

TECHNICAL MEMORANDUM

Contract No.: P2011067
Report No.: 400001-IRS6
Project Name: Impact Testing to MASH Standard for Tuff Curb and Tuff Curb XLP
Sponsor: Impact Recovery Systems, Inc.

DATE: March 14, 2011

TO: Greg Hannah
Impact Recovery Systems, Inc.

COPY TO: Jesus Palomo, TTI RDO
D. L. Bullard, XLP., Head, TTI Roadside Safety and Physical Security
Rebecca Haug, TTI Roadside Safety and Physical Security

FROM: Dusty R. Arrington, Engineering Research Associate, TTI Roadside Safety
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DISCLAIMER:

The contents of this report reflect the views of the authors who are solely responsible for the facts and accuracy of the data, findings and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Impact Recovery Systems, The Texas A&M University System, or Texas Transportation Institute. This report does not constitute a standard, specification, or regulation. In addition, the above listed agencies assume no liability for its contents or use thereof. The names of specific products or manufacturers listed herein do not imply endorsement of those products or manufacturers. The results reported herein apply only to the article being tested. The test was performed according to TTI Proving Ground quality procedures and according to the American Association of State Highway and Transportation Officials (AASHTO) *Manual for Assessing Safety Hardware (MASH)*.

TEST DESIGNATION AND ACTUAL TEST CONDITIONS

On January 19, 2011, Texas Transportation Institute (TTI) Proving Ground performed impact testing on the Impact Recovery Systems, Inc.'s Tuff Curb system according to specifications set forth in *MASH* for longitudinal channelizers. *MASH* recommends two tests on longitudinal channelizers. Test 3-90 involves an 1100C vehicle (2420 lb passenger car) and test 3-91 involves a 2270P vehicle (5000 lb pickup truck). In both tests, the vehicle should impact the device at a nominal impact speed 62 mi/h and an impact angle between 0 and 25 degrees. The impact angle should be determined such that it represents an increased risk for vehicle instability and/or excessive vehicle decelerations.

Both *MASH* test 3-90 and 3-91 were performed on the Impact Recovery Systems Tuff Curb and Tuff Curb XLP systems. Several traversal maneuvers were performed with the 1100C and 2270C vehicles for each test specimen as several hazardous impact angles may exist for the system. The impacts were ordered such that each traversal maneuver was performed with each vehicle type before proceeding to the next maneuver, i.e. IRS6-1 then IRS6-5; IRS6-2 then IRS6-6, etc.

Table 1. Impact Recovery Testing Matrix.

<u>Test Specimen</u>	<u>Vehicle</u>	<u>Test Maneuver</u>	<u>Test No.</u>
Tuff Curb	2270P	Traversal of Curb at 25 deg	IRS6-1
		Traversal of "V"	IRS6-2
		Traversal of Curb at 0 deg	IRS6-3
		Lane Change Maneuver	IRS6-4
	1100C	Traversal of Curb at 25 deg	IRS6-5
		Traversal of "V"	IRS6-6
		Traversal of Curb at 0 deg	IRS6-7
		Lane Change Maneuver	IRS6-8
Tuff Curb XLP with Coupler	2270P	Traversal of Curb at 25 deg	IRS6-9
		Traversal of "V"	IRS6-10
		Traversal of Curb at 0 deg	IRS6-11
		Lane Change Maneuver	IRS6-12
	1100C	Traversal of Curb at 25 deg	IRS6-13
		Traversal of "V"	IRS6-14
		Traversal of Curb at 0 deg	IRS6-15
		Lane Change Maneuver	IRS6-16

TEST ARTICLE DESIGN AND CONSTRUCTION

Tests IRS6-1 through IRS6-8 were performed on a Tuff Curb installation. The Tuff Curb segments were constructed of High Density Polyethylene. Each curb segment was 40 inches long by 12 inches wide and 3.5 inches tall. Each curb segment is constructed of two smaller sections. The sections were joined at the mid-length of the curb segment. The curb was attached to the roadway surface at two bolting locations at either end of the segment. The test installation utilized two ½-inch wedge bolts to anchor each curb section. The test installation was constructed in a 30-degree "V" formation. The longer leg of the "V" was constructed using 40

sections with no gap between segments and with 18-inch long end caps placed at each end (136 ft-4 inches). The shorter leg of the “V” was constructed using 10 segments with no gap between segments and with 18-inch long end caps placed at each end (36 ft-4 inches). A single 36-inch delineator (Model: TP36FQR) with single quick release pin was installed in each segment location. For further details see detail drawings in Attachment A.

Tests IRS6-9 through IRS6-16 were performed on the Tuff Curb XLP with coupler. The Tuff Curb XLP segments were constructed of High Density Polyethylene. Each curb segment was 40 inches long by 8 inches wide and 2 inches tall. Each curb segment was constructed of a single section. The curb was attached to the roadway surface at two bolting locations at either end of the segment. The test installation utilized two ½-inch wedge bolts to anchor each curb section. A 12.3-inch long by 8-inch wide coupler was used to couple successive segments together. The test installation was constructed in a 30-degree “V” formation. The longer leg of the “V” was constructed using 40 sections and 39 couplers with no gap between segments (133 ft-4 inches). The shorter leg of the “V” was constructed using 10 segments with no gap between segments (33 ft-4 inches). A single 36-inch delineator (Model: TP36FQR) with single quick release pin was installed in each segment location. For further details see detail drawings in Attachment A.

Figure 1 shows a typical test setup for the curb installations tested. Further details of the Tuff Curb and Tuff Curb XLP are presented in Attachment A, along with the various maneuvers in which they were tested.



Figure 1. Typical setup.

TEST VEHICLE

A 2004 Kia Rio was used to perform test 3-90. The test inertial mass of the vehicle was 2310 lb and gross static mass (with live driver) was 2500 lb.

A 2003 Dodge Ram 1500 pickup truck was used to perform test 3-91. The test inertial mass of the vehicle was 4760 lb and gross static mass (with live driver) was 4950 lb.

Neither of the above vehicles were instrumented with accelerometers or rate gyros as it was determined that no potential for excessive vehicle deceleration or vehicle rollover was evident. Both the above vehicles were directed into the installation in the various maneuvers by a live driver. No braking inputs were employed until the vehicles were sufficiently clear of the test site.

BRIEF TEST DESCRIPTION

TUFF CURB:

Table 2 presents the results of *MASH* 3-91 and *MASH* 3-90 testing performed on the Tuff Curb. The vehicles remained stable throughout the testing with minimal damage to the vehicles or the test article. The same curb installation was used for all testing with no repairs to the curb performed between tests. The delineators that were dislodged during the testing were reinstalled between tests to restore the system to its original configuration.

Table 2. Impact Recovery Systems Tuff Curb Testing Results.

<u>Vehicle</u>	<u>Test Maneuver</u>	<u>Test No.</u>	<u>Results</u>
2270P: <i>MASH</i> 3-91	Traversal of Curb at 25 deg	IRS6-1	Upstream curb section loosened at 1 curb section
	Traversal of "V"	IRS6-2	Upstream anchor bolt pulled up 1 inch in first curb on short side of "V"
	Traversal of Curb at 0 deg	IRS6-3	Several upstream bolts loosened
	Lane Change Maneuver	IRS6-4	Several anchor bolts pulled up
1100C: <i>MASH</i> 3-90	Traversal of Curb at 25 deg	IRS6-5	1 reflector knocked off curb
	Traversal of "V"	IRS6-6	Upstream anchor bolt pulled up 1 inch in first curb on short side of "V"
	Traversal of Curb at 0 deg	IRS6-7	Several upstream bolts loosened, one pulled out completely, 1 delineator broke loose
	Lane Change Maneuver	IRS6-8	Several anchor bolts pulled up

TUFF CURB XLP WITH COUPLER:

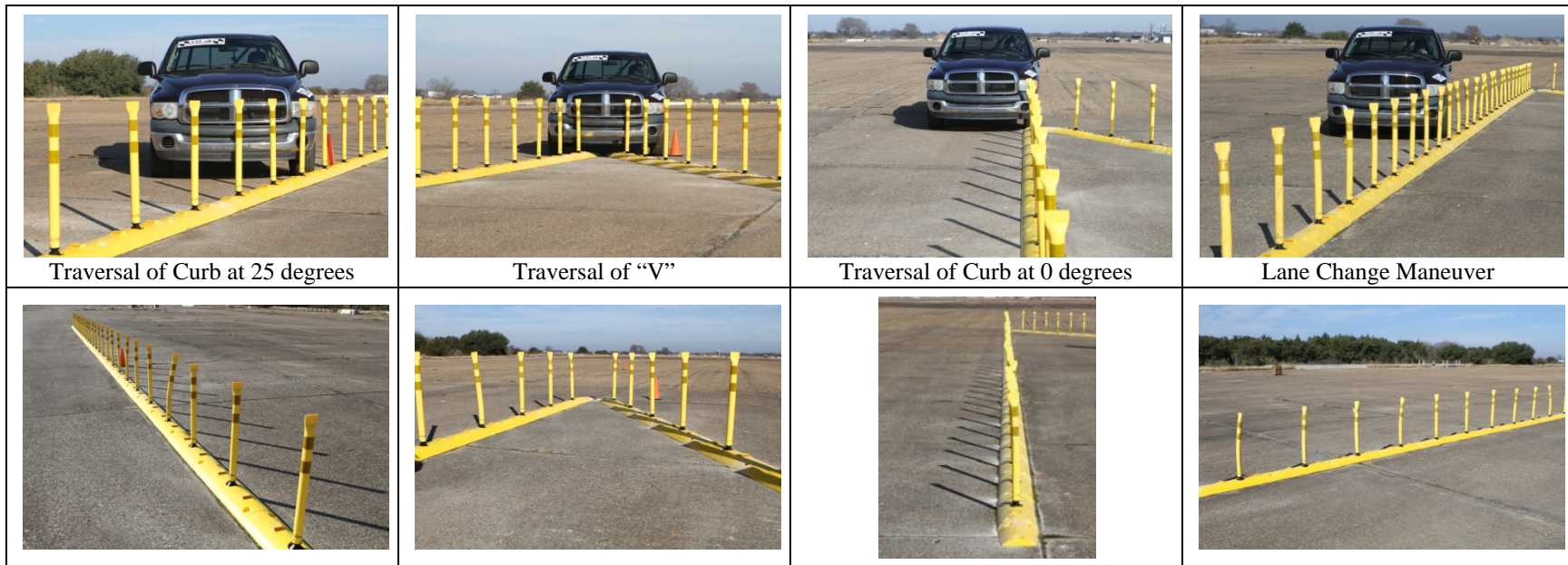
Table 3 presents the results of *MASH* 3-91 and *MASH* 3-90 testing performed on the Tuff Curb XLP with Coupler. The vehicles remained stable throughout the testing with minimal damage to the vehicles and test article. The same curb installation was used for all testing with no repairs to the curb performed between tests. The delineators that were dislodged during the testing were reinstalled between tests to restore the system to its original configuration.

SUMMARY AND CONCLUSIONS

Tests 3-90 (1100C at 100 km/h) and 3-91 (2270P at 100 km/h) defined by *MASH* were both performed at various impact angles on both the Tuff Curb and Tuff Curb XLP test installations. Tuff Curb and Tuff Curb XLP have performed acceptably according to criteria defined in *MASH*.

Table 3. Impact Recovery Systems Tuff Curb XLP with Coupler Testing Results.

Vehicle	Test Maneuver	Test No.	Results
2270P: MASH 3-91	Traversal of Curb at 25 deg	IRS6-9	No apparent damage to curbs or anchor bolts
	Traversal of "V"	IRS6-10	No apparent damage
	Traversal of Curb at 0 deg	IRS6-11	Delineator # 27 pulled out
	Lane Change Maneuver	IRS6-12	Two delineators pulled out
1100C: MASH 3-90	Traversal of Curb at 25 deg	IRS6-13	No apparent damage to curbs, 2 delineators pulled out
	Traversal of "V"	IRS6-14	Upstream bolt pulled up ½ inch on #2 curb on long side, left front tire punctured
	Traversal of Curb at 0 deg	IRS6-15	No apparent damage
	Lane Change Maneuver	IRS6-16	Delineator 18, 21, 24, and 26 pulled out



General Information

Test Agency..... Texas Transportation Institute
 Test Standard Test No. MASH 3-91
 Test No. 400001-IRS6-1 through IRS6-4
 Date 2011-01-19

Test Article

Type..... Curb/Longitudinal Channelizer
 Name Tuff Curb
 Installation Length 133 ft on long leg, 33 ft on short leg
 Material or Key Elements High-Density Polyethylene 3.5 inches tall x 12 inches wide x 40 inches long anchored with 4-inch x 1/2-inch wedge bolts

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

Test Vehicle

Designation.....2270P
 Model.....2003 Dodge Ram 1500
 Mass
 Curb.....4760 lb
 Test Inertial.....4760 lb
 Driver..... 190 lb
 Gross Static.....4950 lb

Impact Conditions

Speed62 mi/h
 AngleVaries as above

Test Article Deflections

Dynamic 0
 Permanent..... 0

Vehicle Damage

Exterior
 VDS..... N/A
 CDC 12UDFW1
 Max. Exterior
 Vehicle Crush..... 0
 Interior
 OCDI FS0000000
 Max. Occupant Compartment
 Deformation 0

Figure 2. Summary of results for *MASH* test 3-91 on the Tuff Curb.

Table 4. Performance evaluation summary for MASH test 3-91 on the Tuff Curbr.

Test Agency: Texas Transportation Institute

Test No.: 400001-IRS6-1 – IRS6-4

Test Date: 2011-01-19

MASH Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
C. <i>Acceptable test article performance may be by redirection, controlled penetration, or controlled stopping of the vehicle.</i>	In all maneuvers, the 2270P vehicle penetrated the Tuff Curb installation.	Pass
Occupant Risk		
D. <i>Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.</i>	Only very small, if any, debris were present during any of the maneuvers. However, these debris did not penetrate, show potential for penetrating, nor to present undue hazard to others in the area. No occupant compartment deformations or intrusions occurred during any of the maneuvers with the 2270P vehicle.	Pass Pass
E. <i>Detached elements, fragments, or other debris from the test article, of vehicular damage should not block the driver's vision or otherwise cause the driver to lose control of the vehicle.</i>	No blockage of the driver's vision occurred during any of the maneuvers with the 2270P vehicle.	Pass
F. <i>The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i>	The 2270P vehicle remained upright and stable during and after all maneuvers.	Pass
H. <i>Longitudinal and lateral occupant impact velocities should fall below the preferred value of 3.0 m/s (9.8 ft/s), or at least below the maximum allowable value of 5.0 m/s (16.4 ft/s).</i>	The vehicle was not instrumented with accelerometers.	N/A
I. <i>Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.0 Gs.</i>	The vehicle was not instrumented with accelerometers.	N/A
Vehicle Trajectory		
N. <i>Vehicle trajectory behind the test article is acceptable.</i>	The 2270P vehicle exited behind the installation.	Pass



General Information

Test Agency..... Texas Transportation Institute
 Test Standard Test No. MASH 3-90
 Test No. 400001-IRS6-5 through IRS6-8
 Date 2011-01-19

Test Article

Type..... Curb/Longitudinal Channelizer
 Name Tuff Curb
 Installation Length 133 ft on long leg, 33 ft on short leg
 Material or Key Elements High-Density Polyethylene 3.5 inches tall x
 12 inches wide x 40 inches long anchored with
 4-inch x 1/2-inch wedge bolts

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

Test Vehicle

Designation.....1100C
 Model.....2004 Kia Rio
 Mass
 Curb.....2310 lb
 Test Inertial.....2310 lb
 Driver.....190 lb
 Gross Static.....2500 lb

Impact Conditions

Speed62 mi/h
 AngleVaries as above

Test Article Deflections

Dynamic 0
 Permanent..... 0

Vehicle Damage

Exterior
 VDS..... N/A
 CDC 12UDFW1
 Max. Exterior
 Vehicle Crush..... 0
 Interior
 OCDI FS0000000
 Max. Occupant Compartment
 Deformation 0

Figure 3. Summary of results for *MASH* test 3-90 on the Tuff Curb.

Table 5. Performance evaluation summary for MASH test 3-90 on the Tuff Curb.

Test Agency: Texas Transportation Institute

Test No.: 400001-IRS6-5 – IRS6-8

Test Date: 2011-01-19

MASH Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
C. <i>Acceptable test article performance may be by redirection, controlled penetration, or controlled stopping of the vehicle.</i>	In all maneuvers, the 1100C vehicle penetrated the Tuff Curb installation.	Pass
Occupant Risk D. <i>Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.</i> <i>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.</i>	Only very small, if any, debris were present during any of the maneuvers. However, these debris did not penetrate, show potential for penetrating, nor to present undue hazard to others in the area. No occupant compartment deformations or intrusions occurred during any of the maneuvers with the 1100C vehicle.	Pass Pass
E. <i>Detached elements, fragments, or other debris from the test article, of vehicular damage should not block the driver's vision or otherwise cause the driver to lose control of the vehicle.</i>	No blockage of the driver's vision occurred during any of the maneuvers with the 1100C vehicle.	Pass
F. <i>The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i>	The 1100C vehicle remained upright and stable during and after all maneuvers.	Pass
H. <i>Longitudinal and lateral occupant impact velocities should fall below the preferred value of 3.0 m/s (9.8 ft/s), or at least below the maximum allowable value of 5.0 m/s (16.4 ft/s).</i>	The vehicle was not instrumented with accelerometers.	N/A
I. <i>Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.0 Gs.</i>	The vehicle was not instrumented with accelerometers.	N/A
Vehicle Trajectory		
N. <i>Vehicle trajectory behind the test article is acceptable.</i>	The 1100C vehicle exited behind the installation.	Pass



General Information

Test Agency..... Texas Transportation Institute
 Test Standard Test No. MASH 3-91
 Test No. 400001-IRS6-9 through IRS6-12
 Date 2011-01-19

Test Article

Type..... Curb/Longitudinal Channelizer
 Name Tuff Curb XLP with Coupler
 Installation Length 140 ft on long leg, 35 ft on short leg
 Material or Key Elements High-Density Polyethylene 2 inches tall x 8 inches wide x 40 inches long anchored with 4-inch x 1/2-inch wedge bolts

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

Test Vehicle

Designation.....2270P
 Model.....2003 Dodge Ram 1500
 Mass
 Curb.....4760 lb
 Test Inertial.....4760 lb
 Driver..... 190 lb
 Gross Static.....4950 lb

Impact Conditions

Speed62 mi/h
 AngleVaries as above

Test Article Deflections

Dynamic0
 Permanent.....0

Vehicle Damage

Exterior
 VDS.....N/A
 CDC12UDFW1
 Max. Exterior
 Vehicle Crush.....0
 Interior
 OCDIFS000000
 Max. Occupant Compartment
 Deformation.....0

Figure 4. Summary of results for *MASH* test 3-91 on the Tuff Curb XLP with Coupler.

Table 6. Performance evaluation summary for MASH test 3-91 on the Tuff Curb XLP with Coupler.

Test Agency: Texas Transportation Institute

Test No.: 400001-IRS6-9 -- IRS 6-12

Date: 2011-01-19

MASH Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
<i>C. Acceptable test article performance may be by redirection, controlled penetration, or controlled stopping of the vehicle.</i>	In all maneuvers, the 2270P vehicle penetrated the Tuff Curb XLP installation.	Pass
Occupant Risk		
<i>D. 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 5.3 and Appendix E of MASH.</i>	Only very small, if any, debris were present during any of the maneuvers. However, these debris did not penetrate, show potential for penetrating, nor to present undue hazard to others in the area. No occupant compartment deformations or intrusions occurred during any of the maneuvers with the 2270P vehicle.	Pass Pass
<i>E. Detached elements, fragments, or other debris from the test article, of vehicular damage should not block the driver's vision or otherwise cause the driver to lose control of the vehicle.</i>	No blockage of the driver's vision occurred during any of the maneuvers with the 2270P vehicle.	Pass
<i>F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i>	The 2270P vehicle remained upright and stable during and after all maneuvers.	Pass
<i>H. Longitudinal and lateral occupant impact velocities should fall below the preferred value of 3.0 m/s (9.8 ft/s), or at least below the maximum allowable value of 5.0 m/s (16.4 ft/s).</i>	The vehicle was not instrumented with accelerometers.	N/A
<i>I. Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.0 Gs.</i>	The vehicle was not instrumented with accelerometers.	N/A
Vehicle Trajectory		
<i>N. Vehicle trajectory behind the test article is acceptable.</i>	The 2270P vehicle exited behind the installation.	Pass



General Information

Test Agency..... Texas Transportation Institute
 Test Standard Test No. MASH 3-90
 Test No. 400001-IRS6-13 through IRS6-16
 Date 2011-01-19

Test Article

Type..... Curb/Longitudinal Channelizer
 Name Tuff Curb XLP with Coupler
 Installation Length 140 ft on long leg, 35 ft on short leg
 Material or Key Elements High-Density Polyethylene 2 inches tall x 8 inches wide x 40 inches long anchored with 4-inch x 1/2-inch wedge bolts

Soil Type and Condition Concrete pavement, dry

Test Vehicle

Designation.....1100C
 Model.....2004 Kia Rio
 Mass
 Curb.....2310 lb
 Test Inertial.....2310 lb
 Driver.....190 lb
 Gross Static.....2500 lb

Impact Conditions

Speed62 mi/h
 AngleVaries as above

Test Article Deflections

Dynamic 0
 Permanent..... 0

Vehicle Damage

Exterior
 VDS..... N/A
 CDC 12UDFW1
 Max. Exterior
 Vehicle Crush..... 0
 Interior
 OCDI FS0000000
 Max. Occupant Compartment
 Deformation 0

Figure 3. Summary of results for *MASH* test 3-90 on the Tuff Curb XLP with Coupler.

Table 7. Performance evaluation summary for MASH test 3-90 on the Tuff Curb XLP with Coupler.

Test Agency: Texas Transportation Institute

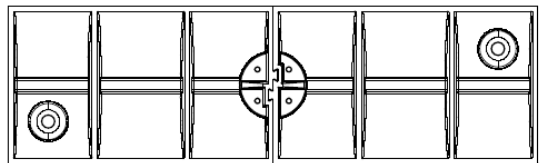
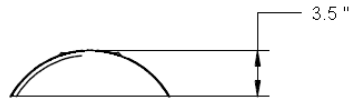
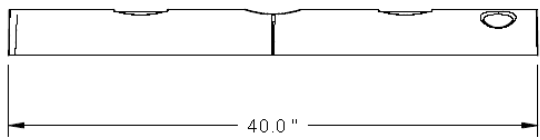
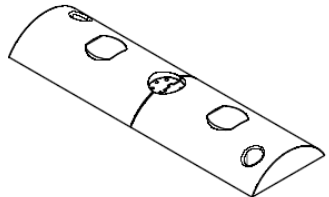
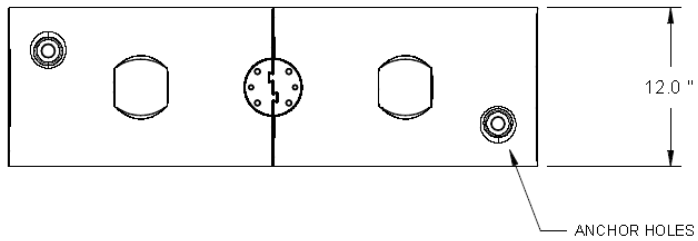
Test No.: 400001-IRS13—IRS16

Test Date: 2011-01-19

MASH Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
C. <i>Acceptable test article performance may be by redirection, controlled penetration, or controlled stopping of the vehicle.</i>	In all maneuvers, the 1100C vehicle penetrated the Tuff Curb XLP installation.	Pass
Occupant Risk		
D. <i>Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.</i>	Only very small, if any, debris were present during any of the maneuvers. However, these debris did not penetrate, show potential for penetrating, nor to present undue hazard to others in the area. No occupant compartment deformations or intrusions occurred during any of the maneuvers with the 1100C vehicle.	Pass
E. <i>Detached elements, fragments, or other debris from the test article, of vehicular damage should not block the driver's vision or otherwise cause the driver to lose control of the vehicle.</i>	No blockage of the driver's vision occurred during any of the maneuvers with the 1100C vehicle.	Pass
F. <i>The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i>	The 1100C vehicle remained upright and stable during and after all maneuvers.	Pass
H. <i>Longitudinal and lateral occupant impact velocities should fall below the preferred value of 3.0 m/s (9.8 ft/s), or at least below the maximum allowable value of 5.0 m/s (16.4 ft/s).</i>	The vehicle was not instrumented with accelerometers.	N/A
I. <i>Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.0 Gs.</i>	The vehicle was not instrumented with accelerometers.	N/A
Vehicle Trajectory		
N. <i>Vehicle trajectory behind the test article is acceptable.</i>	The 1100C vehicle exited behind the installation.	Pass

ATTACHMENT A: TEST ARTICLE DETAILS

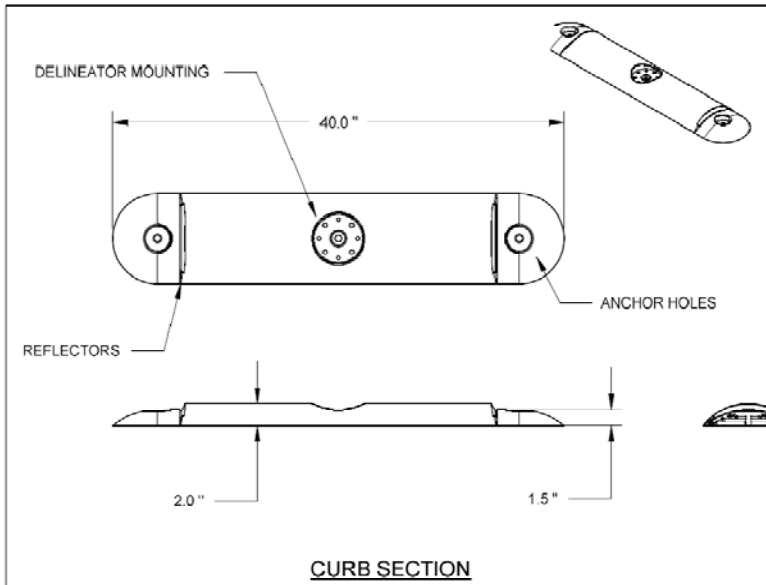
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ZONE	REV	DESCRIPTION	DATE	APPROVED



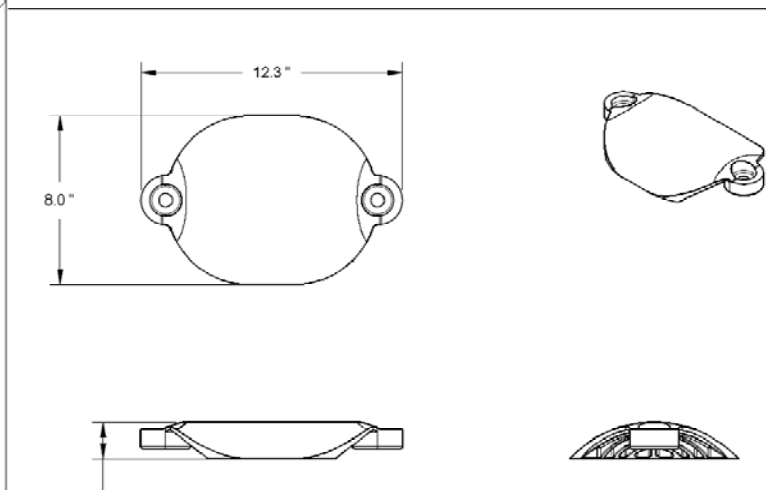
**IMPACT recovery
SYSTEMS**

"Impacting Today's Roads for a Safer Tomorrow"

SIZE A	PART NO.	DWG. TUFF CURB	REV
SCALE	IMPACT RECOVERY SYSTEMS, INC.	DATE 10-08-10	

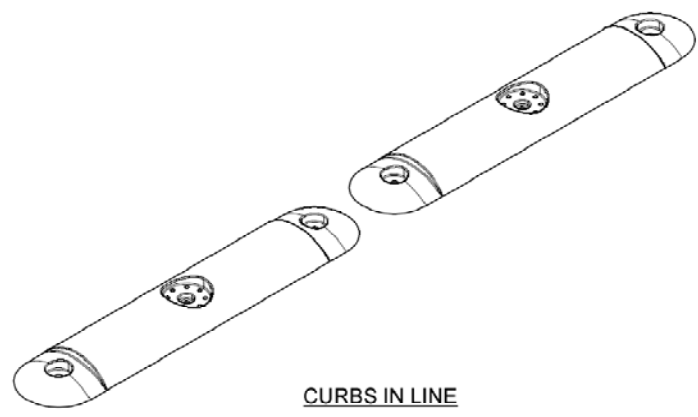


CURB SECTION

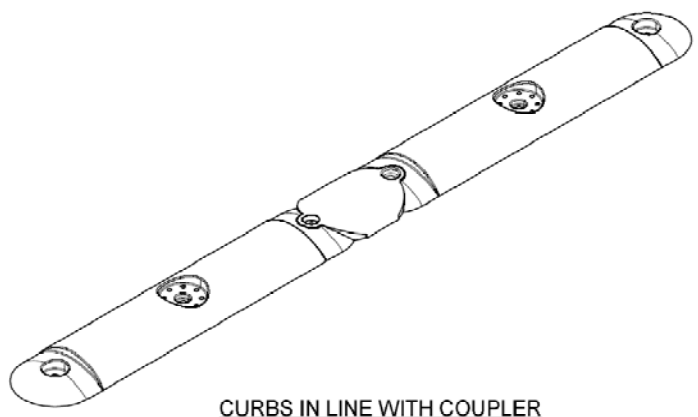


COUPLER

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED



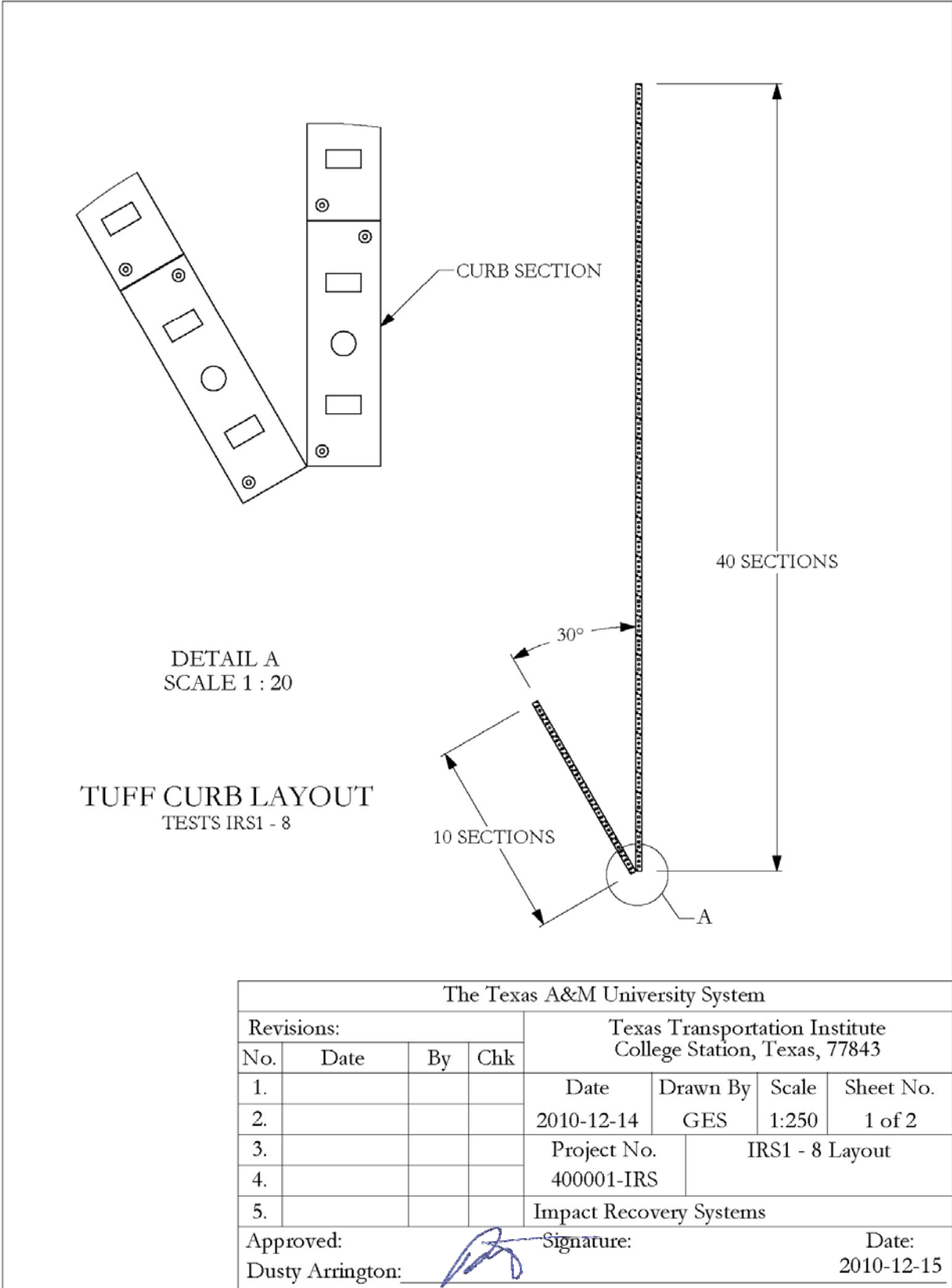
CURBS IN LINE



CURBS IN LINE WITH COUPLER

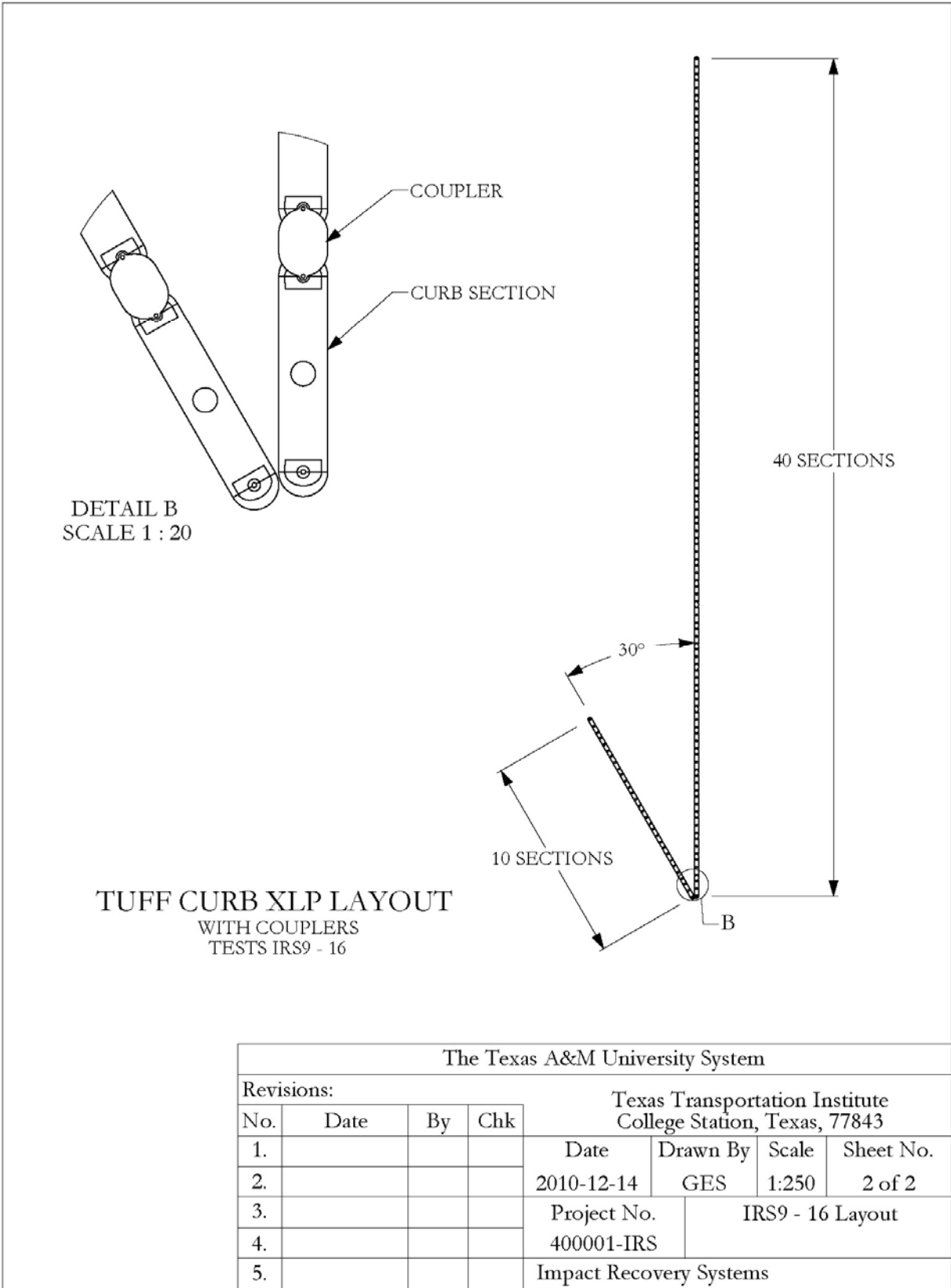
IMPACT recovery SYSTEMS
 "Impacting Today's Roads for a Safer Tomorrow"

SIZE A	PART NO.	DWG. Tuff Curb XLP Assembly	REV A
SCALE	IMPACT RECOVERY SYSTEMS, INC.		DATE 03-01-11

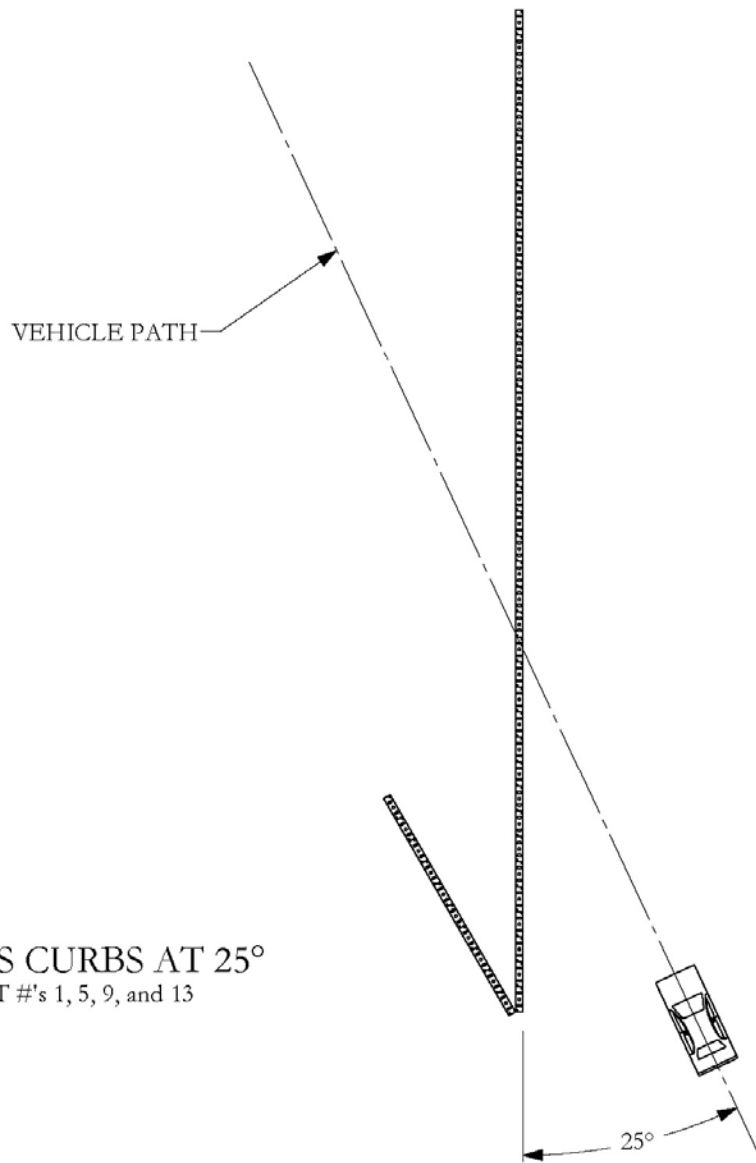


The Texas A&M University System							
Revisions:				Texas Transportation Institute College Station, Texas, 77843			
No.	Date	By	Chk	Date	Drawn By	Scale	Sheet No.
1.				2010-12-14	GES	1:250	1 of 2
2.				Project No.		IRS1 - 8 Layout	
3.				400001-IRS			
4.				Impact Recovery Systems			
5.							
Approved: Dusty Arrington:				Signature:		Date: 2010-12-15	

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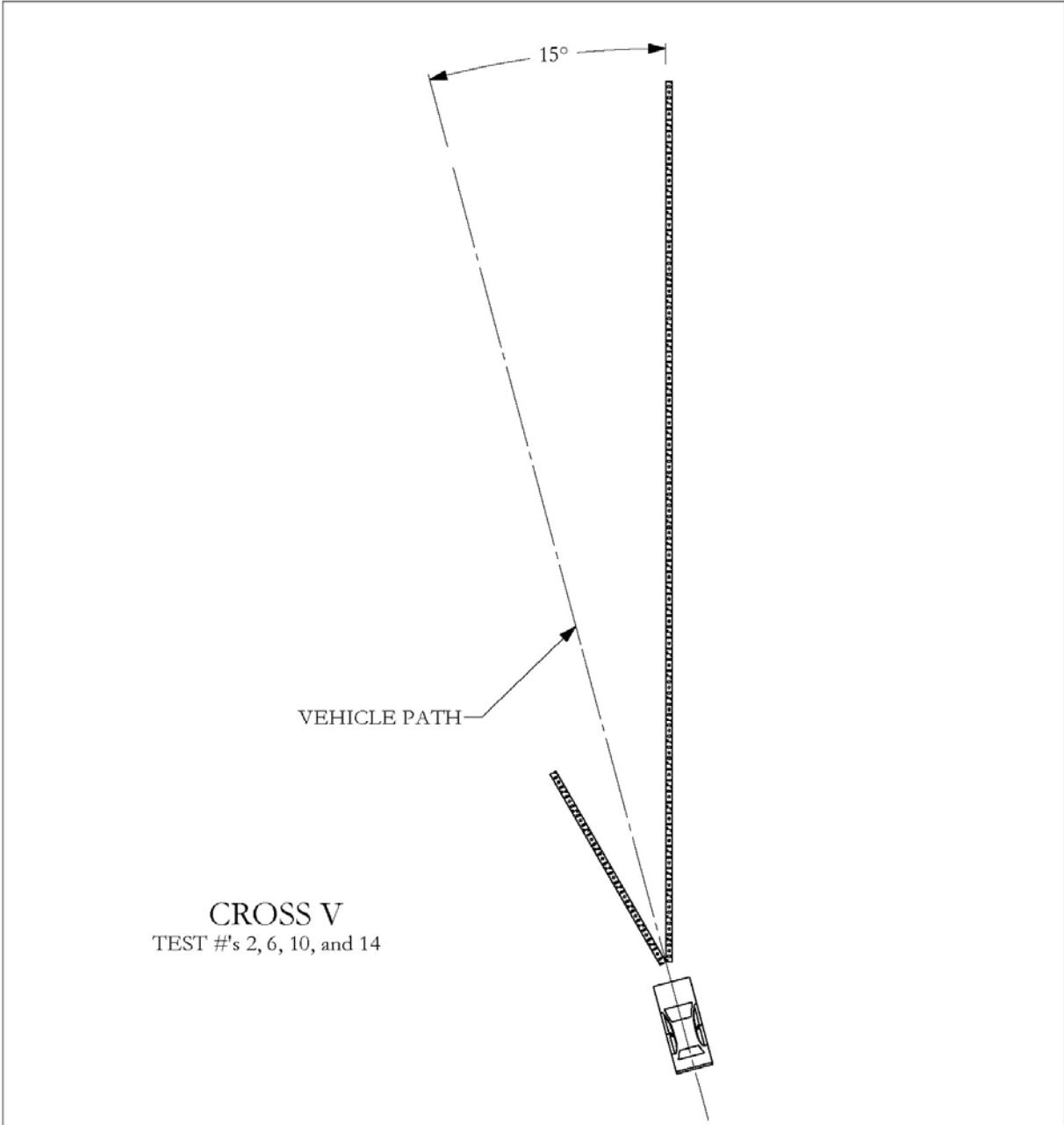
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CROSS CURBS AT 25°
TEST #'s 1, 5, 9, and 13

The Texas A&M University System							
Revisions:				Texas Transportation Institute College Station, Texas, 77843			
No.	Date	By	Chk	Date	Drawn By	Scale	Sheet No.
1.				2010-12-15	GES	1:250	1 of 4
2.				Project No.		25°	
3.				400001-IRS			
4.				Impact Recovery Systems			
5.							
Approved: Dusty Arrington:				Signature:			Date: 2010-12-15

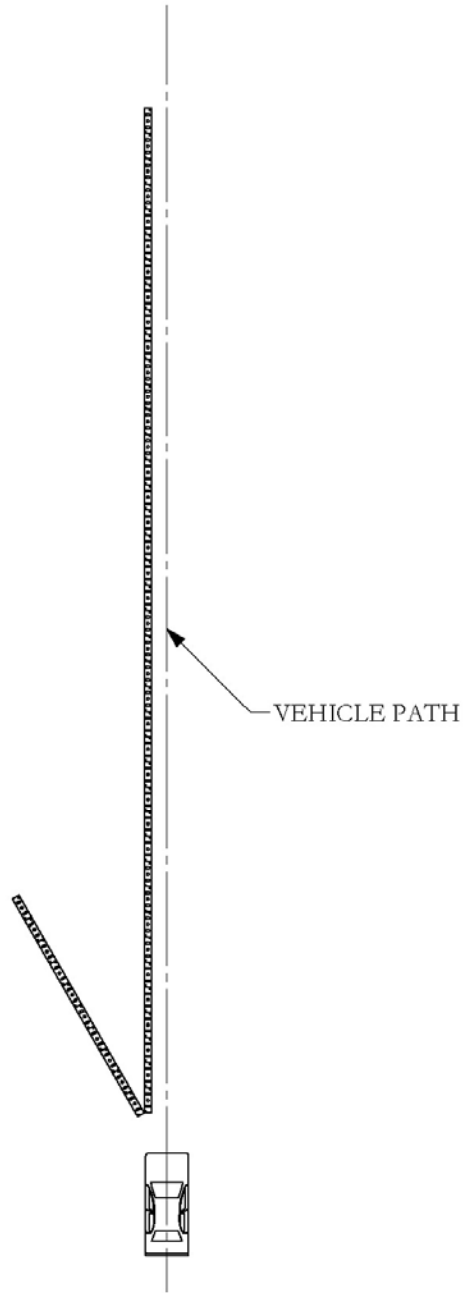
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The Texas A&M University System							
Revisions:				Texas Transportation Institute College Station, Texas, 77843			
No.	Date	By	Chk	Date	Drawn By	Scale	Sheet No.
1.				2010-12-15	GES	1:250	2 of 4
2.							
3.				Project No.	V		
4.				400001-IRS			
5.				Impact Recovery Systems			

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DRIVER'S SIDE TIRE ON CURBS
 TEST #'s 3, 7, 11, and 15

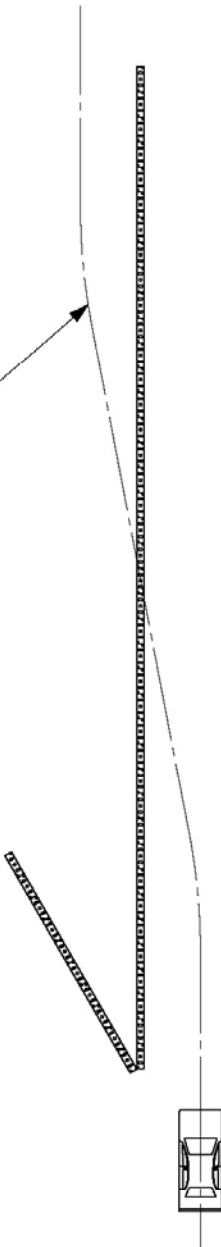


The Texas A&M University System							
Revisions:				Texas Transportation Institute College Station, Texas, 77843			
No.	Date	By	Chk	Date	Drawn By	Scale	Sheet No.
1.				2010-12-15	GES	1:250	3 of 4
2.							
3.				Project No.	0°		
4.				400001-IRS			
5.				Impact Recovery Systems			

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VEHICLE PATH

LANE CHANGE
TEST #'s 4, 8, 12, and 16



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1.				2010-12-15	GES	1:250	4 of 4
2.				Project No.		Lane Change	
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5.							

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