

TEST REPORT FOR:

**Virginia Department of Transportation
X Lite Tangent 50' (15.24 m) System**



PREPARED FOR:

**Virginia Department of Transportation
1401 E. Broad St.
Richmond, VA 23219**

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SECTION 1

INTRODUCTION

1.1 OBJECTIVES

The objective of this crash test was to evaluate the impact performance of the Lindsay Corporation X Lite Tangent 50' (15.24 m) system. This report presents the results of one (1) full-scale crash test conducted on one X Lite Tangent 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 700 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 Lindsay Corporation X Lite Tangent 50' (15.24 m) System is a standard post guardrail terminal/end treatment. The as-tested X Lite Tangent 50' (15.24 m) System consisted of two (2) crimp posts, one (1) post 2 assembly, ground strut, slider assembly, four (4) W-beam guardrail panels, five (5) standard line posts, six (6) composite blocks, and an impact head. The terminal 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.

Post 1 and 3 each consisted of one (1) 1.8 m (6.0 ft) long post constructed of W6 X 8.5 I-beam with crimps located 820 mm (32.3 in.) down from the top on both of their flanges. Post 2 consisted of one (1) 1.8 m (6.0 ft) long post constructed of W6 X 8.5 I-beam and had one (1) 38 mm (1.5 in.) square angle welded on each flange 660 mm (26.0 in.) from the top. A 457 mm (18.0 in.) tall by 457 mm (18.0 in.) wide by 8 mm (0.3 in.) thick soil plate was bolted to the downstream end of post 2 with two (2) 0.625 in. x 3.5 in. bolts, nuts, and washers. The remaining five posts were 1.8 m (6.0 ft.) long standard line posts composed of W6 x 8.5 I-beam.

A ground strut assembly was set between post 1 and post 2. The ground strut was composed of two (2) 2.2 m (7.1 ft.) long, 14 mm (0.6 in) diameter rods. The rods were attached

to post 1 with a 213 mm (8.375 in.) strut square angle with a thickness of 6 mm (0.25 in.). The rods were fastened to both posts with four (4) 16 mm (0.625 in.) diameter nuts.

A front slider panel 371 mm (14.625 in.) long by 3 mm (0.125 in.) thick was mounted at post 3 on the traffic side of the W-beam guardrail with four (4) 0.625 in. x 2.0 in. guardrail bolts and nuts. The slider bracket and slider panel were also mounted at post 3 between the W-beam guardrail and composite block. The slider bracket was 549 mm (21.625 in.) long by 6 mm (0.25 in.) thick and had a 64 mm (2.5 in.) square tube welded on the backside through which the cable anchor was routed. The slider panel was 445 mm (17.5 in.) long by 270 mm (10.625 in.) tall by 5 mm (0.19 in.) thick. The slider panel and composite block were mounted to post 3 with a 0.625 in. x 10 in. long bolt and a 25 mm (1.0 in.) washer.

Four (4) 3.8 m (12.5 ft.) long 12 Ga W-beam guardrail panels are mounted to the posts of the terminal section with the splice located at every other post. The first rail panel was mounted to post 1 via a 0.625 in x 2.0 in. hex bolt, 50 mm (2 in.) square washer, and nut. Post 2 is also mounted to the rail with a 0.625 in. x 2.0 in. The 191 mm (7.5 in.) offset blocks are placed between the remainder of the terminal's line posts and the rail panels. One (1) 0.625 in. x 10.0 in. long bolt, washer, and nut was used to mount the rail to each of the line posts with offset blocks. The rail was not bolted to post 3 and post 5. Yellow 16 mm (0.625 in.) shear bolts were used to splice rail 3 at both the upstream and downstream ends. All posts were spaced at a nominal distance of 1.9 m (6.25 ft.).

The face of the impact head measured 610 mm (24.0 in.) tall by 330 mm (13.0 in.) wide by 5 mm (0.19 in.) thick. A 165 mm (6.5 in.) long by 5 mm (0.19 in.) thick W-beam section was welded to the back of the impact face and was used to mount the impact head to the terminal's first W-beam rail. The W-beam section was reinforced to the impact face with two (2) 165 mm x 127 mm x 6 mm (6.5 in. x 5.0 in. x 0.25 in.) triangular gussets. The impact head was mounted to the rail with four (4) 0.625 in. x 1.25 in. bolts.

For this test, the X Lite Tangent 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. The 191 mm (7.5 in.) plastic offset blocks were on all posts except the last wooden post.

With the exception of post 1, post 2 and the trailing end terminal post, the post 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 native soil. The post 1, post 2 and the trailing end terminal posts were installed by

drilling a 0.6 m (2.0 ft.) diameter hole and a depth of 1.8 m (6.0 ft.). The holes were backfilled with native soil and compacted with a pneumatic compactor.

Photographs of the as-tested unit and installation are available in Appendix A of this report. Manufacturer's drawings are available in Appendix D. The installation instructions are included on KARCO CD-R 2016-4062.

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 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 820C test vehicle was used for this test. The 820C test vehicle used for this test was a front engine model with front wheel drive and a manual 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 Dummy	700 ± 25	820 ± 25	2000 ± 45
Maximum Ballast Gross Static	75 70 775 ± 25	75 80 895 ± 25	--- 200 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 Above Ground	80 ± 15 55 ± 5	80 ± 15 55 ± 5	140 ± 15 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 X Lite Tangent 50' (15.24 m) System. The test conditions were as follows: A 820 kg (1808 lb.) small car 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 within 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 three (3) real-time video camera at 30 frames per second (fps), and six (6) 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 X Lite Tangent 50' (15.24 m) System.

2.3.6 Anthropomorphic Test Device: An uninstrumented Hybrid III 50th percentile adult male Anthropomorphic Test Device was placed in the driver seat of the test vehicle.

SECTION 3 TEST RESULTS

This 100 km/h (62 mph) impact crash test was conducted using a 1999 Chevrolet Metro small car to evaluate the impact performance of the X Lite Tangent 50' (15.24 m) System. The test article was installed at an angle of 5° relative to the test vehicle's direction of travel, with the vehicle's centerline intersecting the leading edge of the W-beam rail. This crash test was documented by three (3) real-time and six (6) 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 August 11, 2016. The as-tested test inertial weight of the vehicle was 814.5 kg (1,795.6 lbs.). The height of the front bumper was 225 mm (8.9 in.) to the lower edge and 550 mm (21.7 in.) to the upper edge. Additional dimensions and test vehicle information are presented in Data Sheets No. 1 and 2.

The test vehicle impacted the X Lite Tangent 50' (15.24 m) System at a velocity of 98.94 km/h (61.48 mph). The test vehicle impacted the X Lite impact head and pushed rail 1 down rail 2. The downstream shear bolts connecting rail 3 and 4 sheared causing the W-beam sections to separate from the article. The vehicle remained in contact with the impact head as the W-beam section rotated toward the traffic side of the article. The vehicle rotated counter-clockwise about its yaw axis before rolling onto its roof. The test vehicles final resting position was 19.6 m (64.3 ft.) downstream from its initial point of impact. As a result of the impact the posts 1 through post 8 were bent towards the ground. W-beam sections 1 through 3 detached from the system. The impact head, ground strut and slider bracket sustained deformation. An overhead illustration of the test vehicle and test article in their pre-test and post-test conditions is shown in Figure 2 in Appendix D. Sequential photographs of the test sequence are shown on Data Sheet 4.

The vehicle sustained damaged to its front end as a result of the impact with the X Lite Tangent 50' (15.24 m) System. The test vehicle's hood and front left quarter panel sustained deformation. The front bumper beam split at its center and the radiator was crushed. The occupant compartment was not penetrated as a result of the impact.

A summary of the electronic data is presented in Data Sheet No. 6; data plots are presented in Appendix B.

SECTION 4
DATA SHEETS

Test Article: X Lite Tangent 50' (15.24 m) System Project No. P36131-01
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 08/11/16

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	°F	°C	$=(T_f - 32)/1.8$
Force	Dynamic Forces	lbf	N	4.448
Moment	Torque	lbf-ft	N•m	1.355

DATA SHEET 1

TEST VEHICLE INFORMATION

Test Article: X Lite Tangent 50' (15.24 m) System Project No. P36131-01
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 08/11/16

TEST VEHICLE INFORMATION

Make	Chevrolet	Cylinders	Inline 3
Model	Metro	Engine Displacement (L)	1.0
Body Style	3-Door Hatchback	Engine Placement	Transverse
VIN	2C1MR2263X6715180	Fuel Type	Gasoline
Color	Purple	Transmission	Manual
Odometer Reading (mi)	280,128	Final Drive	Front
Previous Damage to Vehicle		Minor dents and scratches	

DATA FROM CERTIFICATION LABEL

Manufactured By	Cami Automotive Inc. Canada	GVWR (kg)	1175
		GAWR Front (kg)	635
Date of Manufacture	Feb-99	GAWR Rear (kg)	560

TEST VEHICLE WEIGHTS

	As Received (kg)			Test Inertial (kg)			Gross Static (kg)		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	235.5	155.5	391.0	241.0	168.5	409.5	285.5	194.0	479.5
Right	242.0	160.0	402.0	247.0	158.0	405.0	253.5	176.0	429.5
Ratio (%)	60.2	39.8	100.0	59.9	40.1	100.0	59.3	40.7	100.0
Total	477.5	315.5	793.0	488.0	326.5	814.5	539.0	370.0	909.0

	As Received (lb)			Test Inertial (lb)			Gross Static (lb)		
	Front	Rear	Total	Front	Rear	Total	Front	Rear	Total
Left	519.2	342.8	862.0	531.3	371.5	902.8	629.4	427.7	1057.1
Right	533.5	352.7	886.2	544.5	348.3	892.8	558.9	388.0	946.9
Ratio (%)	60.2	39.8	100.0	59.9	40.1	100.0	59.3	40.7	100.0
Total	1052.7	695.5	1748.2	1075.8	719.8	1795.6	1188.3	815.7	2004.0

DATA SHEET 2

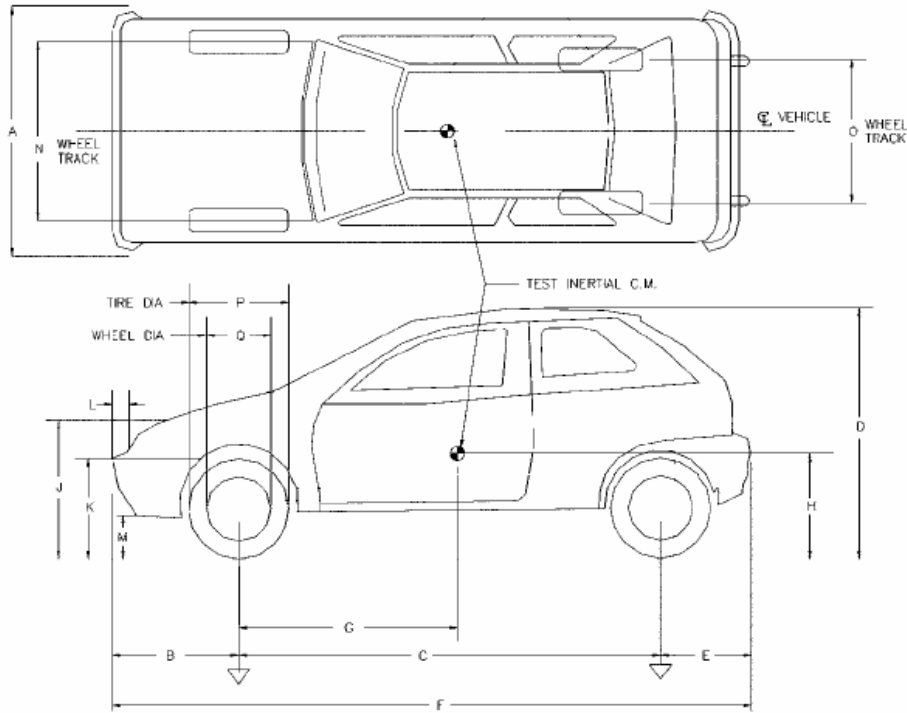
TEST VEHICLE GEOMETRY

Test Article: X Lite Tangent 50' (15.24 m) System

Project No. P36131-01

Test Program: 100 km/h 5° Guardrail Terminal Impact Test

Test Date: 08/11/16



TEST VEHICLE GEOMETRY

	mm	in.		mm	in.		mm	in.		mm	in.
A	1585	62.4	E	570	22.4	J	560	22.0	N	1390	54.7
B	818	32.2	F	3751	147.7	K	550	21.7	O	1357	53.4
C	2368	93.2	G	947	37.3	L	100	3.9	P	552	21.7
D	1400	55.1	H	560	22.0	M	225	8.9	Q	363	14.3

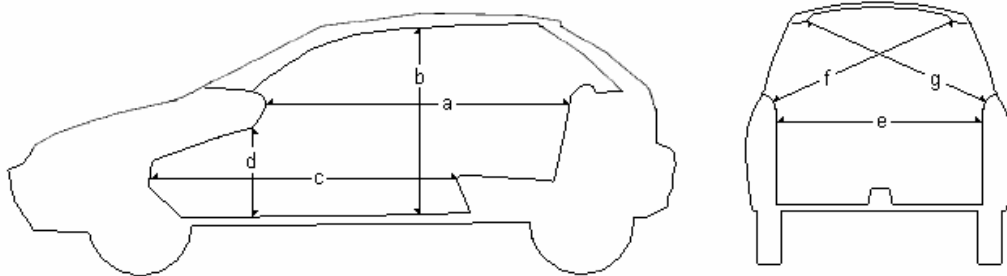
DATA SHEET 3

OCCUPANT COMPARTMENT DEFORMATION INDEX

Test Article: X Lite Tangent 50' (15.24 m) System Project No. P36131-01

Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 08/11/16

The seven subindices 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	1587	62.5	1571	61.9	1.01%
B	1063	41.9	1051	41.4	1.13%
C	1473	58.0	1472	58.0	0.07%
D	300	11.8	302	11.9	-0.67%
E	1261	49.6	1245	49.0	1.27%
F	1175	46.3	1139	44.8	3.06%
G	1188	46.8	1157	45.6	2.61%
Max Deformation	1175	46.3	1139	44.8	3.06%
OCDI	FS0000010				
Comments:	None				

DATA SHEET 4
SUMMARY OF RESULTS

Test Article: X Lite Tangent 50' (15.24 m) System
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test

Project No.: P36131-01
 Test Date: 08/11/16



0 ms 100 ms 300 ms 600 ms 1200 ms 2500 ms

GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO Engineering, LLC.	FLAIL SPACE VELOCITY (m/s)	
TEST ARTICLE		X DIRECTION	5.5
TYPE	Terminal	Y DIRECTION	0.8
TERMINAL LENGTH ¹	15.2 m (59.9 ft.)	THIV (Optional) (m/s)	5.6
ADJOINING BARRIER LENGTH ²	34.3 m (112.5 ft.)	RIDEDOWN ACCELERATION (g)	
TEST VEHICLE		X DIRECTION	-20.5
TYPE	Production Model	Y DIRECTION	12.7
DESIGNATION	820C	PHD (Optional) (g)	24.1
MODEL	Chevrolet Metro	ASI (Optional)	0.97
MASS (CURB)	793.0 kg (1,748.2 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	814.5 kg (1,795.6 lbs)	INTERIOR	
DUMMY MASS	76.0 kg (167.5 lbs)	OCDI	FS0000010
MASS (GROSS STATIC)	909.0 kg (2,004.0 lbs)	POST-IMPACT VEHICULAR BEHAVIOR	
IMPACT CONDITIONS		MAXIMUM ROLL ANGLE (°)	203.1
VELOCITY (km/h)	98.94 km/h (61.48 mph)	MAXIMUM PITCH ANGLE (°)	45.6
ANGLE (°)	4.7	MAXIMUM YAW ANGLE (°)	-58.2
IMPACT SEVERITY (kJ)	307.5		

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: X Lite Tangent 50' (15.24 m) System Project No. P36131-01
Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 08/11/16

Item	Value
Test Time	4:40 PM
Temperature (°C)	36.1 *
Wind Velocity (km/h)	35.4 *
Wind Direction	S *
Impact Speed (km/h)	98.94

*Information provided for reference only

DATA SHEET 6

TEST DATA SUMMARY

Test Article: X Lite Tangent 50' (15.24 m) System Project No. P36131-01
Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 08/11/16

TEST VEHICLE DATA SUMMARY

Tested Parameter	Axis	Units	Max	Time (ms)	Min	Time (ms)
Vehicle Impact Velocity	X	m/s	27.5			
Flail Space Velocity	X	m/s	5.5	172.8		
Flail Space Velocity	Y	m/s	0.8	172.8		
Ridedown Acceleration	X	g	1.6	562.2	-20.5	193.8
Ridedown Acceleration	Y	g	12.7	194.0	-10.8	208.6

TEST VEHICLE ACCELEROMETER PEAK DATA

Location	Axis	Units	Max	Time (ms)	Min	Time (ms)
Vehicle CG	X	g	3.9	155.3	-25.4	185.0
Vehicle CG	Y	g	17.4	192.5	-12.0	200.5
Vehicle CG	Z	g	21.3	190.9	-22.0	35.2

**APPENDIX A
PHOTOGRAPHS**

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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



FIGURE 7. Test Setup Close-Up



FIGURE 8. Test Setup



FIGURE 9. Test Setup Close-Up



FIGURE 10. Test Setup



FIGURE 11. Test Setup Close-Up



FIGURE 12. Test Setup



FIGURE 13. Pre-Test



FIGURE 14. Post-Test



FIGURE 15. Post-Test



FIGURE 16. Post-Test



FIGURE 17. Pre-Test Front View of Test Article



FIGURE 18. Post-Test Front View of Test Article



FIGURE 19. Pre-Test Right Front $\frac{3}{4}$ View of Test Article



FIGURE 20. Post-Test Right Front $\frac{3}{4}$ View of Test Article



FIGURE 21. Pre-Test Right View of Test Article



FIGURE 22. Post-Test Right View of Test Article



FIGURE 23. Pre-Test Right Rear $\frac{3}{4}$ View of Test Article



FIGURE 24. Post-Test Right Rear $\frac{3}{4}$ View of Test Article



FIGURE 25. Pre-Test Rear View of Test Article



FIGURE 26. Post-Test Rear View of Test Article



FIGURE 27. Pre-Test Left Rear $\frac{3}{4}$ View of Test Article



FIGURE 28. Post-Test Left Rear $\frac{3}{4}$ View of Test Article



FIGURE 29. Pre-Test Left View of Test Article



FIGURE 30. Post-Test Left View of Test Article



FIGURE 31. Pre-Test Left Front $\frac{3}{4}$ View of Test Article



FIGURE 32. Post-Test Left Front $\frac{3}{4}$ View of Test Article



FIGURE 33. Test Article Damage



FIGURE 34. Test Article Damage



FIGURE 35. Test Article Damage



FIGURE 36. Test Article Damage



FIGURE 37. Test Article Damage



FIGURE 38. Test Article Damage



FIGURE 39. Pre-Test Left View of Test Vehicle



FIGURE 40. Post-Test Left View of Test Vehicle



FIGURE 41. Pre-Test Left Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 42. Post-Test Left Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 43. Pre-Test Front View of Test Vehicle



FIGURE 44. Post-Test Front View of Test Vehicle



FIGURE 45. Pre-Test Right Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 46. Post-Test Right Front $\frac{3}{4}$ View of Test Vehicle



FIGURE 47. Pre-Test Right View of Test Vehicle



FIGURE 48. Post-Test Right View of Test Vehicle



FIGURE 49. Pre-Test Windshield



FIGURE 50. Post-Test Windshield



FIGURE 51. Pre-Test Driver Side Occupant Compartment



FIGURE 52. Post-Test Driver Side Occupant Compartment



FIGURE 53. Post-Test Driver Side Floorpan



FIGURE 54. Post-Test Driver Side Floorpan



FIGURE 55. Pre-Test Passenger Side Occupant Compartment



FIGURE 56. Post-Test Passenger Side Occupant Compartment



FIGURE 57. Pre-Test Passenger Side Floorpan



FIGURE 58. Post-Test Passenger Side Floorpan



FIGURE 59. Test Vehicle Manufacturer's Label

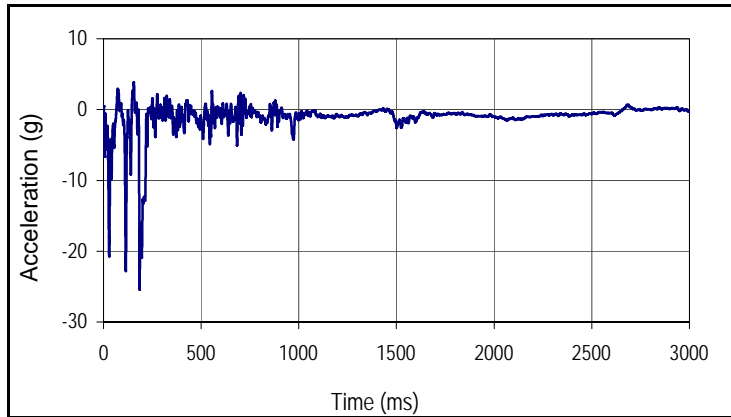
**APPENDIX B
DATA PLOTS**

LIST OF DATA PLOTS

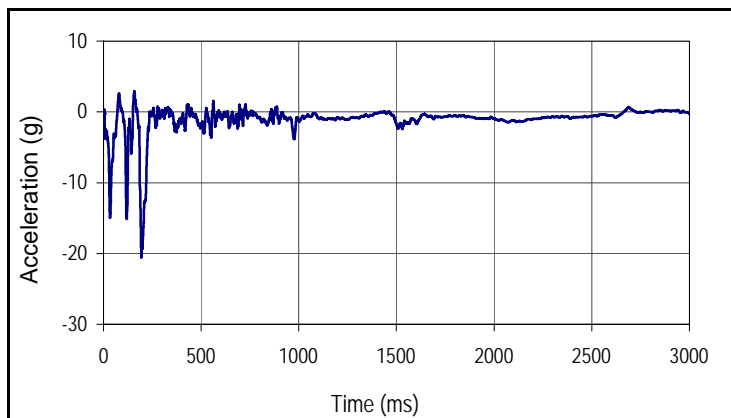
<u>Plot</u>		<u>Page</u>
1	Test Vehicle CG X	B-1
2	Test Vehicle CG X Moving Average	B-1
3	Test Vehicle CG X Velocity	B-1
4	Test Vehicle CG X Displacement	B-1
5	Test Vehicle CG Y	B-2
6	Test Vehicle CG Y Moving Average	B-2
7	Test Vehicle CG Y Velocity	B-2
8	Test Vehicle CG Y Displacement	B-2
9	Test Vehicle CG Z	B-3
10	Test Vehicle Accident Severity Index	B-3
11	Test Vehicle Roll Angle	B-4
12	Test Vehicle Yaw Angle	B-4
13	Test Vehicle Pitch Angle	B-4

Test Article: X LITE TANGENT 50' (15.24 m) System
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test

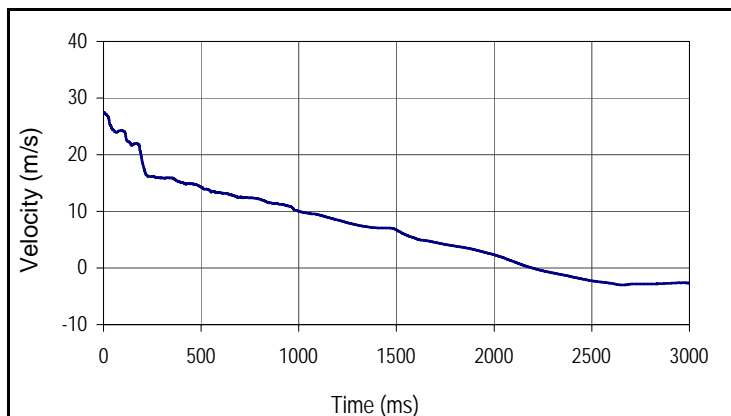
Project No: P36131-01
 Test Date.: 8/11/16



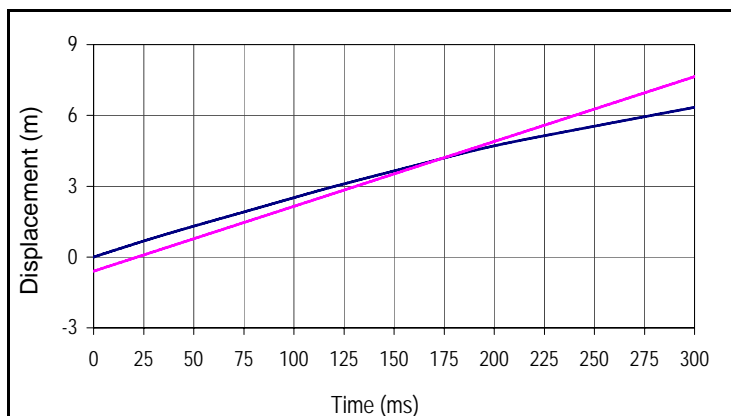
Curve Description			
Test Vehicle CG X			
Plot No.	Type	SAE Class	Units
001	FIL	60	g
Max	Time	Min	Time
3.9	155.3	-25.4	185.0



Curve Description			
Test Vehicle CG X Moving Average			
Plot No.	Type	SAE Class	Units
002	AVG	180	g
Max	Time	Min	Time
2.9	158.0	-20.5	193.8



Curve Description			
Test Vehicle CG X Velocity			
Plot No.	Type	SAE Class	Units
003	IN1	180	m/s
Max	Time	Min	Time
27.5	0.7	-3.0	2657.0

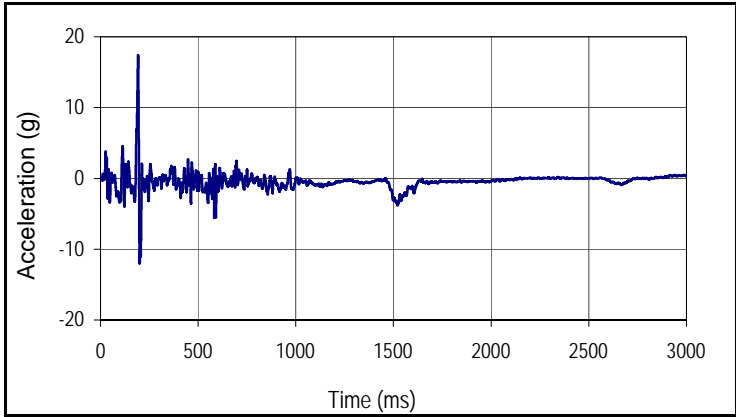


Curve Description			
Test Vehicle CG X Displacement			
Plot No.	Type	SAE Class	Units
004	IN2	180	m
Max	Time	Min	Time
22.0	2194.9	0.0	0.0

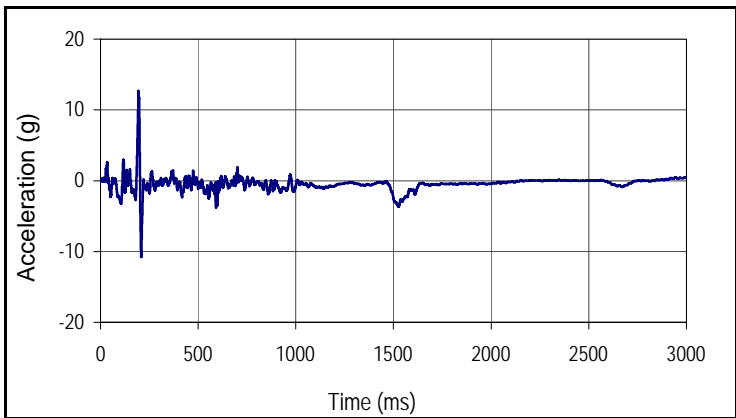
— Vehicle CG X Displacement
 — Occupant X Displacement

Test Article: X LITE TANGENT 50' (15.24 m) System
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test

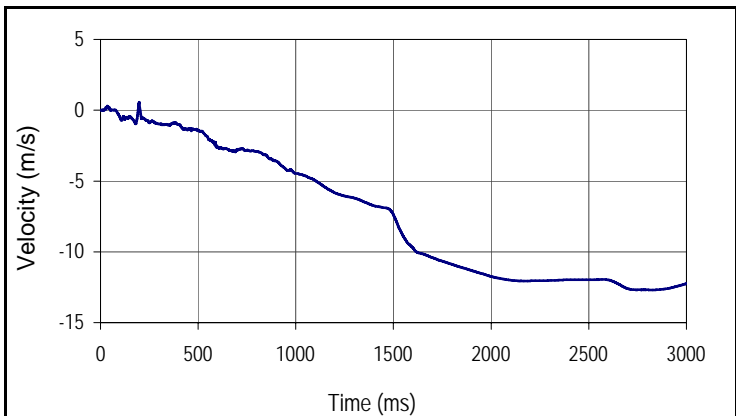
Project No: P36131-01
 Test Date.: 8/11/16



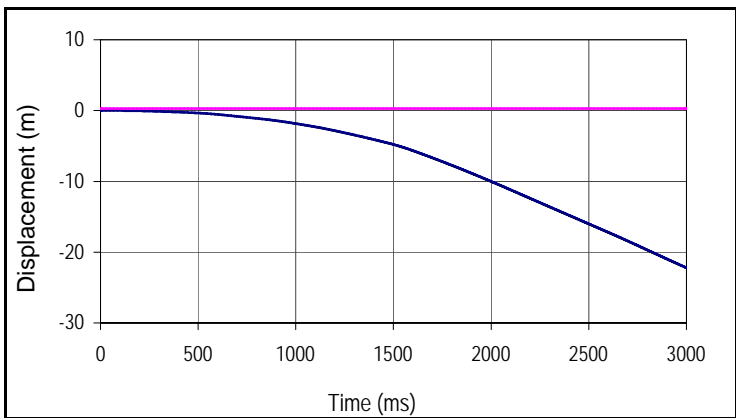
Curve Description			
Test Vehicle CG Y			
Plot No.	Type	SAE Class	Units
005	FIL	60	g
Max	Time	Min	Time
17.4	192.5	-12.0	200.5



Curve Description			
Test Vehicle CG Y Moving Average			
Plot No.	Type	SAE Class	Units
006	AVG	180	g
Max	Time	Min	Time
12.7	194.0	-10.8	208.6



Curve Description			
Test Vehicle CG Y Velocity			
Plot No.	Type	SAE Class	Units
007	IN1	180	m/s
Max	Time	Min	Time
0.6	197.8	-12.7	2815.7

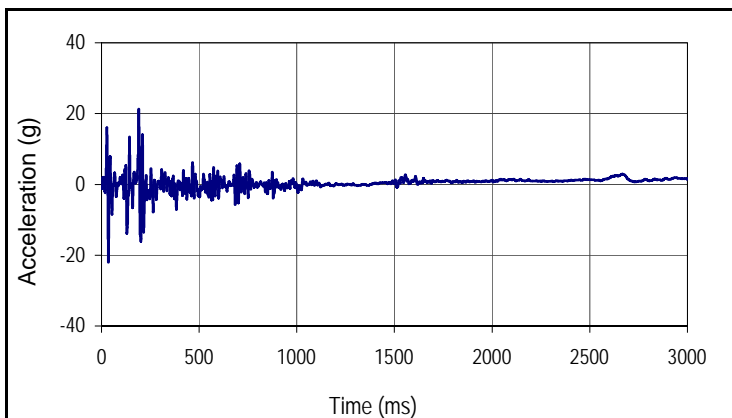


Curve Description			
Test Vehicle CG Y Displacement			
Plot No.	Type	SAE Class	Units
008	IN2	180	m
Max	Time	Min	Time
0.0	78.3	-22.2	2999.9

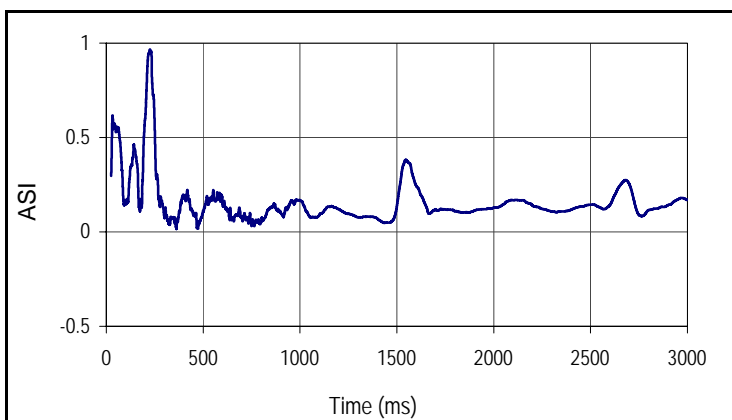
— Vehicle CG Y Displacement
 — Occupant Y Displacement

Test Article: X LITE TANGENT 50' (15.24 m) System
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test

Project No: P36131-01
 Test Date.: 8/11/16



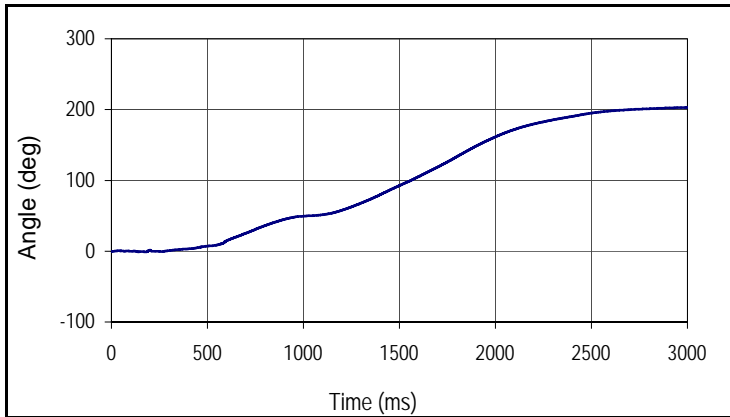
Curve Description			
Test Vehicle CG Z			
Plot No.	Type	SAE Class	Units
009	FIL	60	g
Max	Time	Min	Time
21.3	190.9	-22.0	35.2



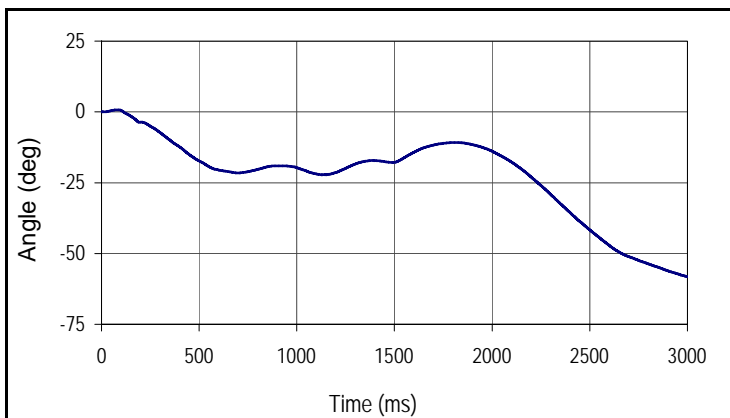
Curve Description			
Test Vehicle Accident Severity Index			
Plot No.	Type	SAE Class	Units
010	ASI	180	ASI
Max	Time	Min	Time
1.0	226.1	0.0	361.8

Test Article: X LITE TANGENT 50' (15.24 m) System
 Test Program: 100 km/h 5° Guardrail Terminal Impact Test

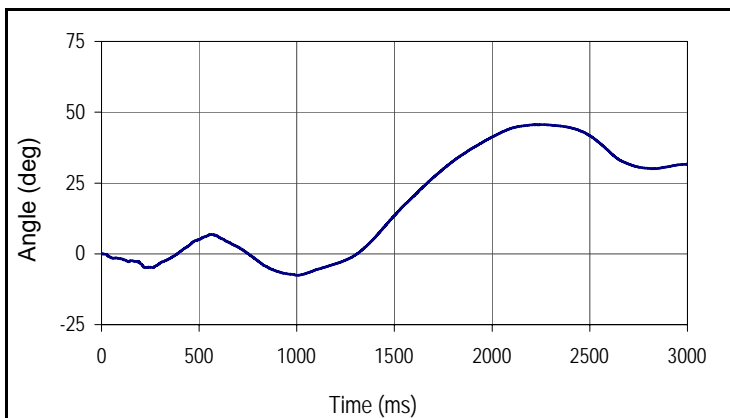
Project No: P36131-01
 Test Date.: 8/11/16



Curve Description			
Test Vehicle Roll Angle			
Plot No.	Type	SAE Class	Units
011	IN1	180	deg
Max	Time	Min	Time
203.1	2999.9	-1.0	138.7



Curve Description			
Test Vehicle Yaw Angle			
Plot No.	Type	SAE Class	Units
012	IN1	180	deg
Max	Time	Min	Time
0.8	84.0	-58.2	2999.9



Curve Description			
Test Vehicle Pitch Angle			
Plot No.	Type	SAE Class	Units
013	IN1	180	deg
Max	Time	Min	Time
45.6	2260.0	-7.6	1005.7

**APPENDIX C
INSTRUMENTATION**

DATA ACQUISITION INFORMATION

Test Article: X Lite Tangent 50' (15.24 m) System Project No. P36131-01
Test Program: 100 km/h 5° Guardrail Terminal Impact Test Test Date: 08/11/16

VEHICLE INSTRUMENTATION

CH	Location	Axis	Ident. No.	Description	MFR	Model	Units
1	Vehicle CG	X	P51708	Accel, Half Bridge	Endevco	2000G	g
2	Vehicle CG	Y	P51700	Accel, Half Bridge	Endevco	2000G	g
3	Vehicle CG	Z	P51696	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

<u>Figure</u>		<u>Page</u>
1	Manufacturer's Drawing	D-1
2	Overhead Illustration	D-2

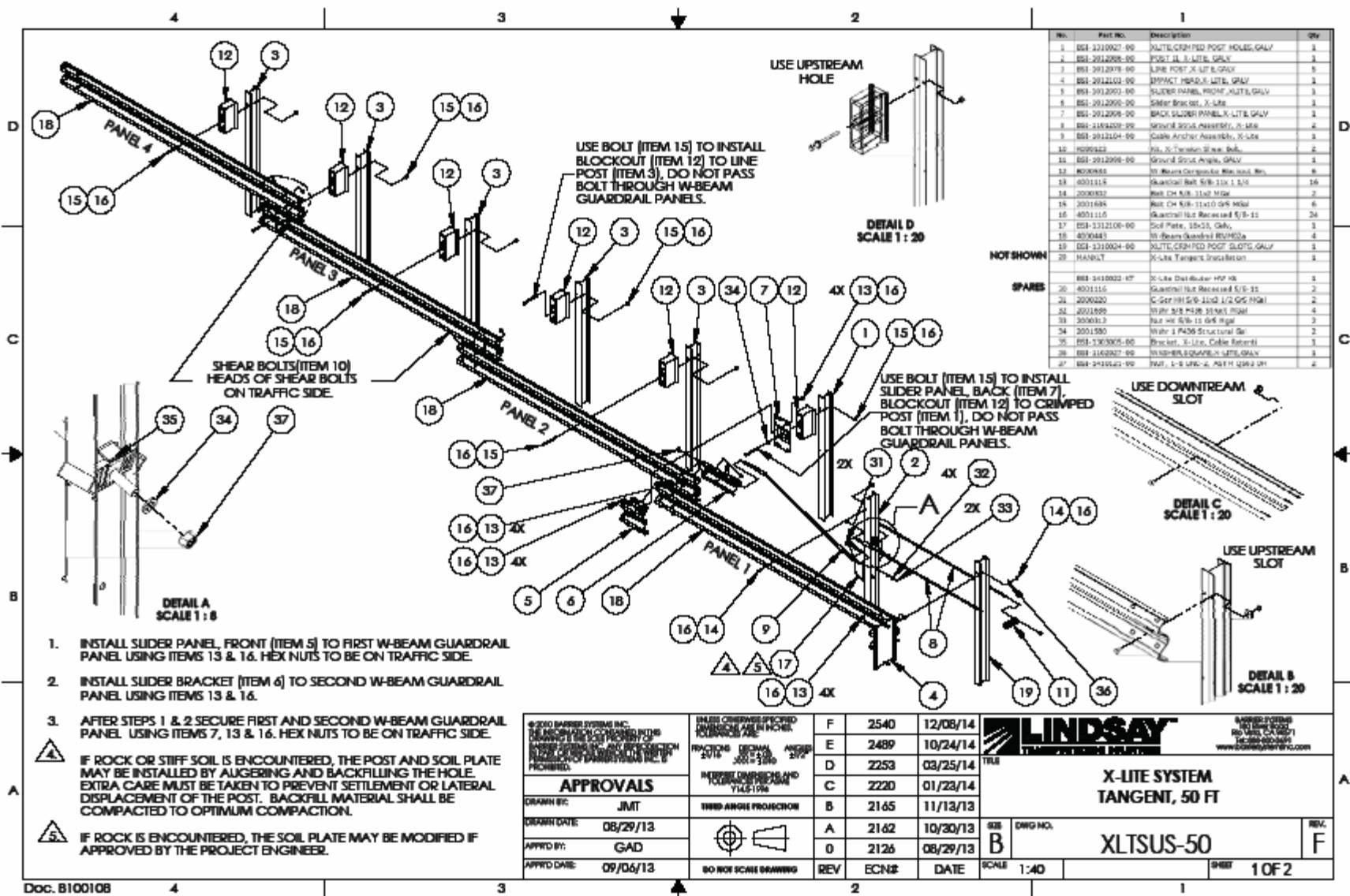


FIGURE 1. Manufacturer's Drawing

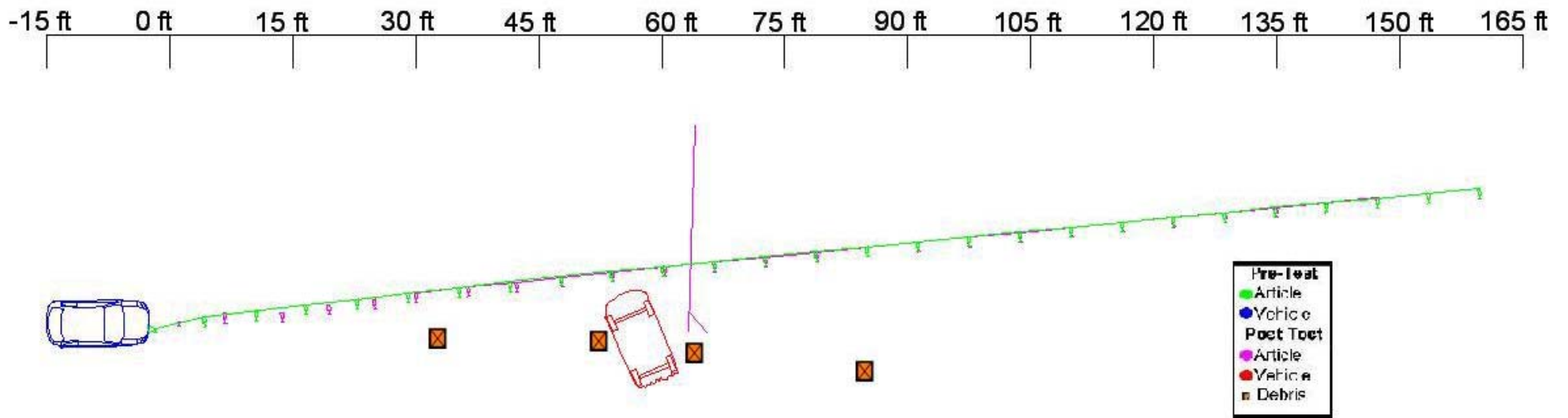


FIGURE 2. Overhead Illustration
FINAL PAGE OF REPORT