TEST REPORT FOR:

Virginia Department of Transportation

ET-Plus 50’ (15.24 m) System 4” Channel

PREPARED FOR:

Virginia Department of Transportation

1401 E. Broad St.

Richmond, VA 23219

TEST REPORT NUMBER:

TR-P35107-06-NC

REPORT DATE:

November 10, 2015

TEST DATE:

October 2, 2015

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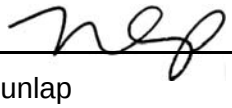
Approved By: 

Mr. Michael L. Dunlap
Director of Operations

Approval Date: November 10, 2015

REVISION CONTROL LOG

TR-P35107-06

Revision	Date	Description
-NC	11/10/15	Original Test Report

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SECTION 1
INTRODUCTION

1.1 OBJECTIVES

The objective of this crash test was to evaluate the impact performance of the Trinity Highway Products ET-Plus 50’ (15.24 m) System 4” Channel. This report presents the results of one (1) full-scale crash test conducted on one ET-Plus 50’ (15.24 m) System. For this test, the terminal section was installed on the front end of a 34.3 m (112.5 ft.) length of guardrail.

The test was conducted in accordance with instructions provided by the Virginia Department of Transportation.

1.2 TEST FACILITY

This test was conducted at KARCO Engineering’s test facility in Adelanto, California. The tow road is a continuous level surface constructed of reinforced concrete and measures 850 ft. long by 14 ft. wide by 6 in. thick. A steel rail is embedded in the road to provide vehicle guidance. Vehicle tow propulsion is provided by a 1 ton truck using a 1-to-2 pulley system. The test vehicle is towed to within 25 ft. of the barrier by a nylon rope clamped to a 3/8 in. steel cable. The clamp is released from the cable on contact with a cable release mechanism positioned to allow the test vehicle to proceed under its own momentum for a maximum of 25 ft. before impacting the barrier.

1.3 TEST ARTICLE

The ET-Plus 50’ (15.24 m) System 4” Channel is a guardrail terminal / end treatment. The as-tested ET-Plus 50’ (15.24 m) System consisted of one (1) ET-Plus 4” Channel Guardrail Extruder Head, one (1) Hinged Breakaway (HBA) post, seven (7) Steel Yielding Terminal Posts (SYTP), one (1) standard I-beam line post, two (2) rail panels, and one (1) cable anchor assembly. The terminal section was installed with a 50:1 flare and a rail height ranging from 705 mm (27.75 in.) to 730 mm (28.75 in.) per Virginia Department of Transportation (VDOT) Road and Bridge Standards.

The first post of the terminal section was a Hinged Breakaway (HBA) post. The HBA post consists of two (2) parts: one (1) 1.8 m (5.8 ft.) long HBA bottom post and one (1) 0.7 m (2.4 ft.) long (1) HBA top post. The HBA posts are constructed of W6 x 8.5 I-beam and have a set of two (2) 13 mm (0.5 in.) thick tabs welded to one end. The posts are connected to each other at the tabs by two (2) 0.375” diameter x 2” long hex head bolt, washer, lock washer, and nut; and two (2) 0.75” diameter x 2.5” long hex head bolt, washer, lock washer, and nut. The HBA bottom post is embedded in the soil foundation and the HBA top post stands above grade.

Posts 2 – 8 were Steel Yielding Terminal Posts (SYTP) and post 9 was a standard line post. All SYTP posts and the standard line post measure 1.8 m (6.0 ft.) long and are constructed of W6 x 8.5 I-beam. A 3" x 3" angle iron strut was bolted to and connected the bases of posts 1 and 2. The strut was attached to post 1 by the 0.75" diameter x 2.5" long hex head bolt, washer, lock washer, and nut which linked the HBA top post to the HBA bottom post. The strut was attached to post 2 by two (2) 0.4375" diameter x 1.5" long hex bolts, flat washers, lock washers, and nuts.

Two (2) 7.6 m (25.0 ft.) long rail panels are mounted to the posts of the terminal section with the splice located at post 5. The rail panels are constructed of 12 Ga W-beam guardrails. The first rail panel is mounted to the first SYTP post via a 0.625" diameter x 1.25" long H.G.R bolt, washer, and nut. 191 mm (7.5 in.) plastic offset blocks are placed between the remainder of the terminal's SYTP posts and the rail panels. One (1) 0.625" diameter x 10" H.G.R. long bolt, washer, and nut is used to mount the rail to each of the SYTP posts with offset blocks. The rail is not mounted to the HBA post. The posts were spaced at a nominal distance of 1.9 m (6.25 ft.) The as-tested length of the ET-Plus 50' (15.24 m) System from post 1 to post 9 was 15.2 m (49.9 ft.).

The ET-Plus 4" Channel Guardrail Extruder Head is installed over the front rail panel and is mounted to the HBA top post by two (2) 0.375" diameter x 1.5" hex head bolts, washers, fender washers, and nuts. The cable anchor assembly anchors the rail panel to the base of the HBA post with a 19 mm (0.75 in.) thick steel cable. The upper end of the cable attaches to the rail via the cable anchor bracket which hooks onto the rail panel. The lower end of the cable is attached to the 16 mm (0.625 in.) thick bearing plate which is hooked onto the HBA post. Each end of the cable is secured by a 1" hex nut and washer which is tightened until the cable is taut.

For this test, the ET-Plus 50' (15.24 m) System was adjoined to the end of a 34.3 m (112.5 ft.) length of guardrail, measured from post 9 to post 27. The adjoining guardrail included a 3.8 m (12.5 ft.) long trailing end terminal treatment, measured from post 25 to post 27. The terminal's adjoining barrier consisted of seventeen (17) 1.8 m (6.0 ft.) long W6 x 8.5 standard I-beam line posts, one (1) 8" x 6" wood post with a soil plate and steel foundation tube, four (4) 7.6 m (25.0 ft.) long 12 Ga W-beam rail panels, one (1) 3.8 m (12.5 ft.) long 12 Ga W-beam rail panel, and one (1) cable anchor assembly. 191 mm (7.5 in.) plastic offset blocks were on all posts except the last wooden post. All of the posts, rails, and plastic offset blocks were fastened in the same manner as the SYTP posts of the ET-Plus Terminal.

With the exception of the trailing end terminal wooden post, the posts were installed by drilling 0.3 m (1.0 ft.) diameter by 0.3 m (1.0 ft.) deep pilot holes and driving the posts into the soil. The trailing end terminal wooden post was installed by drilling a 0.6 m (2.0 ft.) diameter hole and backfilling and compacting the surrounding soil with a pneumatic tamper.

Photographs of the as-tested unit and installation are available in Appendix A of this report. The installation instructions are included on KARCO CD-R 2015-3627.

SECTION 2

TEST PROCEDURE AND INSTRUMENTATION SUMMARY

2.1 TEST PROCEDURE

To meet the recommended properties of the NCHRP 350 test vehicle requirements, a commercially available production model test vehicle was selected. The test vehicle was in free of major body damage and was not missing any structural components. The bumpers were standard equipment and were not modified for this test. All fluids were drained and the battery was removed.

The NCHRP 350 recommended test vehicle properties are shown in Table 1. The 2000P test vehicle was used for this test. The 2000P test vehicle used for this test was a front engine model with rear wheel drive and an automatic transmission.

Table 1. Recommended Properties of 700C, 820C and 2000P Test Vehicles

PROPERTY	700C (Small Car)	820C (Small Car)	2000P (Pickup Truck)
MASS (kg)			
Test Inertial	700 ± 25	820 ± 25	2000 ± 45
Dummy	75	75	---
Maximum Ballast	70	80	200
Gross Static	775 ± 25	895 ± 25	2000 ± 45
DIMENSIONS (cm)			
Wheelbase	230 ± 10	230 ± 10	335 ± 25
Front Overhang	75 ± 10	75 ± 10	80 ± 10
Overall Length	370 ± 20	370 ± 20	535 ± 25
Track Width (average)	135 ± 10	135 ± 10	165 ± 15
CENTER OF MASS LOCATION (cm)			
Aft of Front Axle	80 ± 15	80 ± 15	140 ± 15
Above Ground	55 ± 5	55 ± 5	70 ± 5
LOCATION OF ENGINE	Front	Front	Front
LOCATION OF DRIVE AXLE	Front	Front	Rear
TYPE OF TRANSMISSION	Manual or Automatic	Manual or Automatic	Manual or Automatic

2.2 CRASH TEST SET UP

A full-scale crash test was conducted to evaluate the impact performance of the ET-Plus 50' (15.24 m) System. The test conditions were as follows: A 2000 kg (4409 lb.) pickup truck approaching the test article at a nominal speed of 100 km/h (62 mph) with a critical impact angle of 5°. The test article was installed so that the vehicle centerline intersected the leading edge of the W-beam rail.

2.3 TEST INSTRUMENTATION AND DATA ACQUISITION PROCEDURES

All data acquisition for this certification test was performed in accordance with the NCHRP 350 Recommended Procedure requirements.

2.3.1 Test Vehicle Instrumentation: The test vehicle was instrumented with one (1) tri-axial accelerometer and one tri-axial angular rate sensor. Both the accelerometer and the angular rate sensor were installed with a 5 cm radial of the vehicle's longitudinal and lateral center of gravity. The accelerometers measured longitudinal (x), lateral (y) and vertical (z) acceleration. The angular rate sensors measured vehicle roll, pitch and yaw. Data was recorded using the on-board TDAS. Data was linked to a personal computer and processed using the TDAS Control software. All equipment used in this test meets the requirements of SAE J211.

2.3.1.2 Calibration: All instrumentation used in this test has been calibrated through standards traceable to NIST and is maintained in a calibrated condition.

2.3.2 TDAS Software: The software utilized in this system is written in National Instruments Lab Windows/CVI (C, Visual Interface) programming language, which is a Windows based software package with emphasis on ease of use and good engineering test practices.

2.3.3 SAE Compatibility: The software contains standard point and click processing options for selecting Society of Automotive Engineers (SAE) class post filters and calculating the required integrals, resultants, Head Injury Criteria (HIC), clips, and other data processing parameters that may be required.

2.3.4 Measurement Uncertainty: Measurement uncertainties have been determined for pertinent values affecting the results of this test. KARCO maintains these uncertainty budgets, which are available upon request, but are not included in this report. In certain cases the nature of the test method may preclude rigorous and statistically valid calculation of uncertainty of measurement. In these cases KARCO attempts to identify the components of uncertainty and make a reasonable estimation. Reasonable estimation is based on knowledge of the performance of the method and on the measurement scope and makes use of, for example, previous experience and validation data.

2.3.5 Photographic Documentation: Photographic documentation of this test included a minimum of two (2) real-time video camera at 30 frames per second (fps), and four (4) high-

speed color digital video cameras at 1000 fps All high-speed cameras were activated by a pressure-sensitive tape switch, which was positioned on the test article to indicate the instant of contact (time zero). A digital still camera was used for documenting the pre- and post-test condition of the test vehicle and the ET-Plus 50’ (15.24 m) System.

2.3.6 Anthropomorphic Test Device: An Anthropomorphic Test Device (ATD) was not used for this test.

SECTION 3
TEST RESULTS

This 100 km/h (62 mph) impact crash test was conducted using a 2003 Chevrolet 2500 pickup truck to evaluate the impact performance of the ET-Plus 50’ (15.24 m) System 4” Channel. The test article installed at an angle of 5° relative to the test vehicle’s direction of travel, with the vehicle centerline intersecting the leading edge of the W-beam rail. This crash test was documented by two (2) real-time and four (4) high-speed video cameras. Pre- and post-test photographs of the test vehicle and test article can be found in Appendix A.

The test was conducted on October 2, 2015. The as-tested test inertial weight of the vehicle was 2044.5 kg (4507.3 lbs.). The height of the front bumper was 385 mm (15.2 in.) to the lower edge and 835 mm (32.9 in.). Additional dimensions and test vehicle information are presented in Data Sheets No. 1 and 2.

The test vehicle impacted the ET-Plus 50’ (15.24 m) System at a velocity of 102.13 km/h (63.46 mph). The test vehicle impacted the ET-Plus extruder head and pushed it down the guardrail past the HBA post and the first SYTP post. Shortly after the extruder head passed the first SYTP post, the rail kinked and the vehicle proceeded toward the non-traffic side of the guardrail. The vehicle’s left front tire impacted the second SYTP post and rolled toward its passenger side. The vehicle landed back on its wheels and rotated counter clockwise back toward the guardrail. The vehicle reengaged with the guardrail and rolled 360° toward its passenger side before landing back on its wheels, on top of the guardrail. The test vehicle came to rest approximately 47.0 m (154.1 ft.) forward and 2.9 m (9.5 ft.) left of its position at the point of impact. An overhead illustration of the test vehicle and test article in their pre-test and post-test conditions is shown in Figure 62 in Appendix D. Sequential photographs of the test sequence are shown on Data Sheet 4.

The vehicle sustained damage to the front end, roof, and across the length of the driver side of the vehicle as a result of the impact with the ET Plus 50’ (15.24 m) System. The left front tire was flattened and detached from its axle. The left rear tire was also flattened. The occupant compartment was not penetrated as a result of the impact.

A summary of the electronic data is presented in Data Sheet No. 7; data plots are presented in Appendix B.

SECTION 4

DATA SHEETS

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15

CONVERSION FACTORS

Quantity	Typical Application	Std Units	Metric Unit	Multiply By
Mass	Vehicle Weight	lb	kg	0.4536
Linear Velocity	Impact Velocity	miles/hr	km/hr	1.609344
Length or Distance	Measurements	in	mm	25.4
Volume	Fuel Systems	gal	liter	3.785
Volume	Small Fluids	oz	mL	29.574
Pressure	Tire Pressures	lbf/in^2	kPa	6.895
Temperature	General Use	^oF	^oC	=(Tf -32)/1.8
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET 1

TEST VEHICLE INFORMATION

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15

TEST VEHICLE INFORMATION

Make	Chevrolet	Cylinders	V8
Model	2500	Engine Displacement (L)	6.0
Body Style	2-Door Truck	Engine Placement	Longitudinal
VIN	1GCC24UX3E302681	Fuel Type	Gasoline
Color	White	Transmission	Automatic
Odometer Reading (mi)	142,348	Final Drive	Rear
Previous Damage to Vehicle		Minor dents and scratches	

DATA FROM CERTIFICATION LABEL

Manufactured By	General Motors Corp	GVWR (kg)	4173
		GAWR Front (kg)	2000
Date of Manufacture	Apr-03	GAWR Rear (kg)	2760

TEST VEHICLE WEIGHTS

	As Received (kg)			Test Inertial (kg)			Gross Static (kg)		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	653.0	542.0	1195.0	607.0	427.5	1034.5	607.0	427.5	1034.5
Right	659.0	491.0	1150.0	624.0	386.0	1010.0	624.0	386.0	1010.0
Ratio (%)	55.9	44.1	100.0	60.2	39.8	100.0	60.2	39.8	100.0
Total	1312.0	1033.0	2345.0	1231.0	813.5	2044.5	1231.0	813.5	2044.5

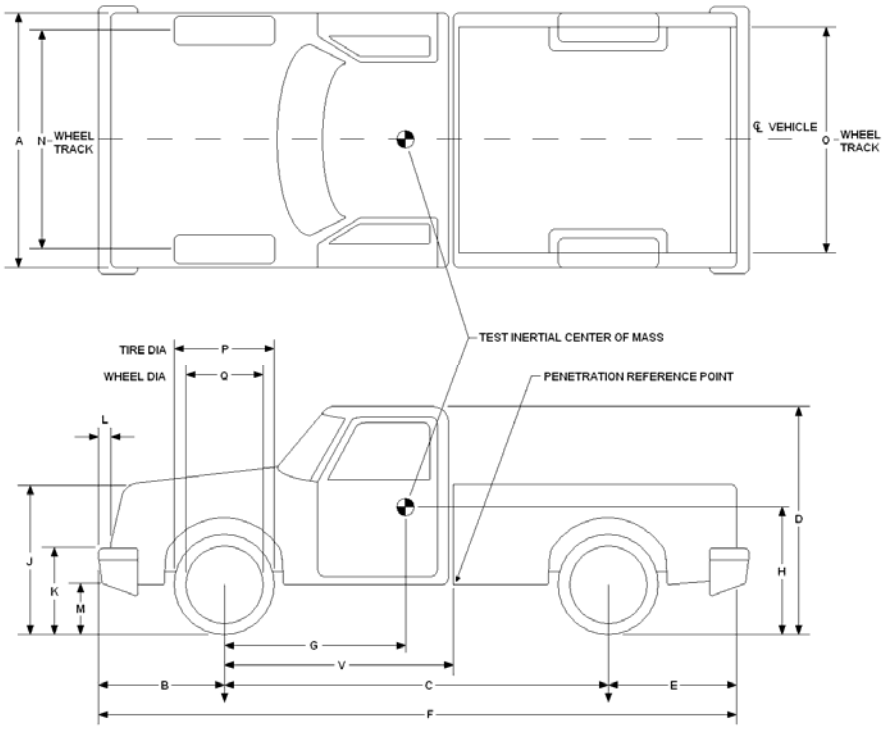
	As Received (lb)			Test Inertial (lb)			Gross Static (lb)		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	1439.6	1194.9	2634.5	1338.2	942.5	2280.7	1338.2	942.5	2280.7
Right	1452.8	1082.5	2535.3	1375.7	851.0	2226.7	1375.7	851.0	2226.7
Ratio (%)	55.9	44.1	100.0	60.2	39.8	100.0	60.2	39.8	100.0
Total	2892.4	2277.4	5169.8	2713.9	1793.5	4507.4	2713.9	1793.5	4507.4

DATA SHEET 2

TEST VEHICLE GEOMETRY

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15



TEST VEHICLE GEOMETRY

	mm	in.		mm	in.		mm	in.		mm	in.
A	2000	78.7	E	1138	44.8	J	810	31.9	N	1715	67.5
B	970	38.2	F	5488	216.1	K	835	32.9	O	1675	65.9
C	3380	133.1	G	2350	92.5	L	85	3.3	P	750	29.5
D	1925	75.8	H	748	29.4	M	385	15.2	Q	441	17.4

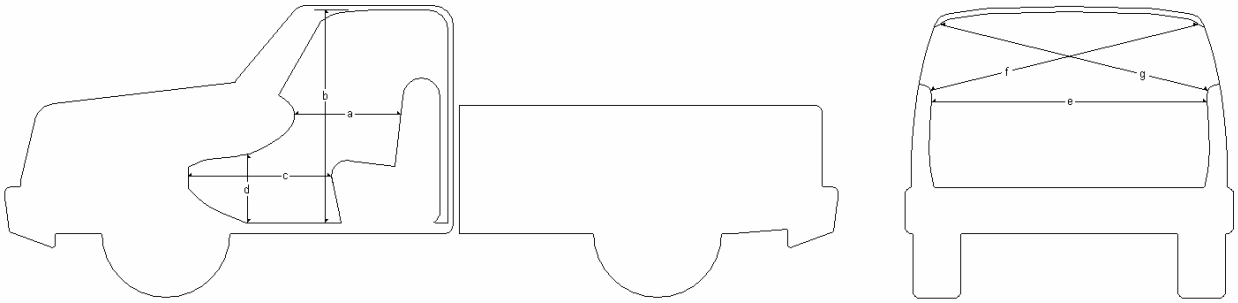
DATA SHEET 3

OCCUPANT COMPARTMENT DEFORMATION INDEX

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15

The seven subindicies a, b, c, d, e, f and g indicate the percentage of reduction of seven interior dimensions shown on the following figure:



where,

a = distance between the dashboard and a reference point at the rear of the occupant compartment, such as top of rear seat, or the rear part of the cab on a pickup;
b = distance between the roof and the floor panel;
c = distance between a reference point at the rear of the occupant compartment and the motor panel;
d = distance between the lower dashboard and the floor panel;
e = interior width;
f = distance between the lower edge of right window and the upper edge of left window; and
g = distance between the lower edge of left window and the upper edge of right window

Sub-Indices	Pre-Test		Post-Test		Percent Reduction
	mm	in.	mm	in.	
A	1042	41.0	1043	41.1	-0.10%
B	1115	43.9	1070	42.1	4.04%
C	1431	56.3	1443	56.8	-0.84%
D	389	15.3	386	15.2	0.77%
E	1655	65.2	1783	70.2	-7.73%
F	1540	60.6	1643	64.7	-6.69%
G	1540	60.6	1603	63.1	-4.09%
Max Deformation	1115	43.9	1070	42.1	4.04%
OCDI	FS0100000				
Comments:	None				

DATA SHEET 4

SUMMARY OF RESULTS

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No.: P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15


0 ms


540 ms


1080 ms


1620 ms


2160 ms


2700 ms


3240 ms

GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO Engineering, LLC.	FLAIL SPACE VELOCITY (m/s)	
TEST ARTICLE		X DIRECTION	4.9
TYPE	Terminal	Y DIRECTION	0.9
TERMINAL LENGTH[1]	15.2 m (49.9 ft.)	THIV (Optional) (m/s)	5.0
ADJOINING BARRIER LENGTH[2]	34.3 m (112.5 ft.)	RIDEDOWN ACCELERATION (g)	
TEST VEHICLE		X DIRECTION	-12.5
TYPE	Production Model	Y DIRECTION	7.1
DESIGNATION	2000P	PHD (Optional) (g)	13.5
MODEL	Chevrolet 2500	ASI (Optional)	0.47
MASS (CURB)	2345.0 kg (5169.8 lbs)	**VEHICLE DAMAGE**	
MASS (TEST INERTIAL)	2044.5 kg (4507.4 lbs)	INTERIOR	
MASS (GROSS STATIC)	2044.5 kg (4507.4 lbs)	OCDI	FS0100000
IMPACT CONDITIONS		**POST-IMPACT VEHICULAR BEHAVIOR**	
VELOCITY (km/h)	102.13 km/h (63.46 mph)	MAXIMUM ROLL ANGLE (°)	332.8
ANGLE (°)	5.0	MAXIMUM PITCH ANGLE (°)	-56.0
IMPACT SEVERITY (kJ)	822.5	MAXIMUM YAW ANGLE (°)	-99.2

[1] Terminal Length measured from Post 1 to Post 9
[2] Adjoining Barrier Length measured from Post 9 to Post 27

DATA SHEET 5

IMPACT CONDITIONS

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15

Item	Value	
Test Time	10:04 AM	
Temperature (°C)	22.2	*
Wind Velocity (km/h)	0.0	*
Wind Direction		*
Impact Speed (km/h)	102.13	

*Information provided for reference only

DATA SHEET 6

TEST DATA SUMMARY

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 10/02/15

TEST VEHICLE DATA SUMMARY

Tested Parameter	Axis	Units	Max	Time (ms)	Min	Time (ms)
Vehicle Impact Velocity	X	m/s	28.4			
Flail Space Velocity	X	m/s	4.9	181.7		
Flail Space Velocity	Y	m/s	0.9	181.7		
Ridedown Acceleration	X	g	10.6	254.2	-12.5	243.8
Ridedown Acceleration	Y	g	7.1	250.0	-4.5	286.8

TEST VEHICLE ACCELEROMETER PEAK DATA

Location	Axis	Units	Max	Time (ms)	Min	Time (ms)
Vehicle CG	X	g	10.7	252.8	-15.5	239.8
Vehicle CG	Y	g	11.0	2924.4	-6.9	278.8
Vehicle CG	Z	g	30.5	257.3	-42.4	262.4

APPENDIX A
PHOTOGRAPHS

LIST OF PHOTOGRAPHS

LIST OF PHOTOGRAPHS … (CONTINUED)

FIGURE 1. Test Article, As Received

FIGURE 2. Test Article, As Received

FIGURE 3. Test Vehicle, As Received

FIGURE 4. Test Vehicle, As Received

FIGURE 5. Test Setup

FIGURE 6. Test Setup Close-Up

FIGURE 7. Test Setup

FIGURE 8. Test Setup Close-Up

FIGURE 9. Test Setup

FIGURE 10. Test Setup Close-Up

FIGURE 11. Test Setup

FIGURE 12. Test Setup Close-Up

FIGURE 13. Test Setup

FIGURE 14. Test Setup Close-Up

FIGURE 15. Pre-Test

FIGURE 16. Post-Test

FIGURE 17. Post-Test

FIGURE 18. Post-Test

FIGURE 19. Pre-Test Front View of Test Article

FIGURE 20. Post-Test Front View of Test Article

FIGURE 21. Pre-Test Right Front ¾ View of Test Article

FIGURE 22. Post-Test Right Front ¾ View of Test Article

FIGURE 23. Pre-Test Right View of Test Article

FIGURE 24. Post-Test Right View of Test Article

FIGURE 25. Pre-Test Right Rear ¾ View of Test Article

FIGURE 26. Post-Test Right Rear ¾ View of Test Article

FIGURE 27. Pre-Test Rear View of Test Article

FIGURE 28. Post-Test Rear View of Test Article

FIGURE 29. Pre-Test Left Rear ¾ View of Test Article

FIGURE 30. Post-Test Left Rear ¾ View of Test Article

FIGURE 31. Pre-Test Left View of Test Article

FIGURE 32. Post-Test Left View of Test Article

FIGURE 33. Pre-Test Left Front ¾ View of Test Article

FIGURE 34. Post-Test Left Front ¾ View of Test Article

FIGURE 35. Test Article Damage

FIGURE 36. Test Article Damage

FIGURE 37. Test Article Damage

FIGURE 38. Test Article Damage

FIGURE 39. Test Article Damage

FIGURE 40. Pre-Test Left View of Test Vehicle

FIGURE 41. Post-Test Left View of Test Vehicle

FIGURE 42. Pre-Test Left Front ¾ View of Test Vehicle

FIGURE 43. Post-Test Left Front ¾ View of Test Vehicle

FIGURE 44. Pre-Test Front View of Test Vehicle

FIGURE 45. Post-Test Front View of Test Vehicle

FIGURE 46. Pre-Test Right Front ¾ View of Test Vehicle

FIGURE 47. Post-Test Right Front ¾ View of Test Vehicle

FIGURE 48. Pre-Test Right View of Test Vehicle

FIGURE 49. Post-Test Right View of Test Vehicle

FIGURE 50. Pre-Test View of Windshield

FIGURE 51. Post-Test View of Windshield

FIGURE 52. Pre-Test View of Driver's Side Occupant Compartment

FIGURE 53. Post-Test View of Driver's Side Occupant Compartment

FIGURE 54. Pre-Test View of Driver's Floorpan

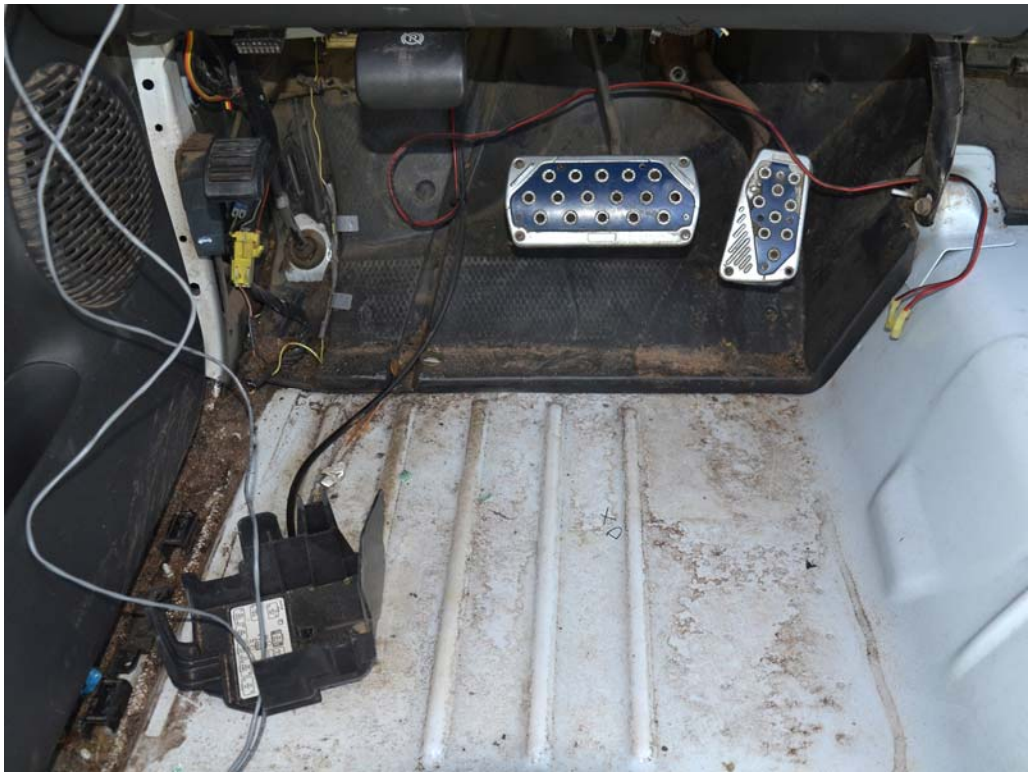


FIGURE 55. Post-Test View of Driver's Floorpan

FIGURE 56. Pre-Test View of Passenger's Side Occupant Compartment

FIGURE 57. Post-Test View of Passenger's Side Occupant Compartment

FIGURE 58. Pre-Test View of Passenger's Floorpan

FIGURE 59. Post-Test View of Passenger's Floorpan

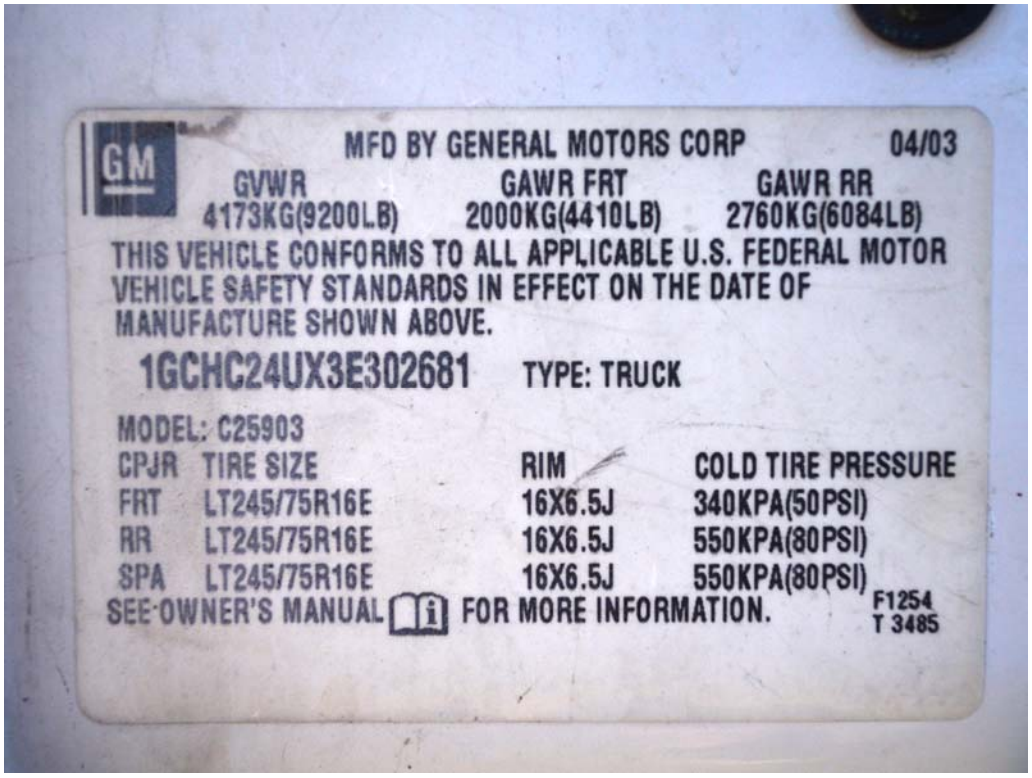


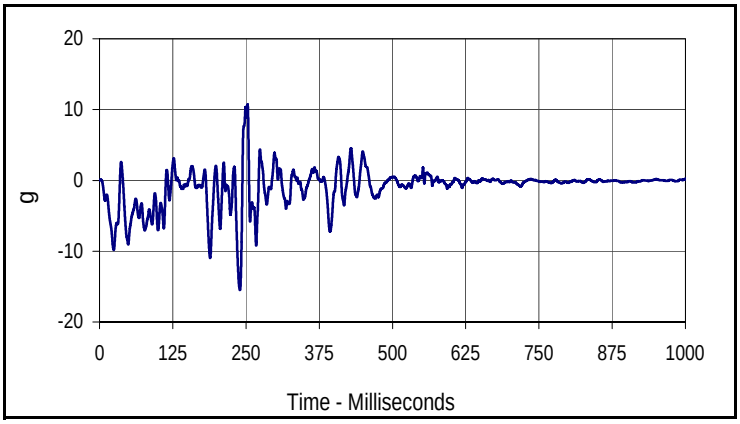
FIGURE 60. Test Vehicle Manufacturer’s Label

APPENDIX B

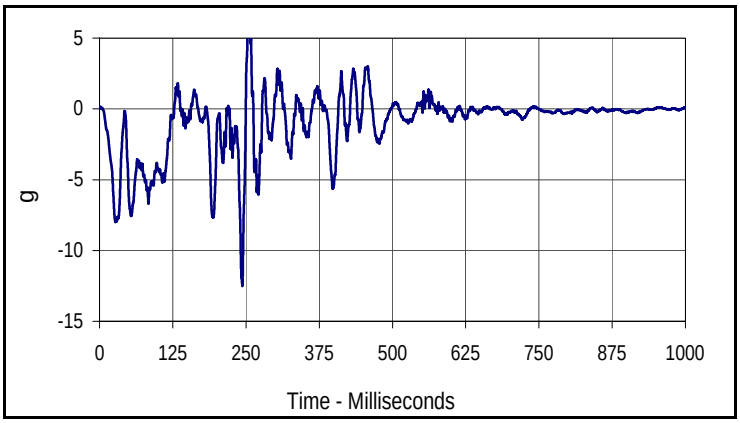
DATA PLOTS

LIST OF DATA PLOTS

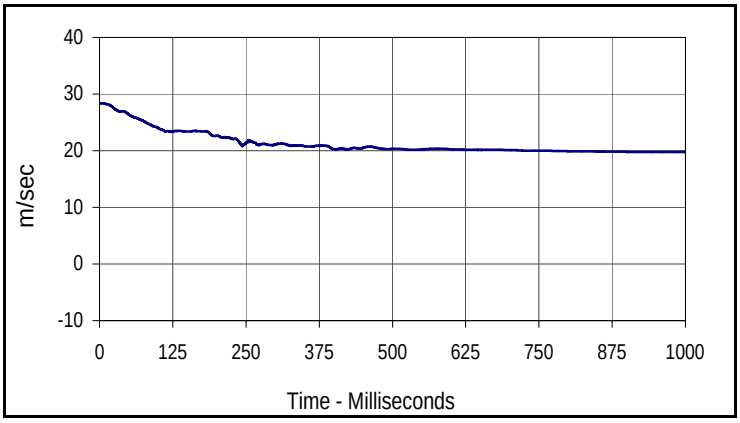
Test Article:	ET-Plus 50' (15.24 m) System 4" Channel	Project No:	P35107-06
Test Program:	100 km/h 5" Guardrail Terminal Impact Test	Test Date.:	10/2/15



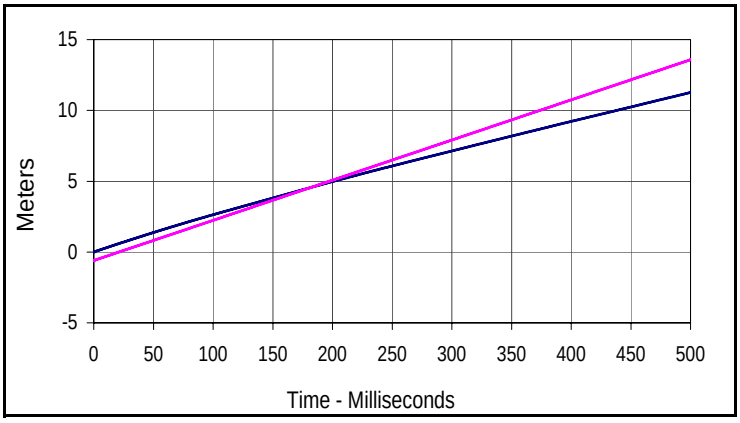
Curve Description			
Test Vehicle CG X			
Plot No.	Type	SAE Class	Units
001	FIL	60	g
Max	Time	Min	Time
10.7	252.8	-15.5	239.8



Curve Description			
Test Vehicle CG X Moving Average			
Plot No.	Type	SAE Class	Units
002	AVG	180	g
Max	Time	Min	Time
10.6	254.2	-12.5	243.8

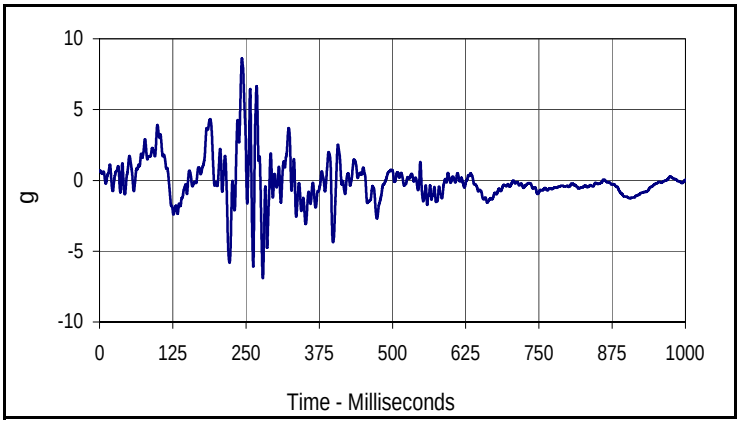


Curve Description			
Test Vehicle CG X Velocity			
Plot No.	Type	SAE Class	Units
003	IN1	180	m/sec
Max	Time	Min	Time
28.4	4.2	8.8	2513.5

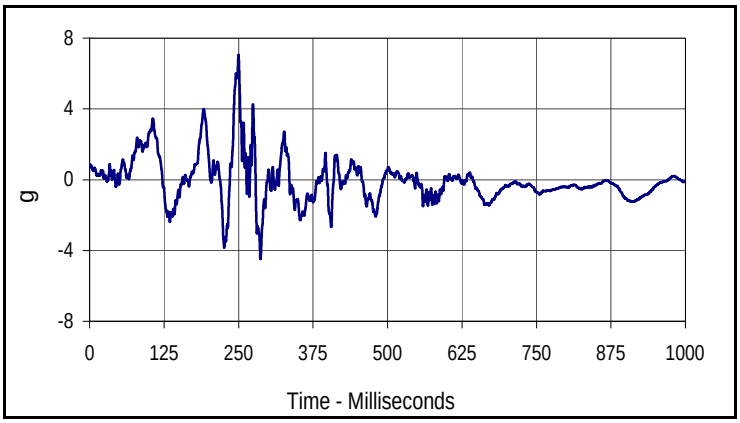


Curve Description			
Test Vehicle CG X Displacement			
Plot No.	Type	SAE Class	Units
004	IN2	180	Meters
Max	Time	Min	Time
103.3	6551.6	0.0	0.0

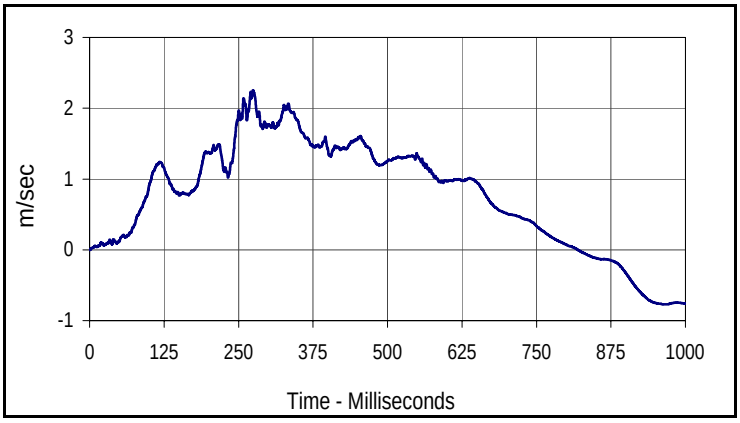
Vehicle CG X Displacement
Occupant X Displacement



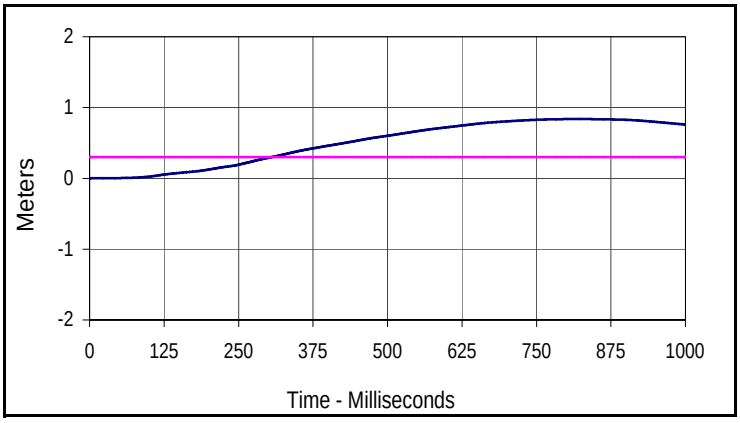
Curve Description			
Test Vehicle CG Y			
Plot No.	Type	SAE Class	Units
005	FIL	60	g
Max	Time	Min	Time
11.0	2924.4	-6.9	278.8



Curve Description			
Test Vehicle CG Y Moving Average			
Plot No.	Type	SAE Class	Units
006	AVG	180	g
Max	Time	Min	Time
7.1	250.0	-4.5	286.8



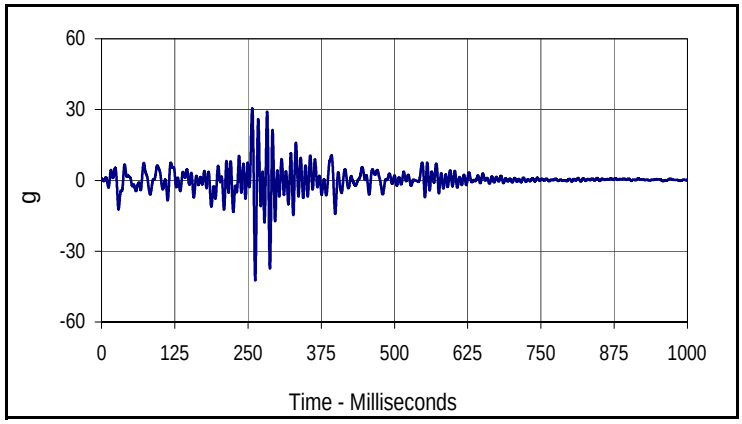
Curve Description			
Test Vehicle CG Y Velocity			
Plot No.	Type	SAE Class	Units
007	IN1	180	m/sec
Max	Time	Min	Time
14.4	6551.6	-12.2	3086.0



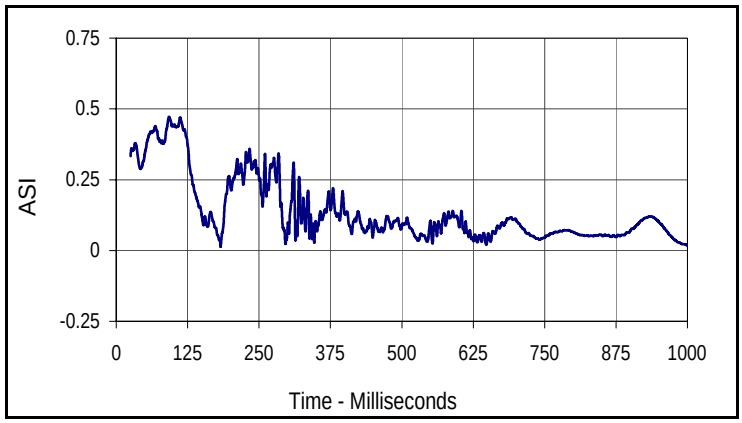
Curve Description			
Test Vehicle CG Y Displacement			
Plot No.	Type	SAE Class	Units
008	IN2	180	Meters
Max	Time	Min	Time
0.8	819.3	-21.0	4330.3

Vehicle CG Y Displacement
Occupant Y Displacement

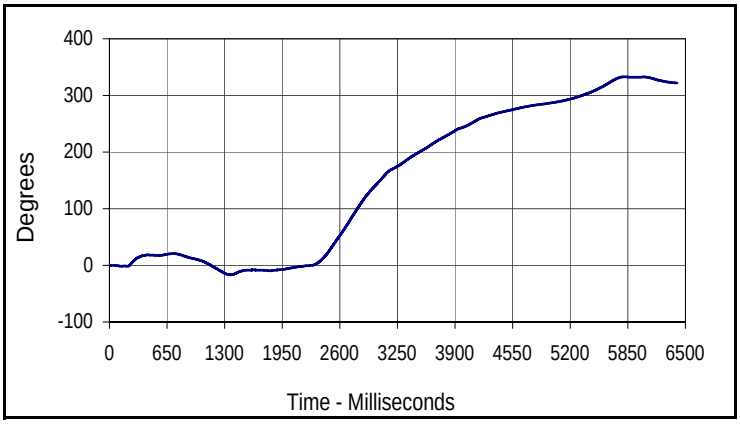
Test Article:	ET-Plus 50’ (15.24 m) System 4” Channel	Project No:	P35107-06
Test Program:	100 km/h 5” Guardrail Terminal Impact Test	Test Date.:	10/2/15



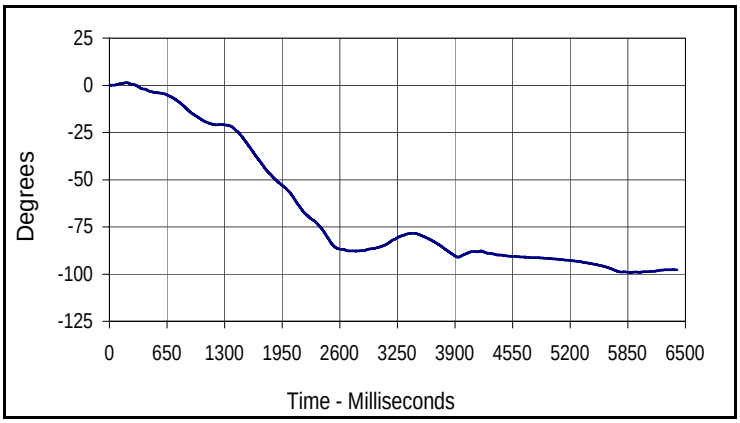
Curve Description			
Test Vehicle CG Z			
Plot No.	Type	SAE Class	Units
009	FIL	60	g
Max	Time	Min	Time
30.5	257.3	-42.4	262.4



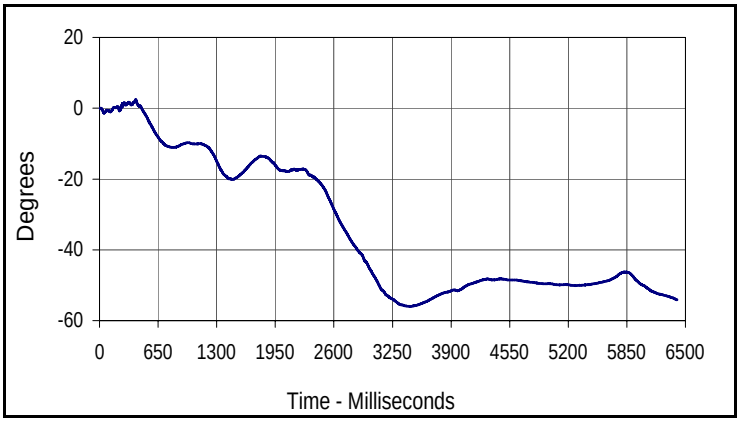
Curve Description			
Test Vehicle Accident Severity Index			
Plot No.	Type	SAE Class	Units
010	ASI	180	ASI
Max	Time	Min	Time
0.5	92.6	0.0	182.8



Curve Description			
Test Vehicle Roll Angle			
Plot No.	Type	SAE Class	Units
011	IN1	180	Degrees
Max	Time	Min	Time
332.8	5804.0	-16.7	1363.1



Curve Description			
Test Vehicle Yaw Angle			
Plot No.	Type	SAE Class	Units
012	IN1	180	Degrees
Max	Time	Min	Time
1.5	193.7	-99.2	5878.0



Curve Description			
Test Vehicle Pitch Angle			
Plot No.	Type	SAE Class	Units
013	IN1	180	Degrees
Max	Time	Min	Time
2.4	399.7	-56.0	3445.2

APPENDIX C
INSTRUMENTATION

DATA ACQUISITION INFORMATION

Test Article: ET-Plus 50’ (15.24 m) System 4” Channel Project No. P35107-06

Test Program: 100 km/h 5° Guardrail Terminal Impact Test) Test Date: 10/02/15

VEHICLE INSTRUMENTATION

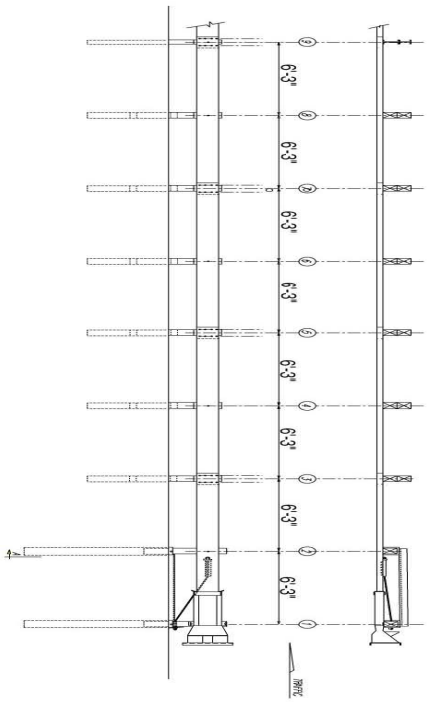
CH	Location	Axis	Ident. No.	Description	MFR	Model	Units
1	Vehicle CG	X	J48139	Accel, Half Bridge	Endevco	2000G	g
2	Vehicle CG	Y	J48135	Accel, Half Bridge	Endevco	2000G	g
3	Vehicle CG	Z	J48123	Accel, Half Bridge	Endevco	2000G	g
4	Vehicle CG	Yaw	ARS8486	Rate Gyro	DTS	ARS-18K	Deg/s
5	Vehicle CG	Pitch	ARS8532	Rate Gyro	DTS	ARS-18K	Deg/s
6	Vehicle CG	Roll	ARS8537	Rate Gyro	DTS	ARS-18K	Deg/s

APPENDIX D

MANUFACTURER DOCUMENTS

LIST OF FIGURES

ET- PLUS™
50' (15.24 m) System
FOR SPECIFIC DETAILS, REFER TO THE TRINITY ET DRAWING(S)
AND THE STATE STANDARD DRAWING(S)



(This represents 1 version of the 50' (15.24 m) system)

NOTES:

1. Alternate to long foundation tube without soil plate is short tube with soil plate at locations 1 and 2, Hinged Breakaway (HBA) Post™ at locations 1 and 2, or Hinged Breakaway (HBA) Post™ at location 1 and Steel Yielding Terminal Post™ (SYTP) at location 2; long foundation tube or short tube with soil plate at location 1 and SYTP at location 2.
2. Alternate to two 12'6" (3.81 m) long rail elements is one 25'0" (7.62 m) long rail element.
3. Short steel foundation tubes without soil plates and breakaway wood posts, or Hinged Breakaway (HBA) Post™ may be specified for locations 3 and 4. Controlled Release Terminal (CRT) posts can be used for post locations 5 through 8.
4. Alternates to Note 3 combinations for locations 3 through 8 are: 1) All short tubes without soil plates and breakaway wood posts; 2) All HBA posts; 3) All CRT posts; 4) All SYTP.

FIGURE 61. Manufacturer's Drawing

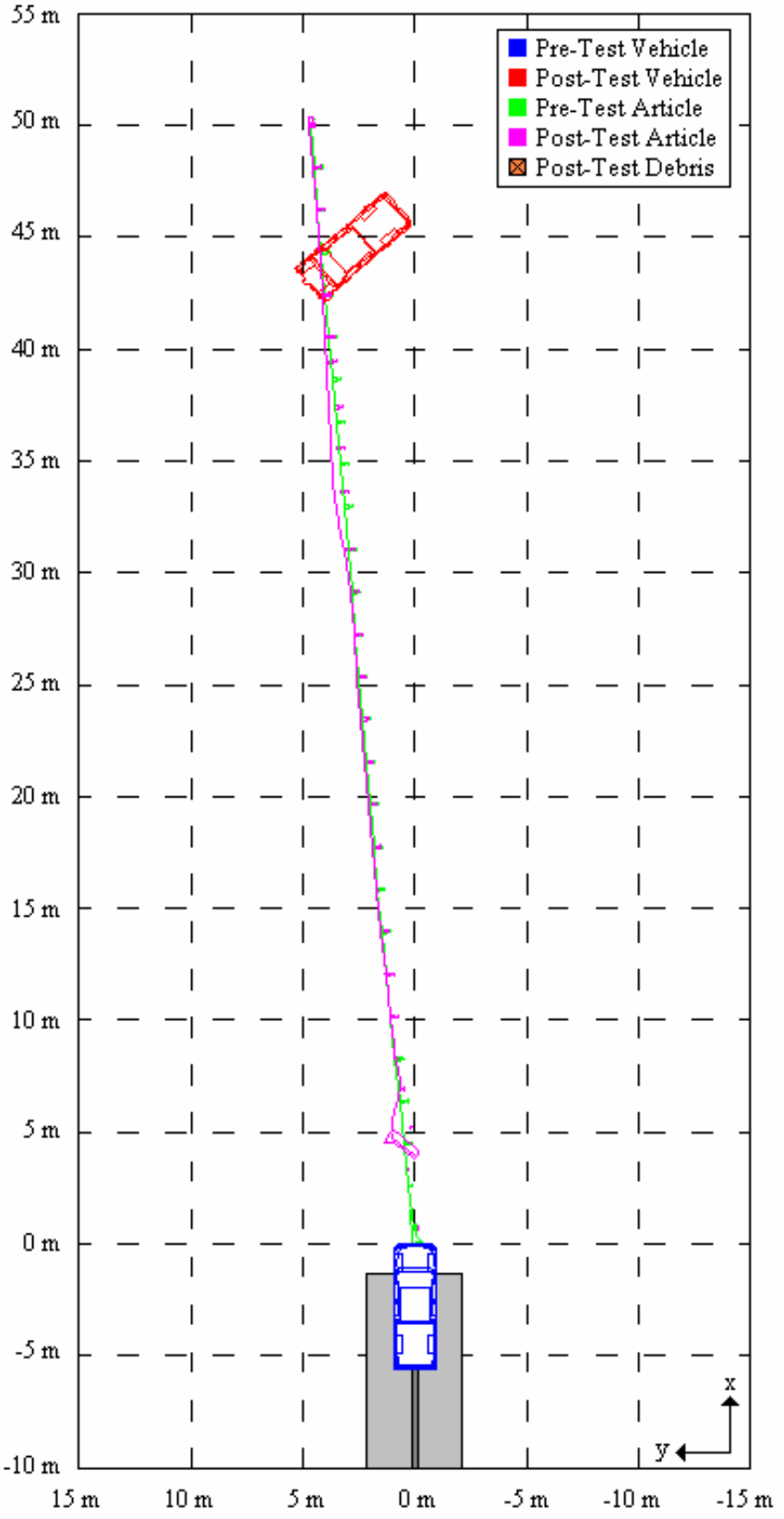


FIGURE 62. Overhead Illustration

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