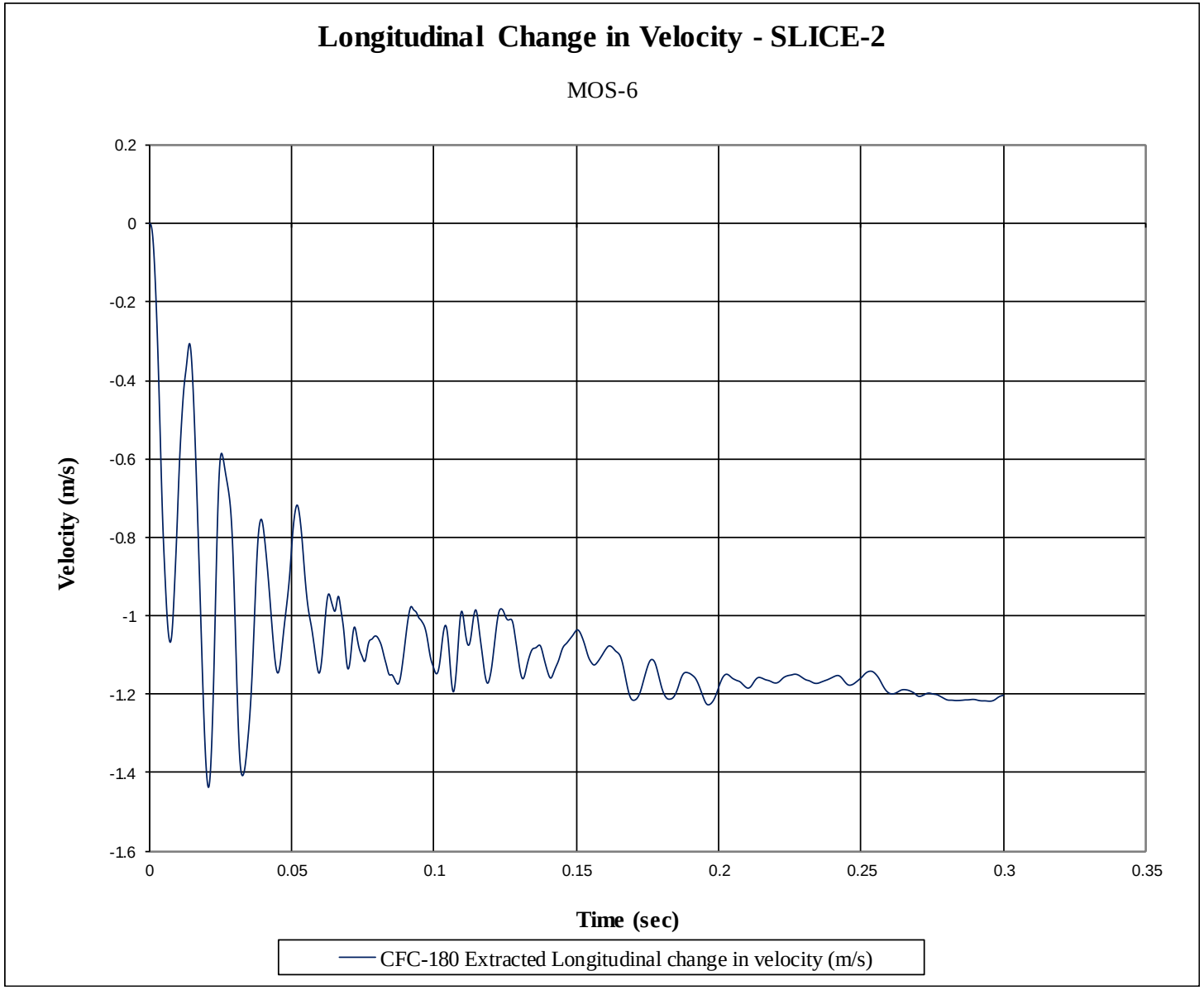


Figure F-10. Longitudinal Occupant Impact Velocity (SLICE-2), Test No. MOS-6

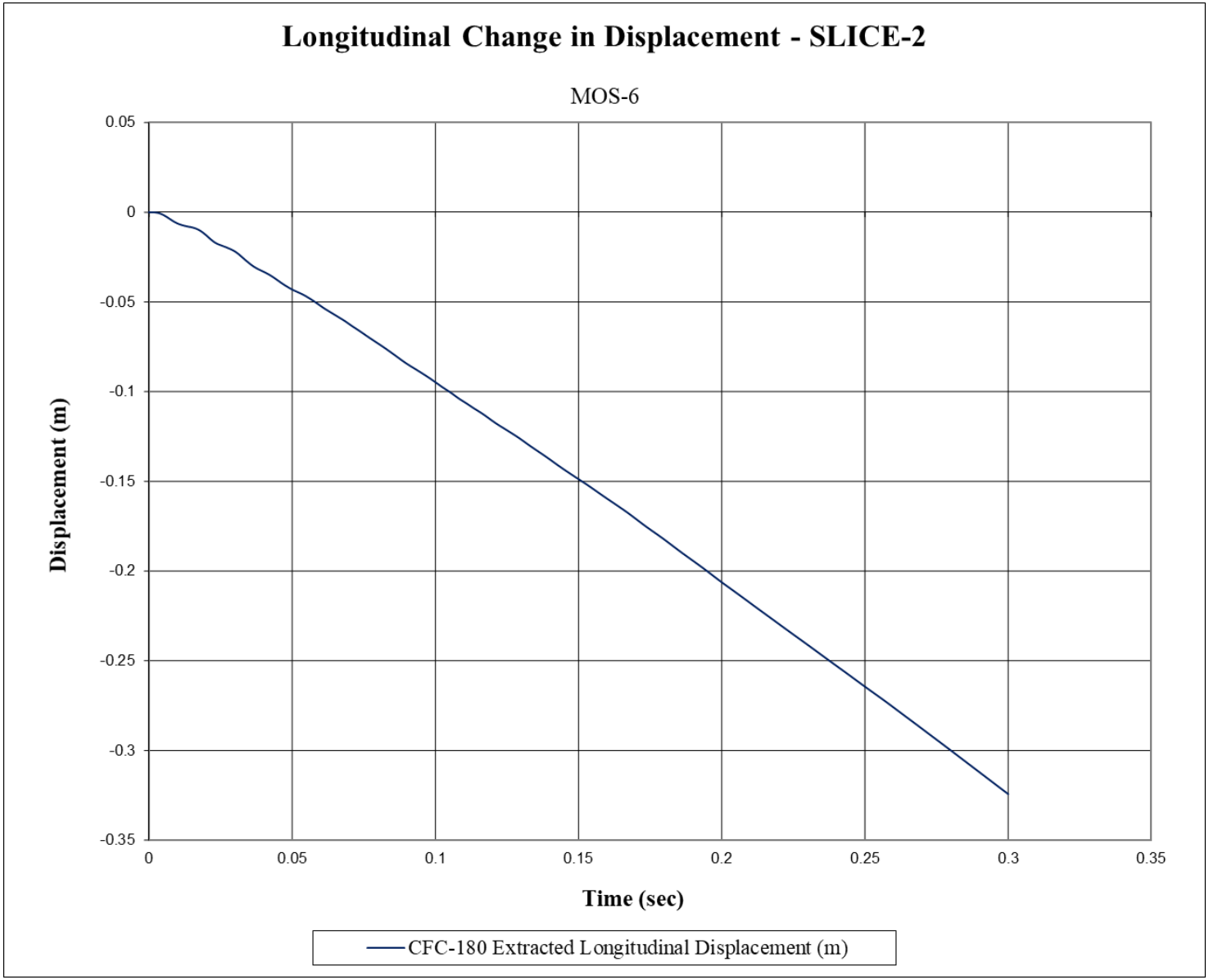


Figure F-11. Longitudinal Occupant Displacement (SLICE-2), Test No. MOS-6

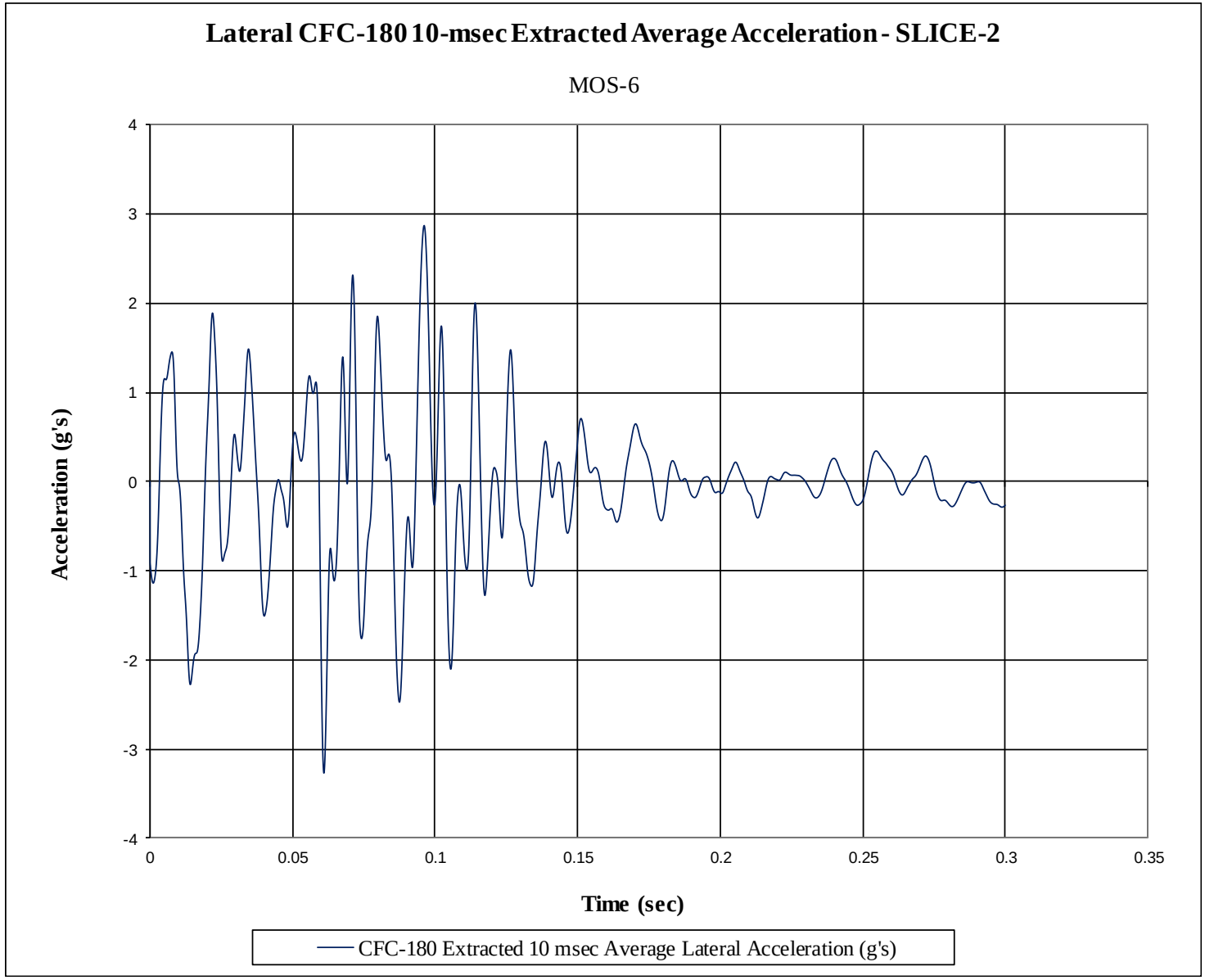


Figure F-12. 10-ms Average Lateral Deceleration (SLICE-2), Test No. MOS-6

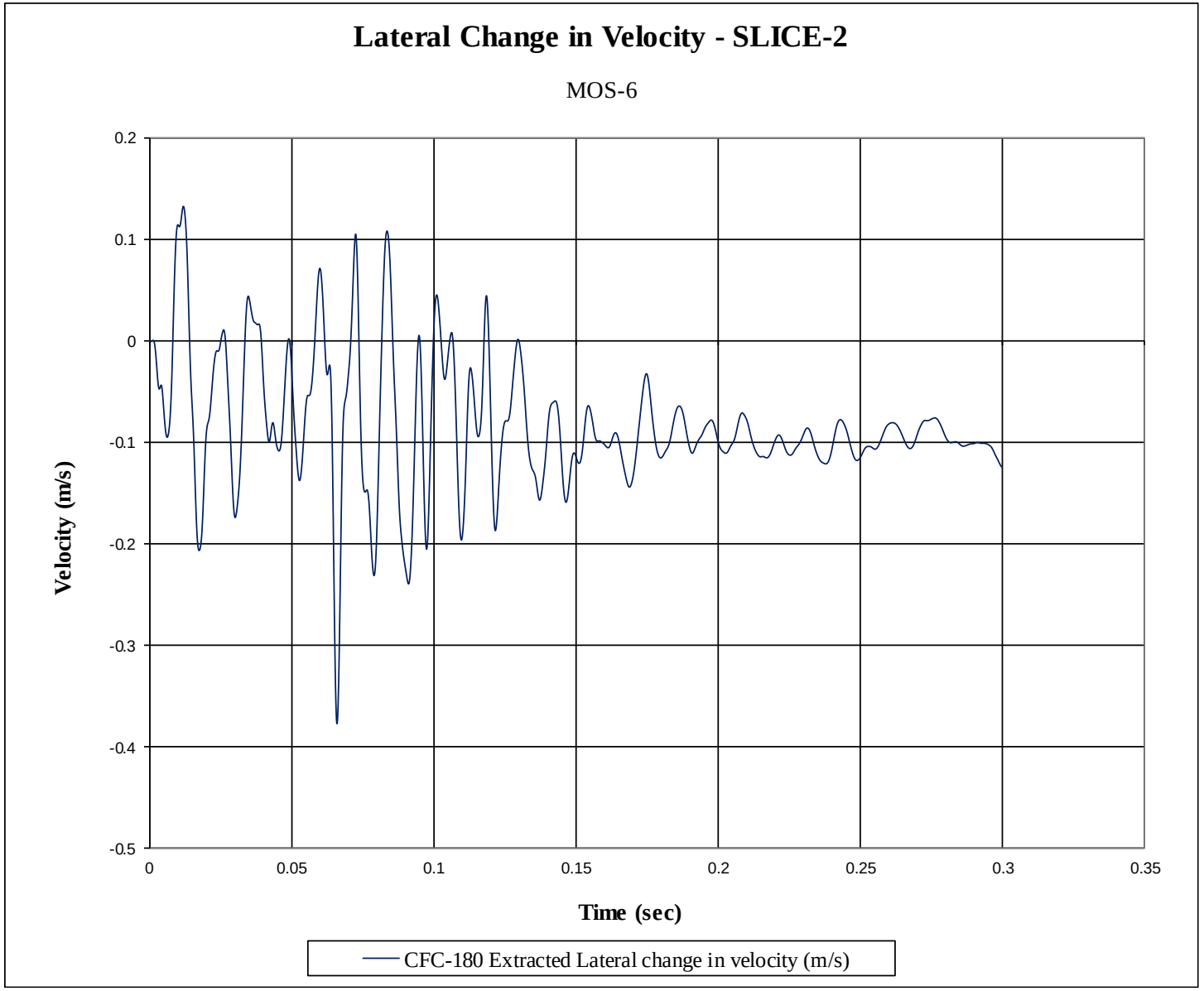


Figure F-13. Lateral Occupant Impact Velocity (SLICE-2), Test No. MOS-6

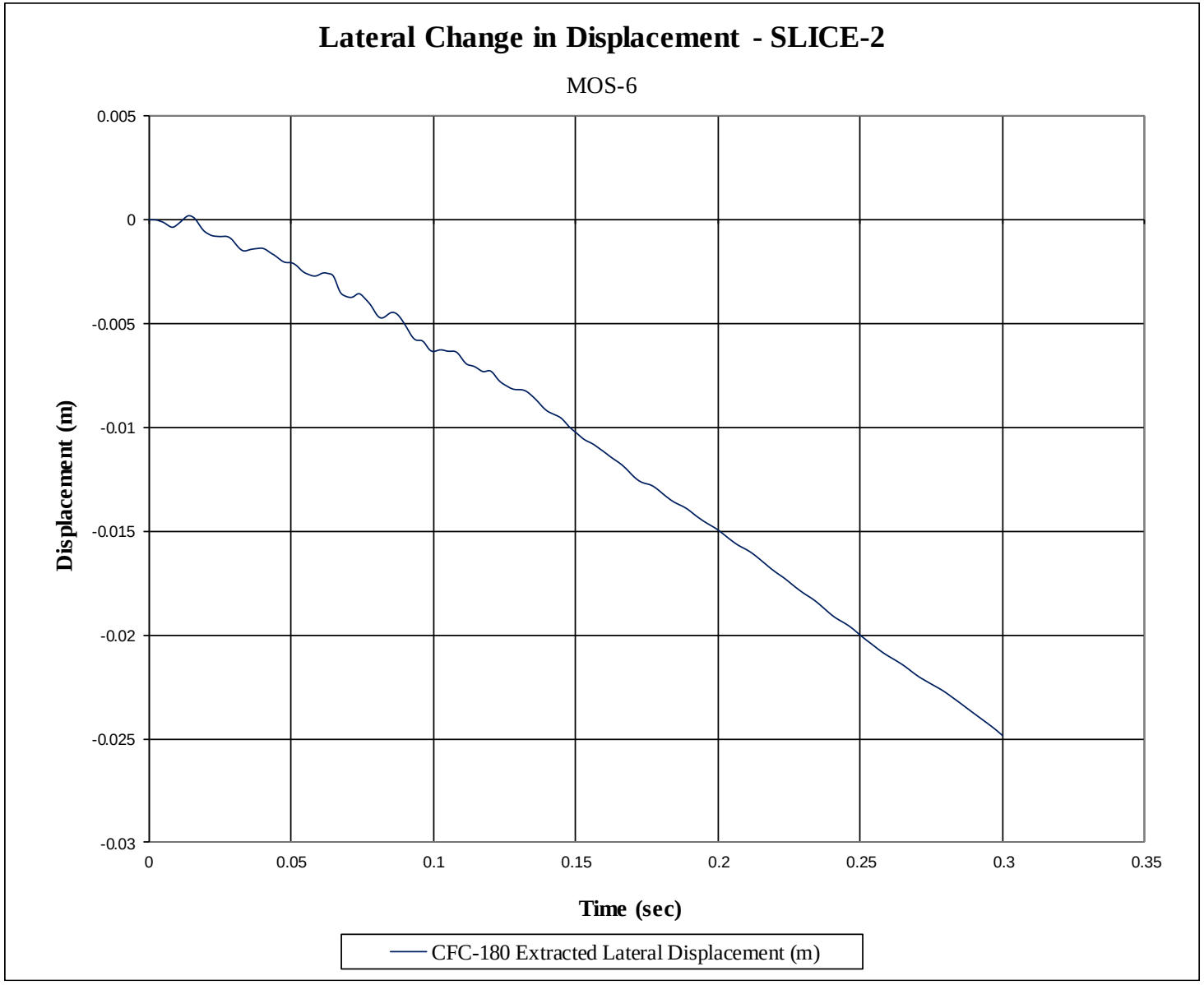


Figure F-14. Lateral Occupant Displacement (SLICE-2), Test No. MOS-6

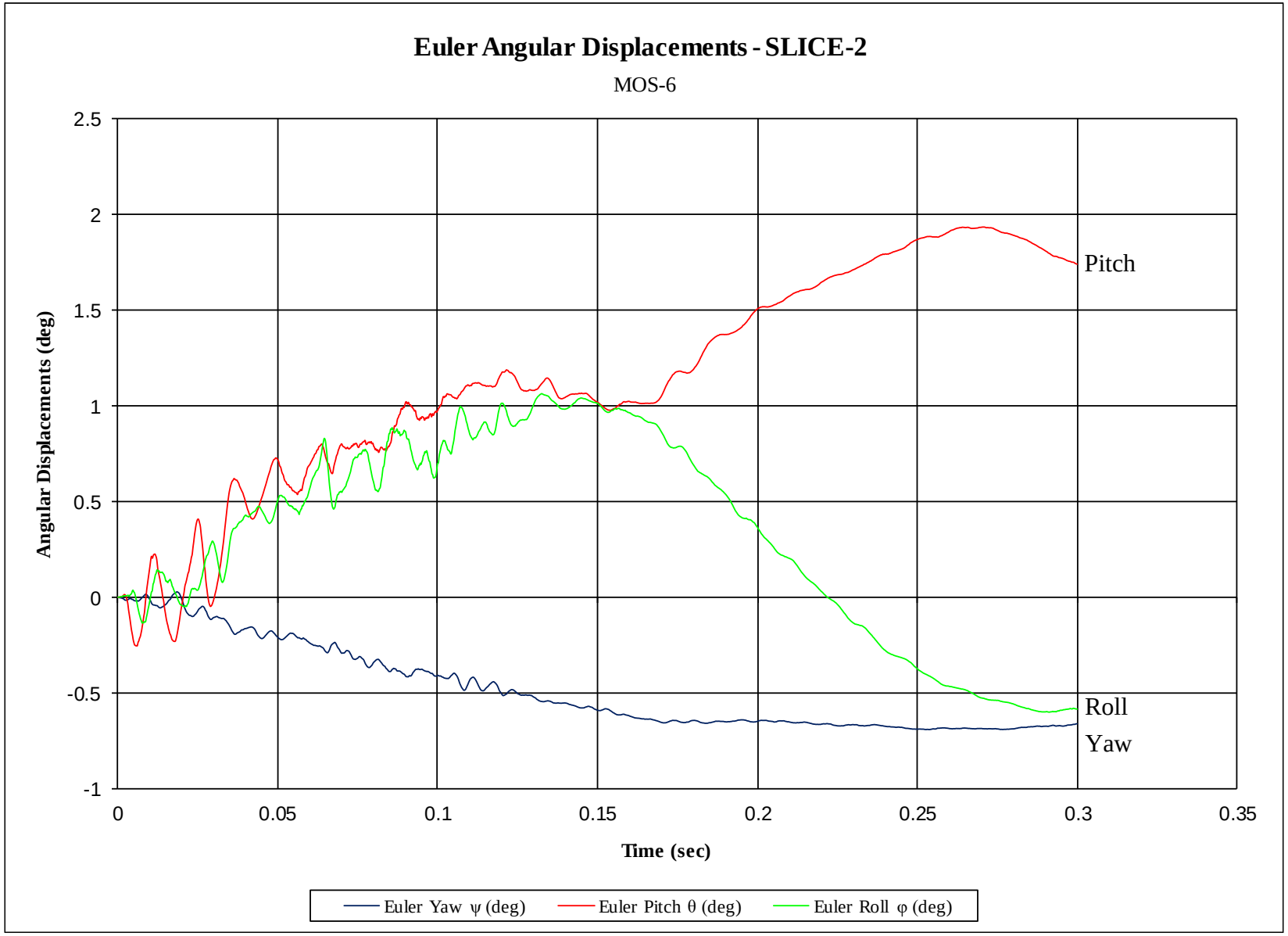


Figure F-15. Vehicle Angular Displacements (SLICE-2), Test No. MOS-6

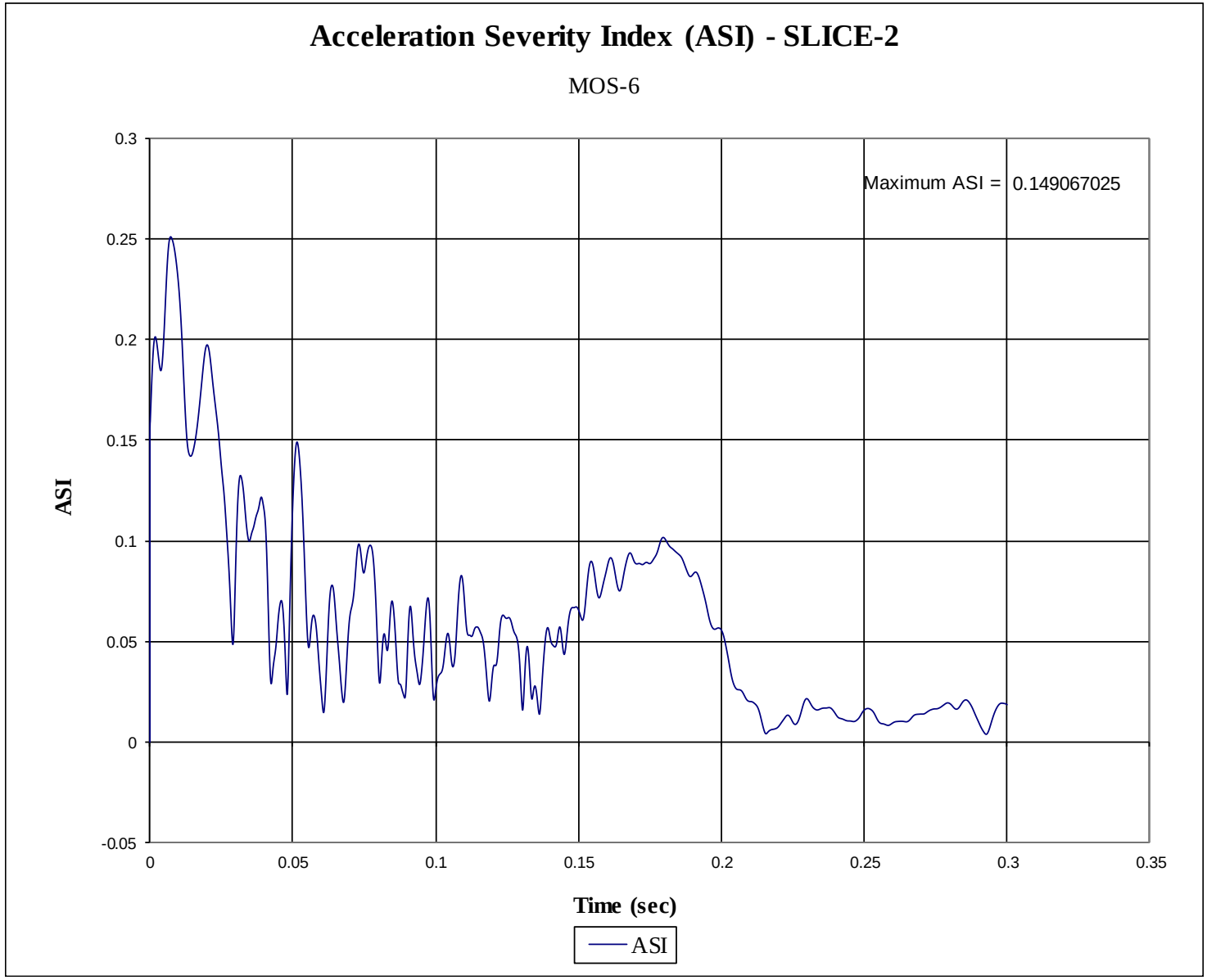


Figure F-16. Acceleration Severity Index (SLICE-2), Test No. MOS-6

Appendix G. Accelerometer and Rate Transducer Data Plots, Test No. MOS-7

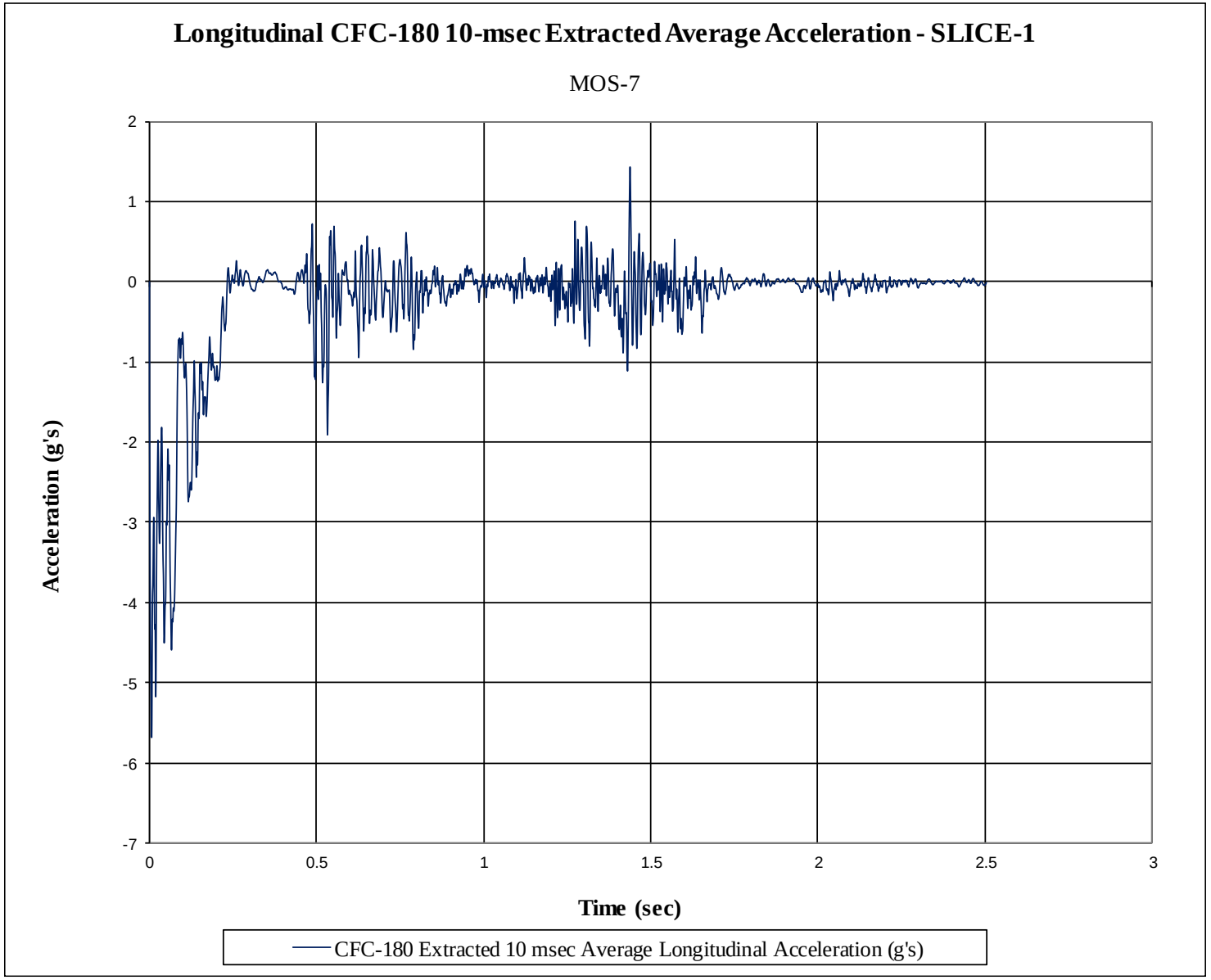


Figure G-1. 10-ms Average Longitudinal Deceleration (SLICE-1), Test No. MOS-7

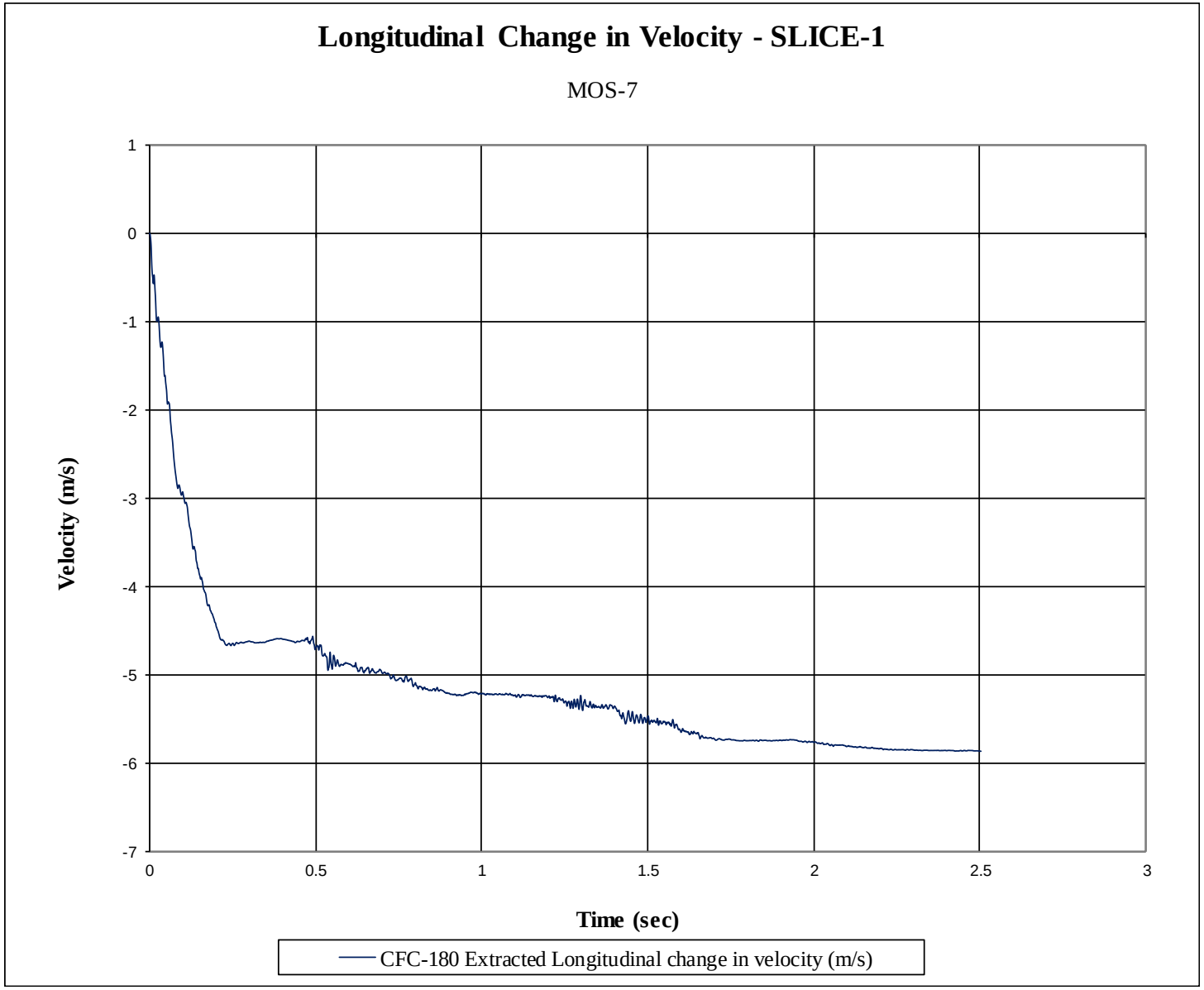


Figure G-2. Longitudinal Occupant Impact Velocity (SLICE-1), Test No. MOS-7

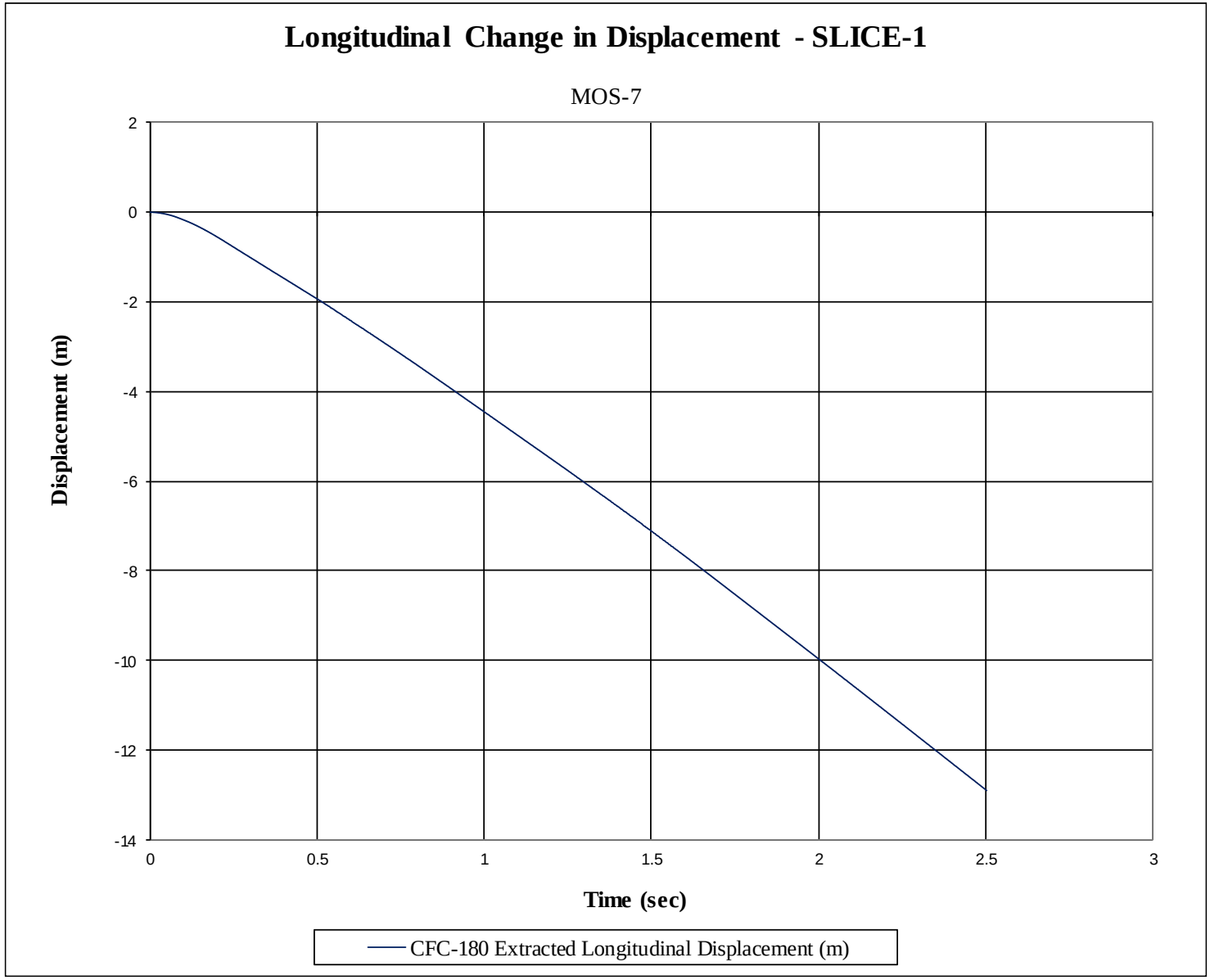


Figure G-3. Longitudinal Occupant Displacement (SLICE-1), Test No. MOS-7

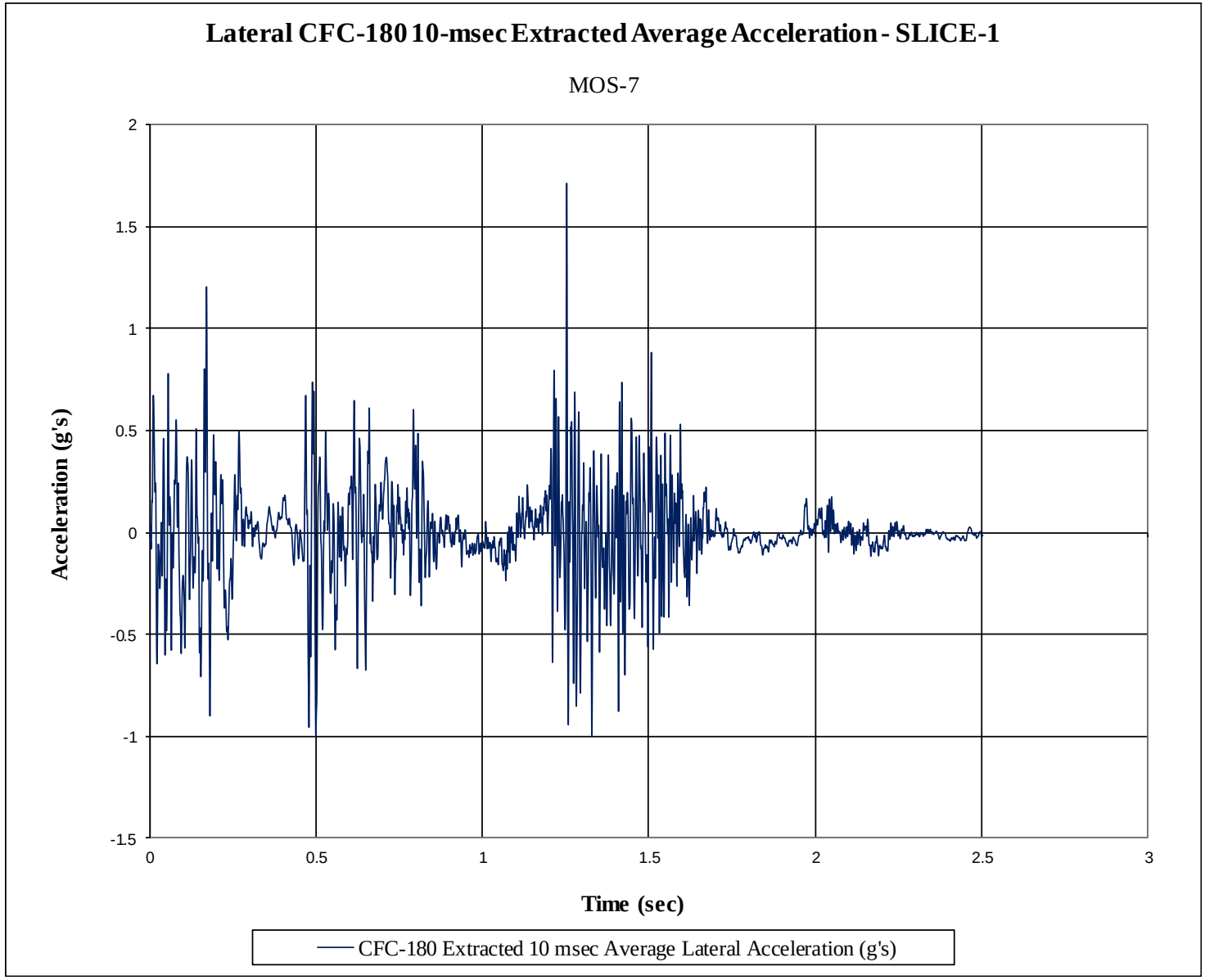


Figure G-4. 10-ms Average Lateral Deceleration (SLICE-1), Test No. MOS-7

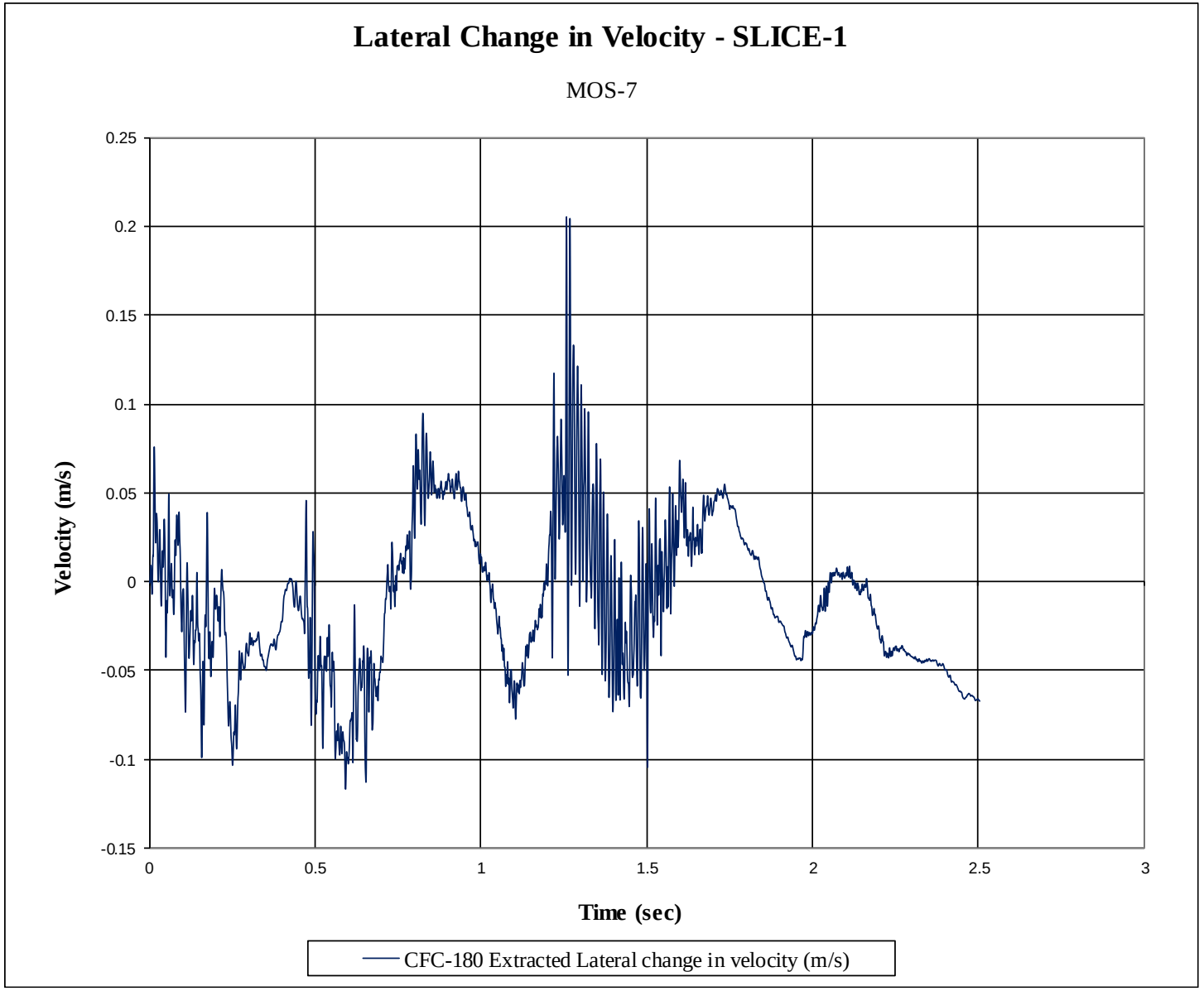


Figure G-5. Lateral Occupant Impact Velocity (SLICE-1), Test No. MOS-7

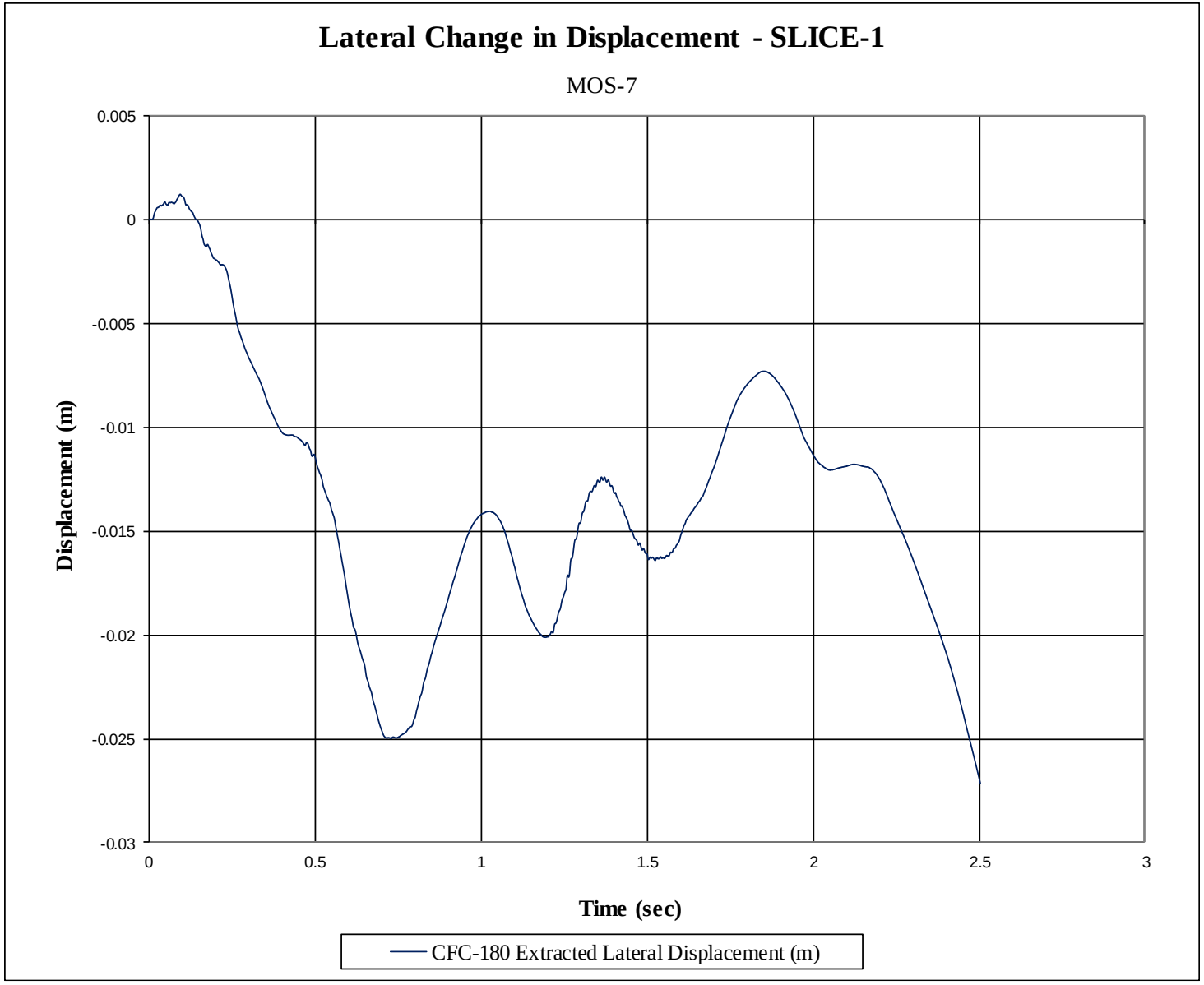


Figure G-6. Lateral Occupant Displacement (SLICE-1), Test No. MOS-7

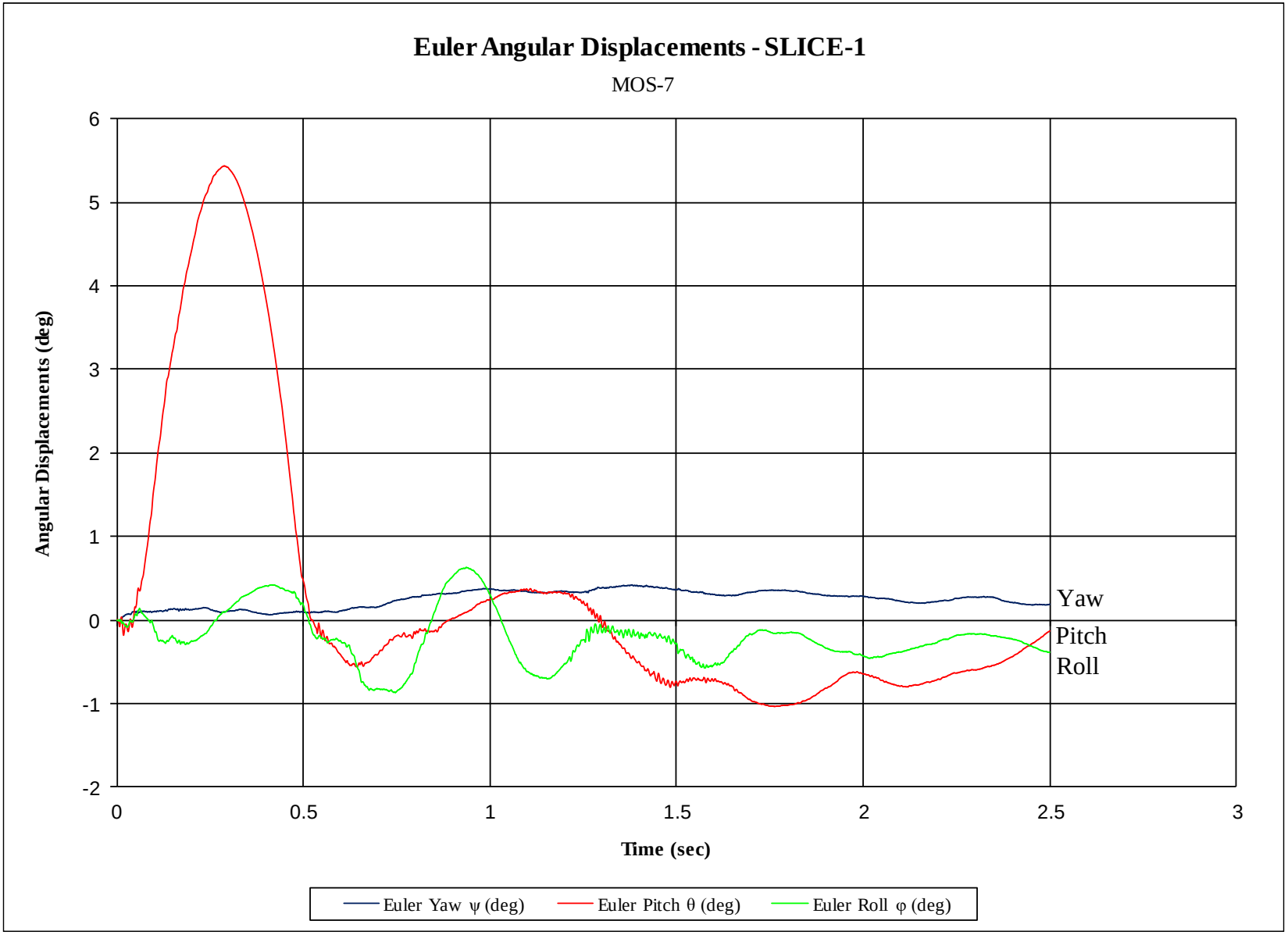


Figure G-7. Vehicle Angular Displacements (SLICE-1), Test No. MOS-7

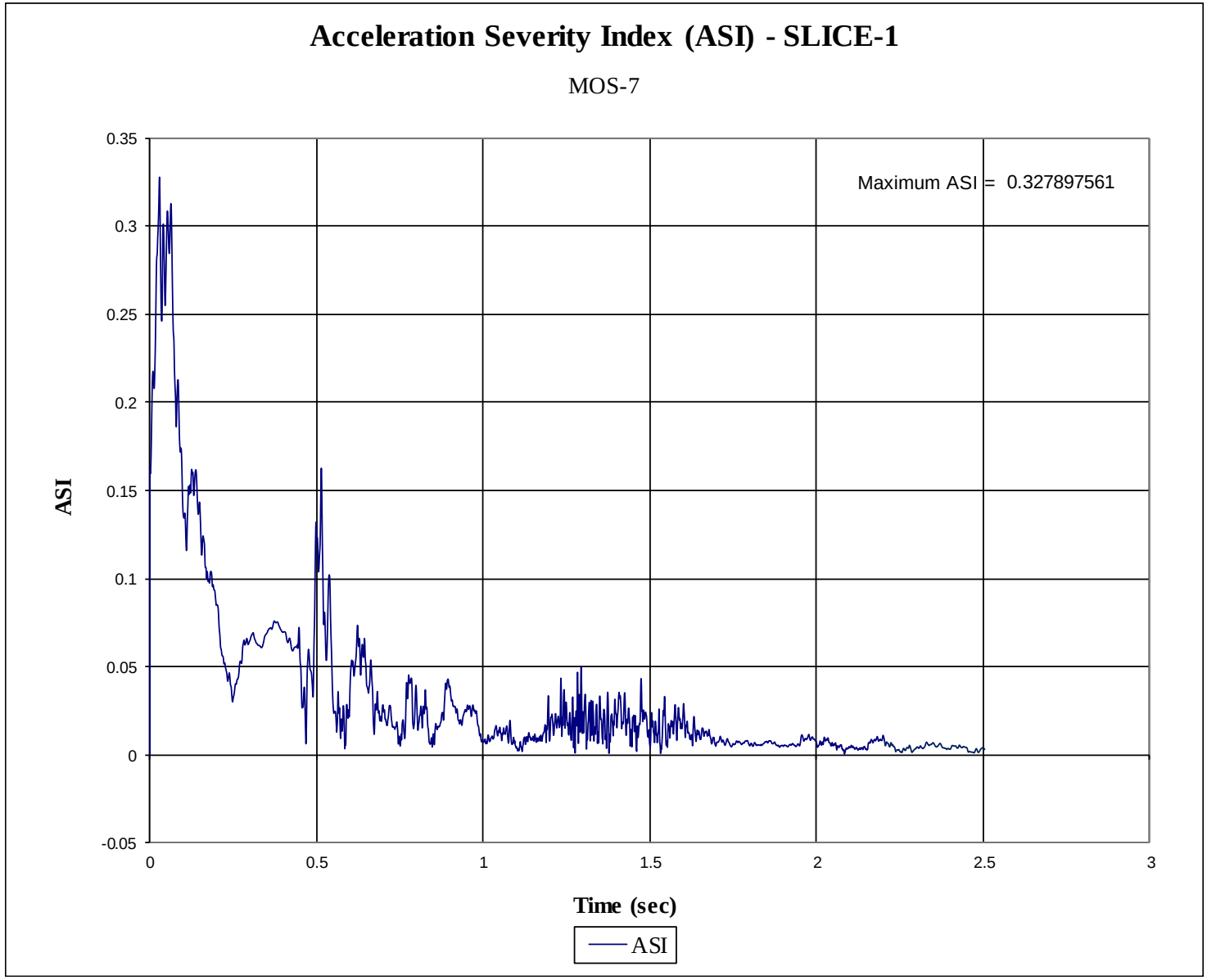


Figure G-8. Acceleration Severity Index (SLICE-1), Test No. MOS-7

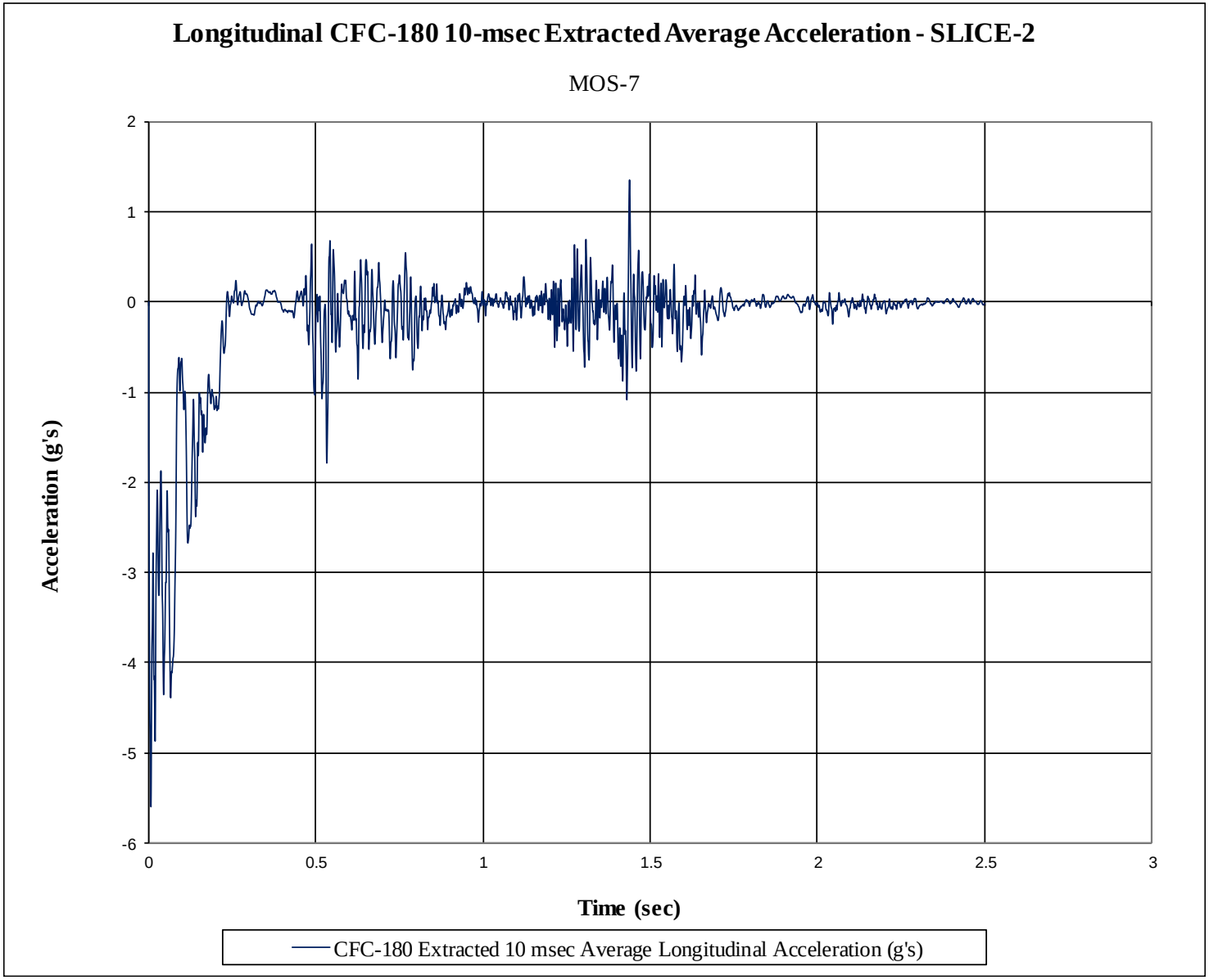


Figure G-9. 10-ms Average Longitudinal Deceleration (SLICE-2), Test No. MOS-7

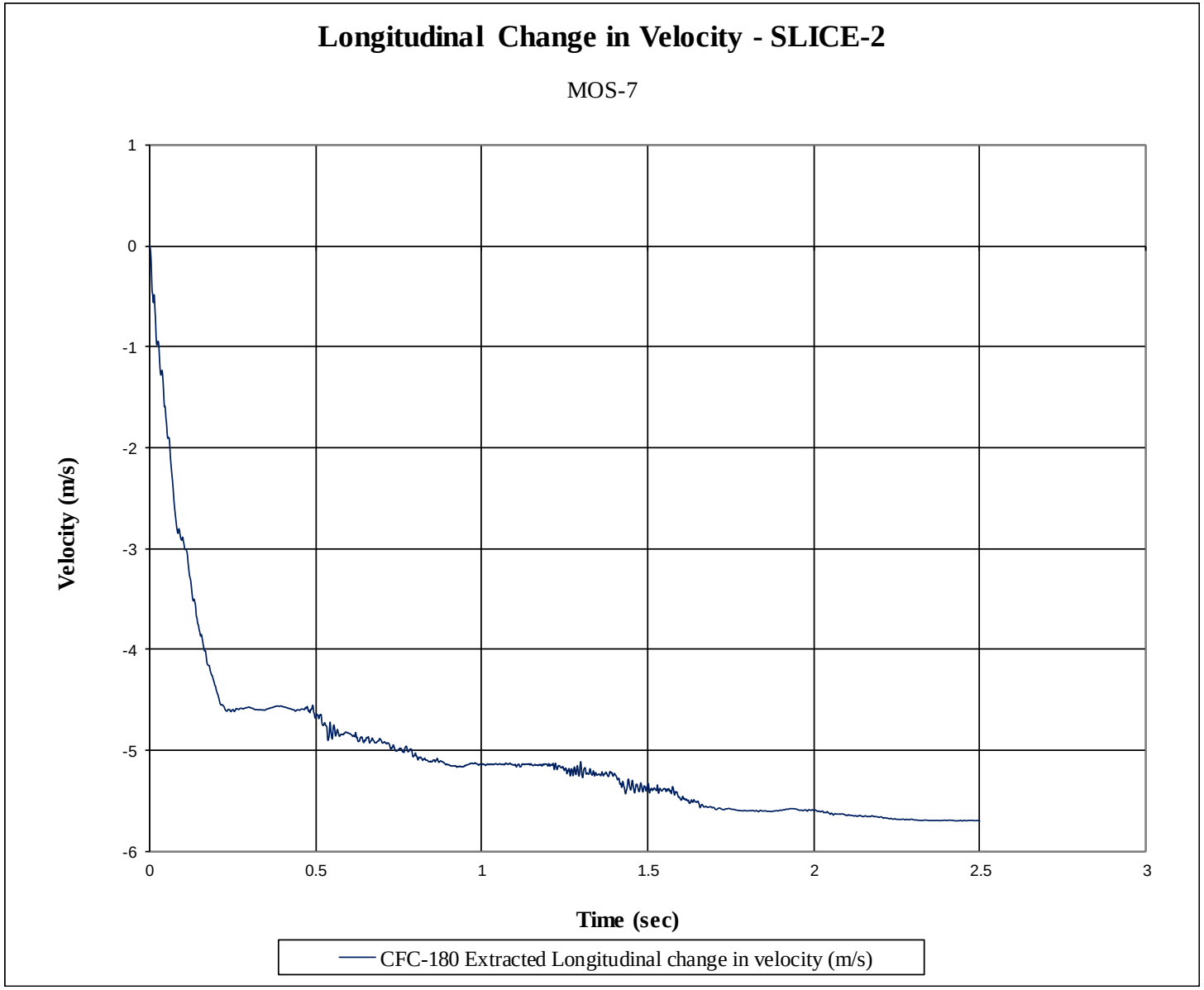


Figure G-10. Longitudinal Occupant Impact Velocity (SLICE-2), Test No. MOS-7

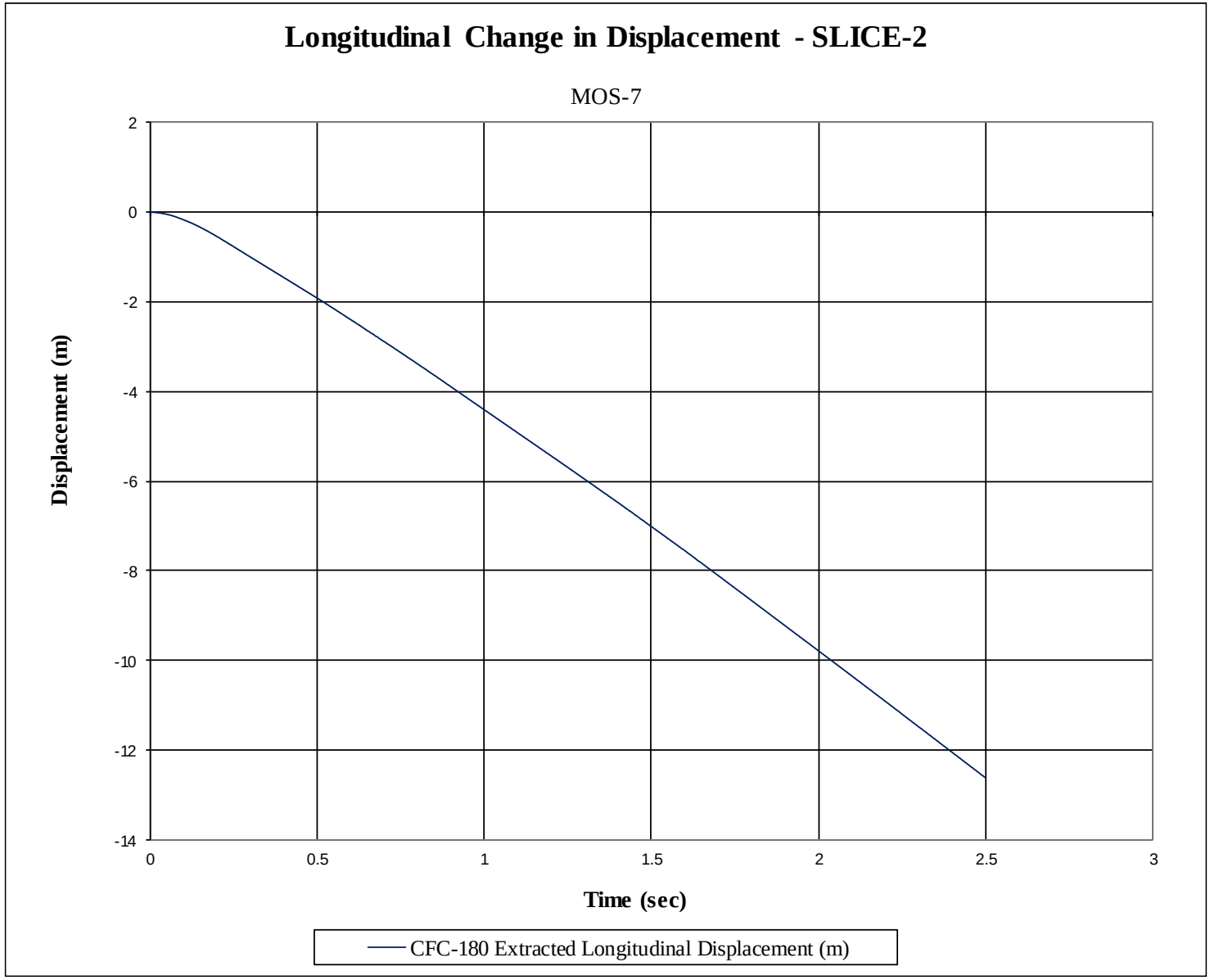


Figure G-11. Longitudinal Occupant Displacement (SLICE-2), Test No. MOS-7

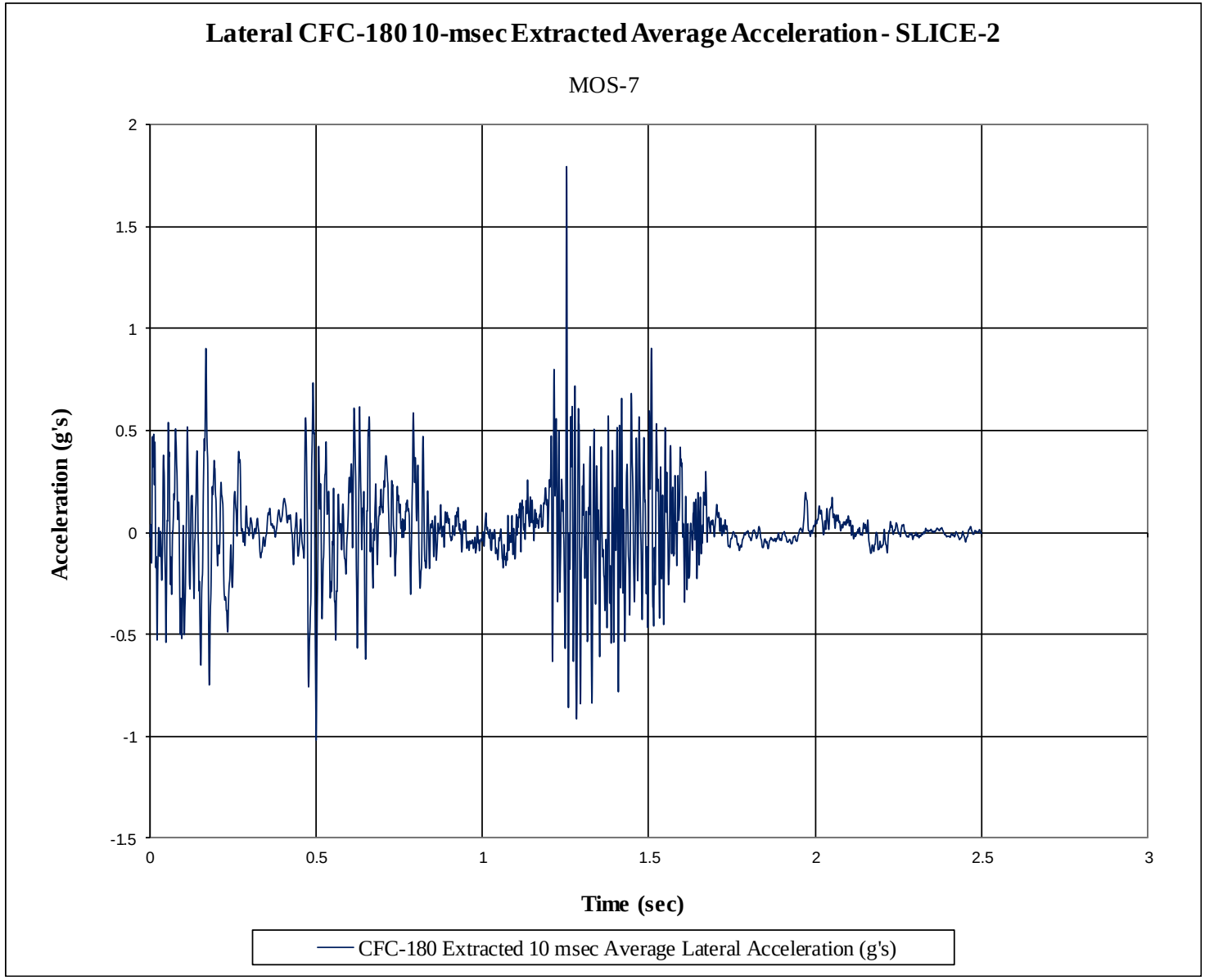


Figure G-12. 10-ms Average Lateral Deceleration (SLICE-2), Test No. MOS-7

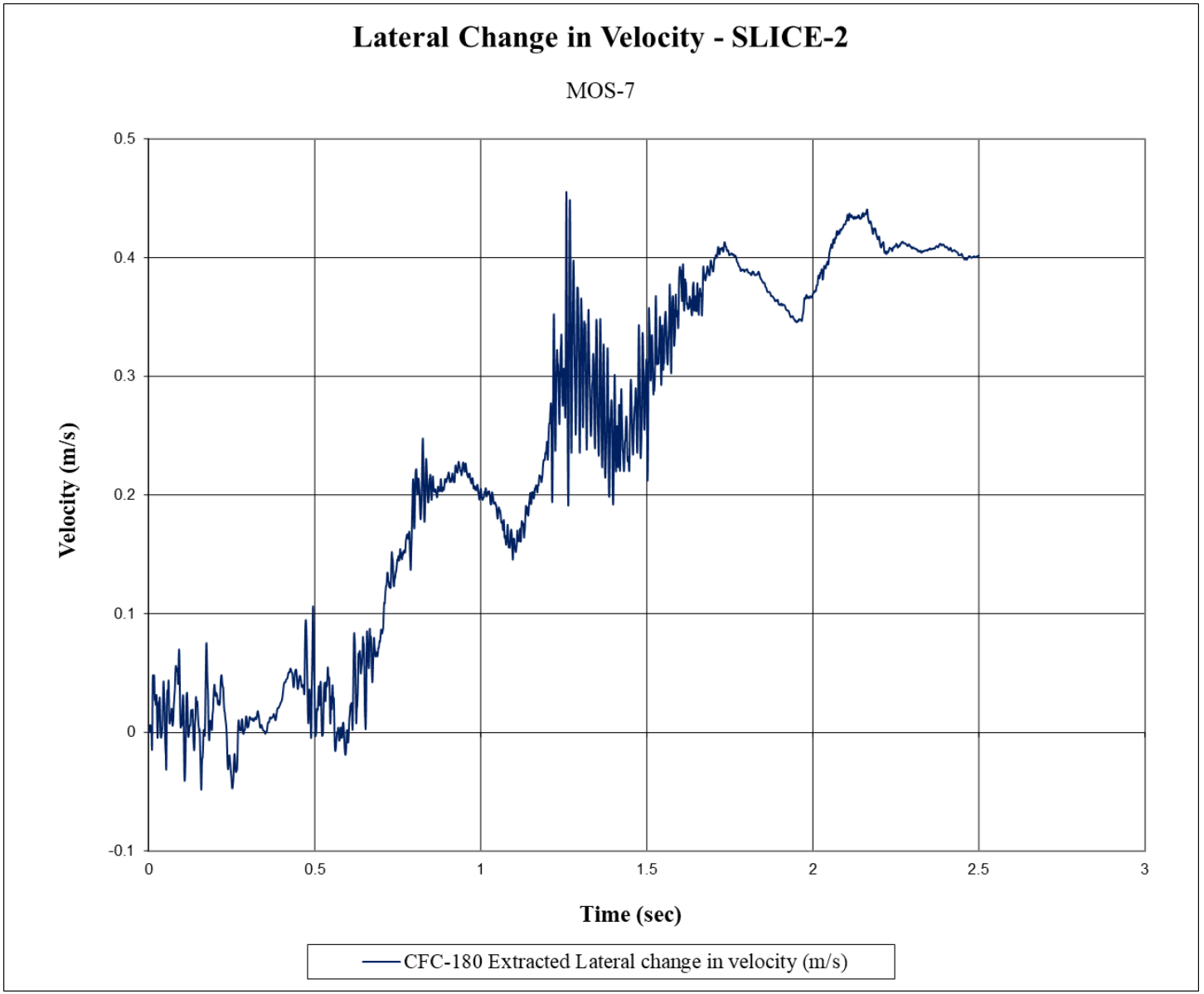


Figure G-13. Lateral Occupant Impact Velocity (SLICE-2), Test No. MOS-7

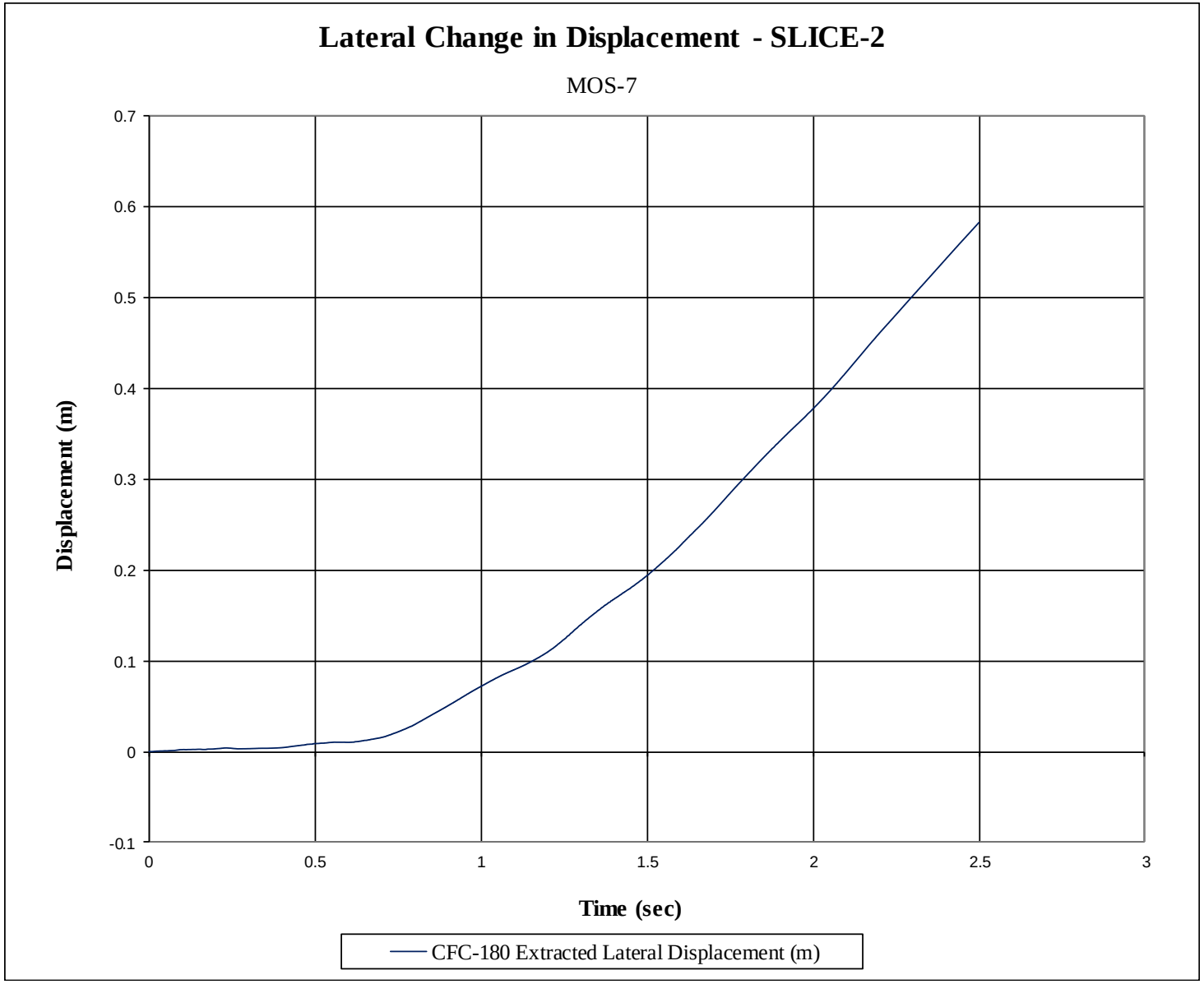


Figure G-14. Lateral Occupant Displacement (SLICE-2), Test No. MOS-7

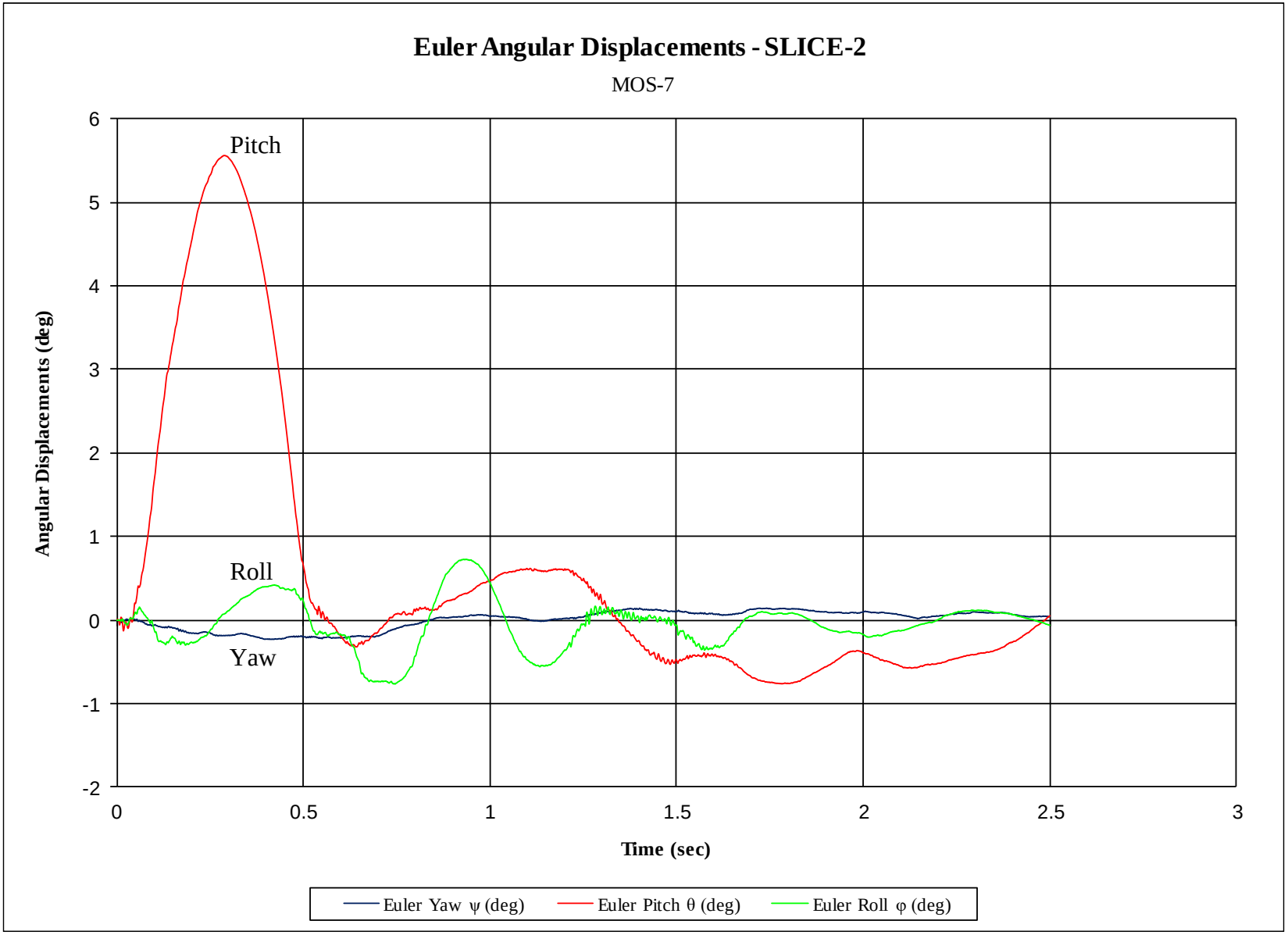


Figure G-15. Vehicle Angular Displacements (SLICE-2), Test No. MOS-7

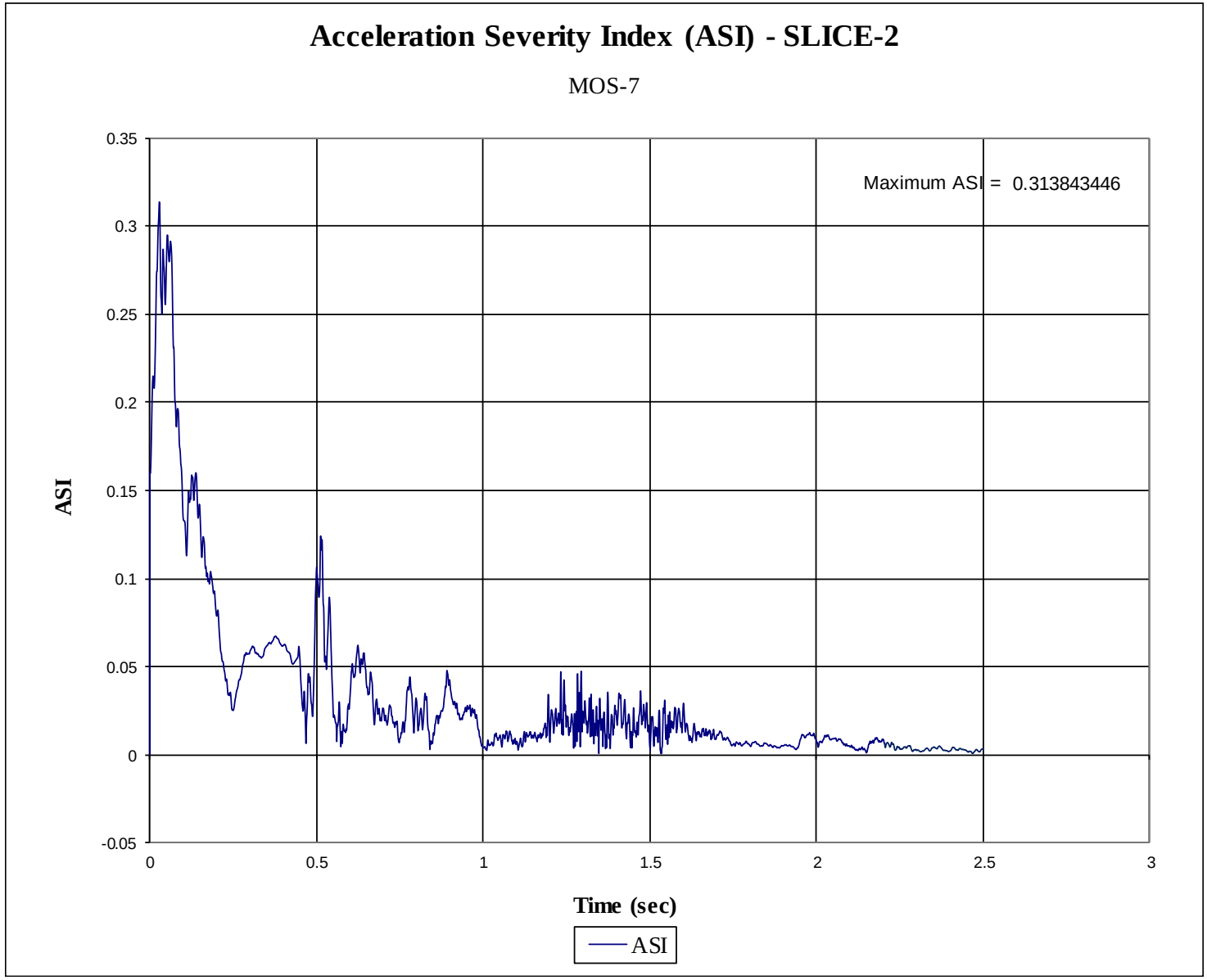


Figure G-16. Acceleration Severity Index (SLICE-2), Test No. MOS-7

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