U.S. Department of Transportation
Federal Highway Administration

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

September 9, 2011

In Reply Refer To:
HSST/CC-120

Mr. Dallas James
Armorflex International Ltd.
8 Paul Matthews Road,
North Harbour 0751
New Zealand

Dear Mr. James:

This letter is in response to your request for Federal Highway Administration (FHWA) acceptance of a roadside safety system for use on the National Highway System (NHS).

Name of system:	X-LITE Terminal
Type of system:	Tangent & Flared Re-directive Gating W-Beam Terminal
Test Level:	NCHRP Report 350 TL-3
Testing conducted by:	Safe Technologies Inc.
Date of request:	December 20, 2010
Request acknowledged:	December 27, 2010
Task Force 13 Designator:	SEW23 Tangent SEW24 Flared

You requested that we find this system acceptable for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

Requirements
Roadside safety devices tested prior to January 1, 2011 should meet the guidelines contained in NCHRP Report 350; those tested after that date must follow the guidelines contained in the American Association of State Highway and Transportation Officials' (AASHTO) Manual for Assessing Safety Hardware (MASH). The FHWA Memorandum "Identifying Acceptable Highway Safety Features" of July 25, 1997 provides further guidance on crash testing requirements for longitudinal barriers.

Decision
The following barrier design was found acceptable, with details provided below:

- X-LITE Tangent & Flared Re-directive Gating W-Beam Terminal

FHWA: HSST: WLongstreet: ms: x60087:8/22/11
File: h://directory folder/HSST/ CC-120.docx
cc: HSST Will Longstreet

Description

The X-LITE Terminal evolved from the original X-Tension Terminal (FHWA letter CC-91) and incorporates many of the key components and design features of the X-Tension. Like the earlier design, the X-LITE Terminal absorbs the kinetic energy of the impacting vehicle when struck head on by telescoping the W beam panels, gathering and retaining the rails into the slider mechanism. The friction applied by the slider mechanism increases with each additional rail that it gathers and retains, thereby gradually increasing the energy absorbing capability of the X-LITE Terminal. When hit at an angle at or beyond the third post, the X-LITE Terminal is restrained laterally by the W-Beam panels and its end anchor. This anchor consists of posts #1 and #2 connected by tension struts and a soil plate below grade on post #2.

The X-LITE Terminal consists of 3 standard W-beam panels installed on I-beam posts, using either composite or routed wood offset blocks. It can be installed parallel to the roadway or flared with a 1220-millimeter (48-inch) offset over 11.4 meters (37.5 feet), there are 6 modified (crimped) posts used in the flared design and 3 in the tangent design, including post #2 in both designs. The flared design includes an offset block at post #2, whereas the tangent design does not. For both layouts, only the offset block is bolted to post #5. Based on the test results reported below, the X-LITE can be installed with the top of the rail at either 702 millimeters (27 5/8 inches) or 787 millimeters (31 inches) above grade. The slider mechanism is at the joint between rails 1 and 2, with shear bolts at the joint between rail 2 and 3. An additional set of shear bolts between rails 3 and 4 are used in the tangent system only

Enclosures 1 and 2 show the design and assembly of the flared and tangent X-LITE Terminal systems respectively. .

Crash Testing

The crash test matrix was developed in consultation with the FHWA's Office of Safety Design and the following tests were conducted to validate the crashworthiness of the X-LITE Terminal: NCHRP Report 350 test designations 3-31 and 3-35 were conducted on the flared system at 27 5/8 inches high and test 3-30 was run using a rail height of 31 inches; tests 3-31 and 3-30 were also run on the tangent system. To provide additional support of the X-LITE at 31 inches high, test 3-34 was run on the X-Tension Terminal. Each of these tests is briefly described below.

Flared design:

Test 3-30 was conducted with the rail height set at 787 millimeters (31 inches) to verify that the 820C vehicle would not underride the impact head. Enclosure 3 is the summary sheet for this test.

Test 3-31 was conducted with the rail height set at 702 millimeters (27 5/8 inches) to verify impact performance with the 2000P test vehicle. The pickup truck proceeded through the terminal and came to rest behind the test installation, 27 meters (approximately 90 feet) downstream from the impact point. While this trajectory is common to all flared, gating W-beam terminals, it serves to emphasize the importance of a clear and traversable runout area behind and beyond such terminals. Enclosure 4 is the summary sheet for this test.

Test 3-34 with the 820C vehicle impacting the side of the system at the critical impact point (CIP) at a 15-degree angle was conducted using the flared X-Tension design at the 787-

millimeter (31-inch) height. Since the X-Tension has only two weakened posts at the front, followed by standard steel line posts, this test was considered to be a more severe test of wheel snag than the X-LITE with its six crimped posts. Enclosure 5 is the summary sheet for this test.

Test 3-35 was conducted with the 2000P vehicle impacting the side of the terminal at post #3 at a nominal angle of 20 degrees. Because of the flared terminal layout, the actual impact angle was approximately 26 degrees. For this test, the lower rail height of 702 millimeters (27 5/8 inches) was used. The pickup truck was contained and redirected, thus confirming the barrier length of need (LON) begins at post #3. Enclosure 6 is a summary of the test conditions and results.

In your request, you noted that tests 3-32 and 3-34 were not run because these tests have always been shown to be less severe than the end-on tests for gating terminals. Test 3-39, a reverse-direction, 20 degree test with the pickup truck was not run on the flared X-LITE design based on the successful performance of the tangent X-Tension test which you conducted during certification testing for that design. The flared X-LITE layout reduces the effective impact angle to approximately 14 degrees so the impact would be less severe than the earlier test. The FHWA reconfirms that these three tests can be waived.

Tangent design:
Test 3-30 was run on the X-LITE tangent design which uses only three modified (crimped) posts. For this test, the 820C vehicle was offset the field side of the terminal to maximize the likelihood of the car yawing into the standard steel posts beginning with post #4. The rail height was set at 702 millimeters (27 5/8 inches). Although all Report 350 test criteria were met, the car travelled over 20 meters (66 feet) behind the rail from the initial impact point and exhibited a roll angle slightly over 50 degrees. This post-impact trajectory again reinforces the need for a relatively clear and traversable runout area behind and beyond all gating terminals. Enclosure 7 is a summary of these test results.

Test 3-31 was run with the rail set at its lower limit of 702 millimeters (27 5/8 inches) to verify its capability to stop the 2000P vehicle without override. Enclosure 8 is a summary of this successful test.

Tests 3-32 and 3-33 were not run on the tangent layout for the same reason they were waived for the flared design. Test 3-34 and 3-35 were not run on the tangent system because these test were successfully completed on the more-critical flared design and would be less severe on the tangent system. Test 3-39, as noted earlier, was successfully run on the stiffer X-Tension design during earlier testing. The FHWA agrees that these five tests can be waived for the tangent X-LITE.

Finally, your December 20th request summarized the design changes made to the X-LITE terminal after your initial test 3-35 that were incorporated into the final design. The FHWA concurs that these modifications will not adversely affect the crash test performance of the first test and it need not be repeated.

Findings
You requested FHWA acceptance of the following configurations for the X-LITE Terminal as an NCHRP Report 350 TL-3 Redirective, Gating, W-Beam Terminal:

- X-LITE Flared Terminal with a 1220-millimeter (48-inch) offset over 11.4 meters (37.5 feet) at both 702-millimeter (27 5/8-inch) and 787-milimeter (31-inch) rail heights, using either composite or timber offset blocks.

- X-LITE Tangent Terminal with a 0 to 300-millimeter (0 to 1-foot) offset at both 702-millimeter (27 5/8-inch) and 787-milimeter (31-inch) rail heights, using either composite or timber offset blocks.

Both systems described above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency.

Please note the following standard provisions that apply to FHWA letters of acceptance:

- This letter includes an AASHTO/ARTBA/AGC Task Force 13 designation that should be used when drafting new or revised Task Force 13 drawings.
- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-120 and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- The X-LITE Terminal system is a patented product and considered proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

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

U.S. Department
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Federal Highway Administration

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

September 7, 2011

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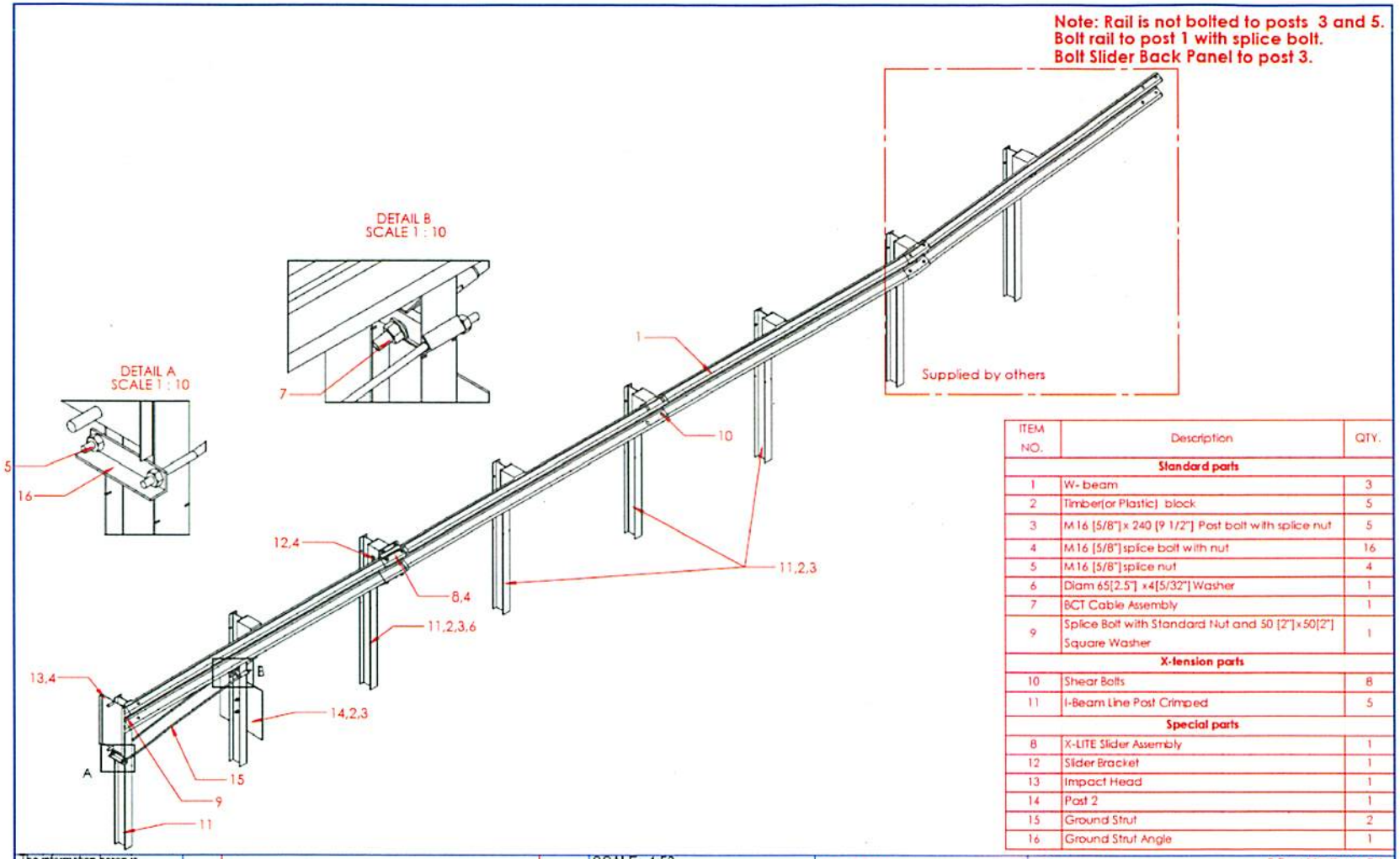
Sincerely yours,

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

Enclosure 1 (1 of 3)



ITEM NO.	Description	QTY.
	Standard parts	
1	W- beam	3
2	Timber(or Plastic) block	5
3	M16 [5/8"] x 240 [9 1/2"] Post bolt with splice nut	5
4	M16 [5/8"] splice bolt with nut	16
5	M16 [5/8"] splice nut	4
6	Diam 65[2.5"] x4[5/32"] Washer	1
7	BCT Cable Assembly	1
9	Splice Bolt with Standard Nut and 50 [2"]x50[2"] Square Washer	1
	X-tension parts	
10	Shear Bolts	8
11	I-Beam Line Post Crimped	5
	Special parts	
8	X-LITE Slider Assembly	1
12	Slider Bracket	1
13	Impact Head	1
14	Post 2	1
15	Ground Strut	2
16	Ground Strut Angle	1

REV.	CHANGES	DATE

SCALE: 1:50

	DATE	INIT.
DRAWN BY	17/12/2010	AD
APPR'D BY	17/12/2010	DJ

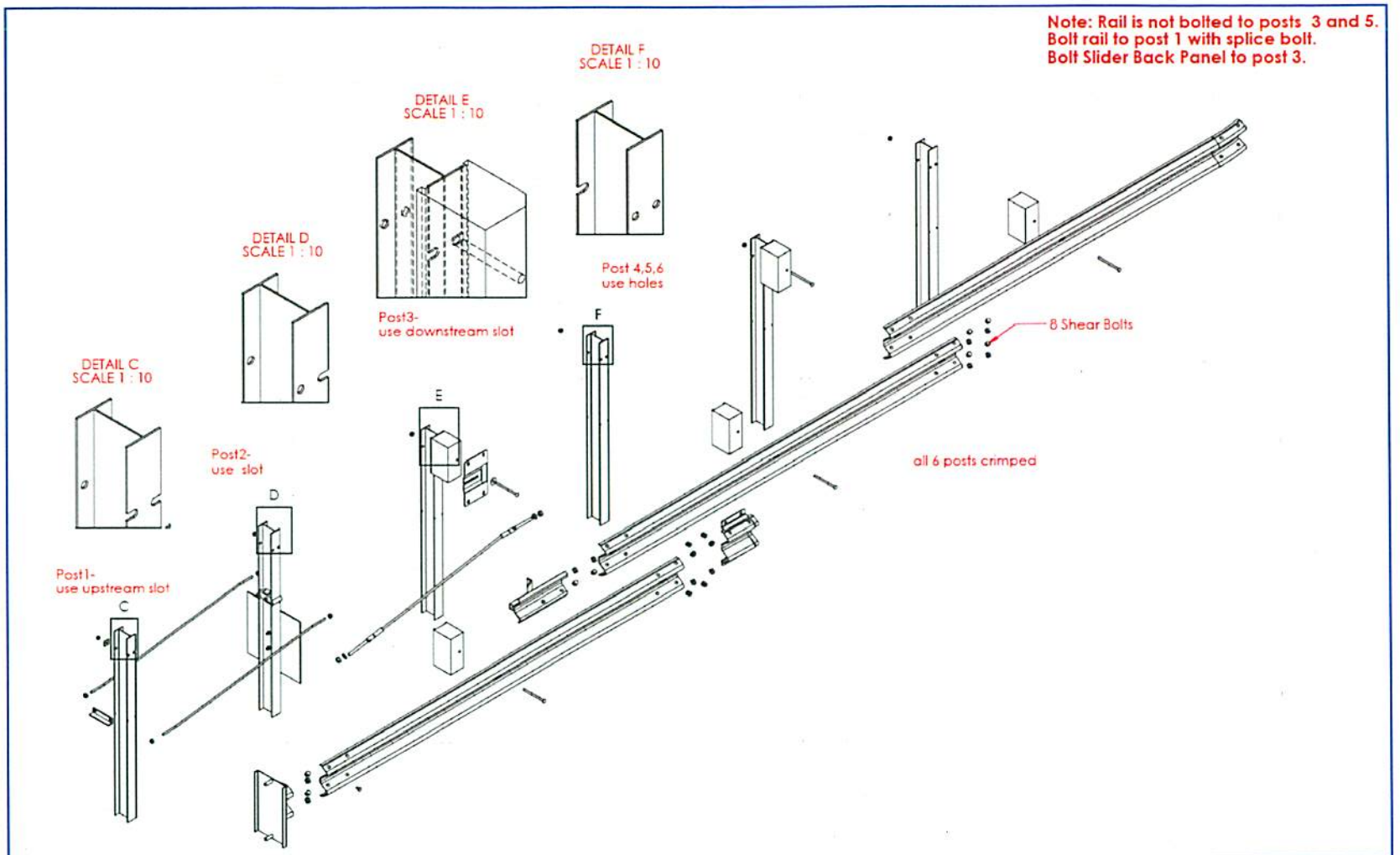
Standard Tolerance

X-LITE (Flared)
Isometric

ARMORFLEX
8 Paul Matthews Rd.
Albany.Auckland.
New Zealand
tel. 64 9 415 2991
fax. 64 9 415 2993
info@armorflex.co.nz

SHEET	DRAWING NUMBER	REV.
1 OF 3	XL-001Fd	

Enclosure 1 (2 of 3)



REV.	CHANGES	DATE

SCALE: 1:40

	DATE	INIT.
DRAWN BY	17/12/2010	AD
APPR'D BY	17/12/2010	DJ

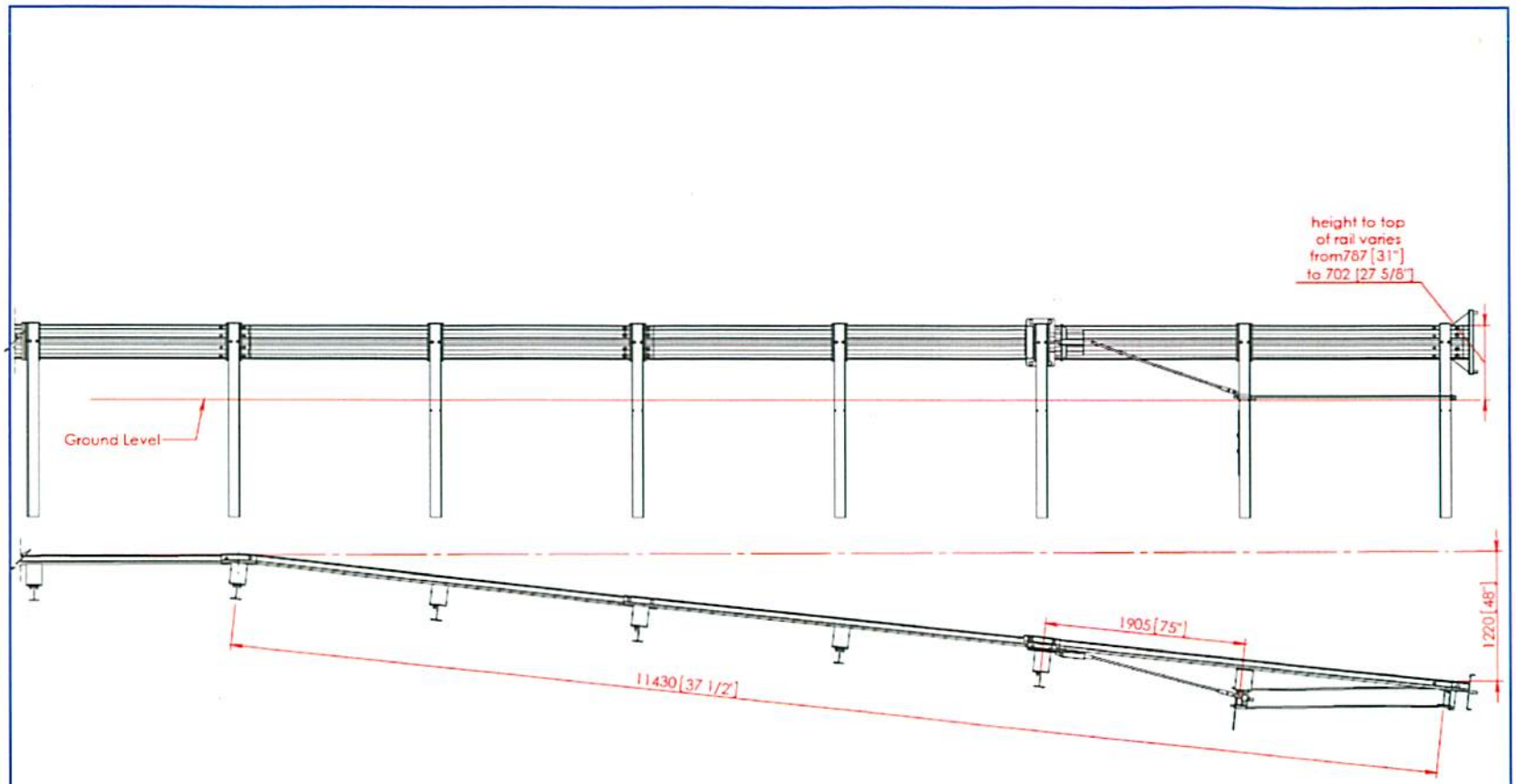
Standard Tolerance

X-LITE (Flared)
Exploded

ARMORFLEX
8 Paul Matthews Rd.
Albany,Auckland.
New Zealand
tel. 64 9 415 2991
fax. 64 9 415 2993
info@armorflex.co.nz

SHEET	DRAWING NUMBER	REV.
2 OF 3	XL-001Fd	

Enclosure 1 (3 of 3)



REV.	CHANGES	DATE

SCALE: 1:50

	DATE	INIT.
DRAWN BY	17/12/2010	AD
APPR'D BY	17/12/2010	DJ

Standard Tolerance

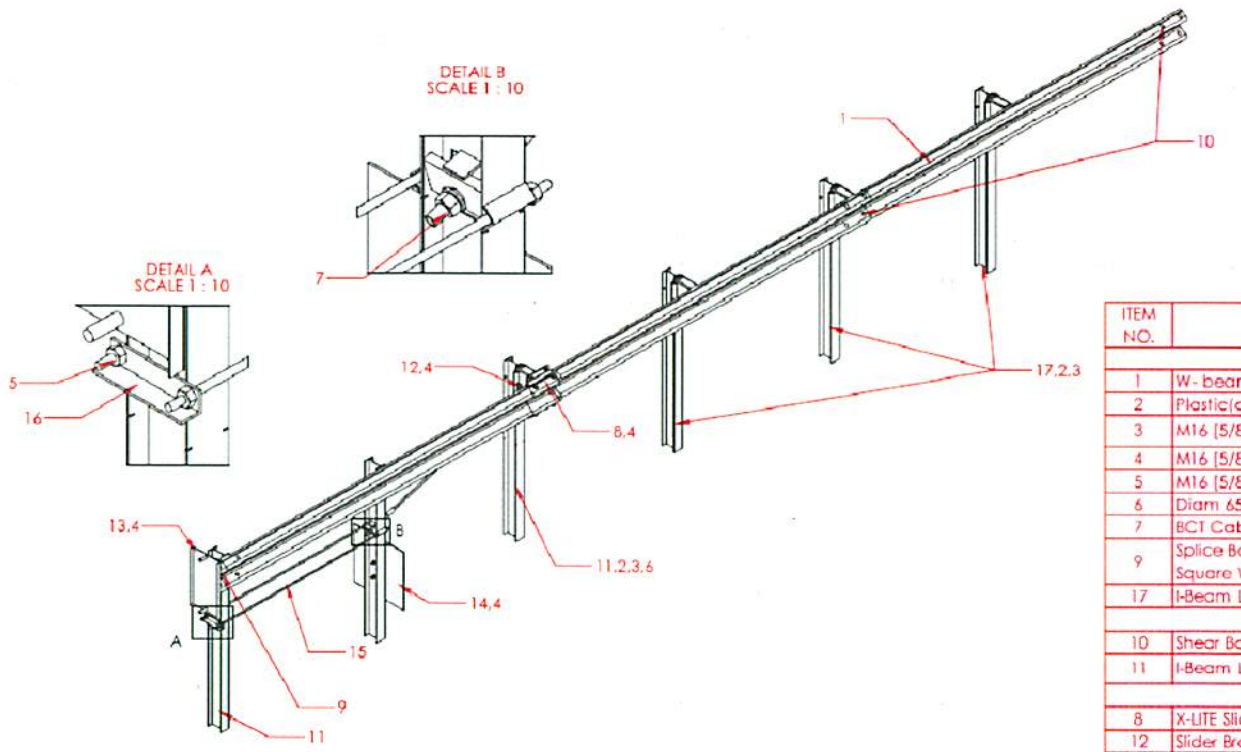
X-LITE (Flared)
Plan,Elevation

ARMORFLEX
8 Paul Matthews Rd.
Albany,Auckland.
New Zealand
tel. 64 9 415 2991
fax. 64 9 415 2993
info@armorflex.co.nz

SHEET	DRAWING NUMBER	REV.
3 OF 3	XL-001Fd	

Enclosure 2 (1 of 3)

Note: Rail is not bolted to posts 3 and 5.
Bolt rail to post 1 and 2 with splice bolt.
Bolt Slider Back Panel to post 3.



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Isometric

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1 OF 3	XL-001Td	

Sincerely yours,

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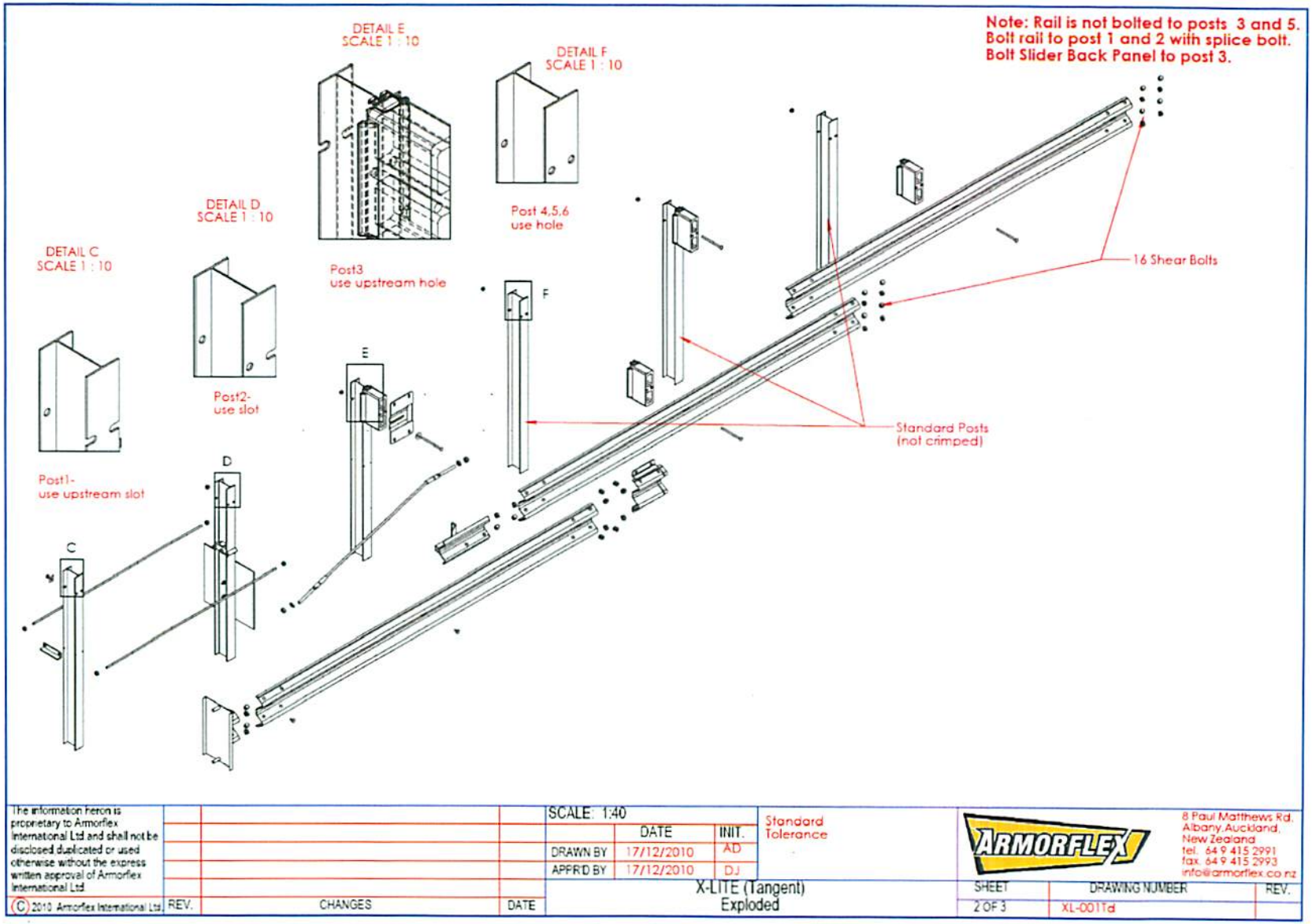
Office of Safety

Enclosures

Enclosure 2 (2 of 3)



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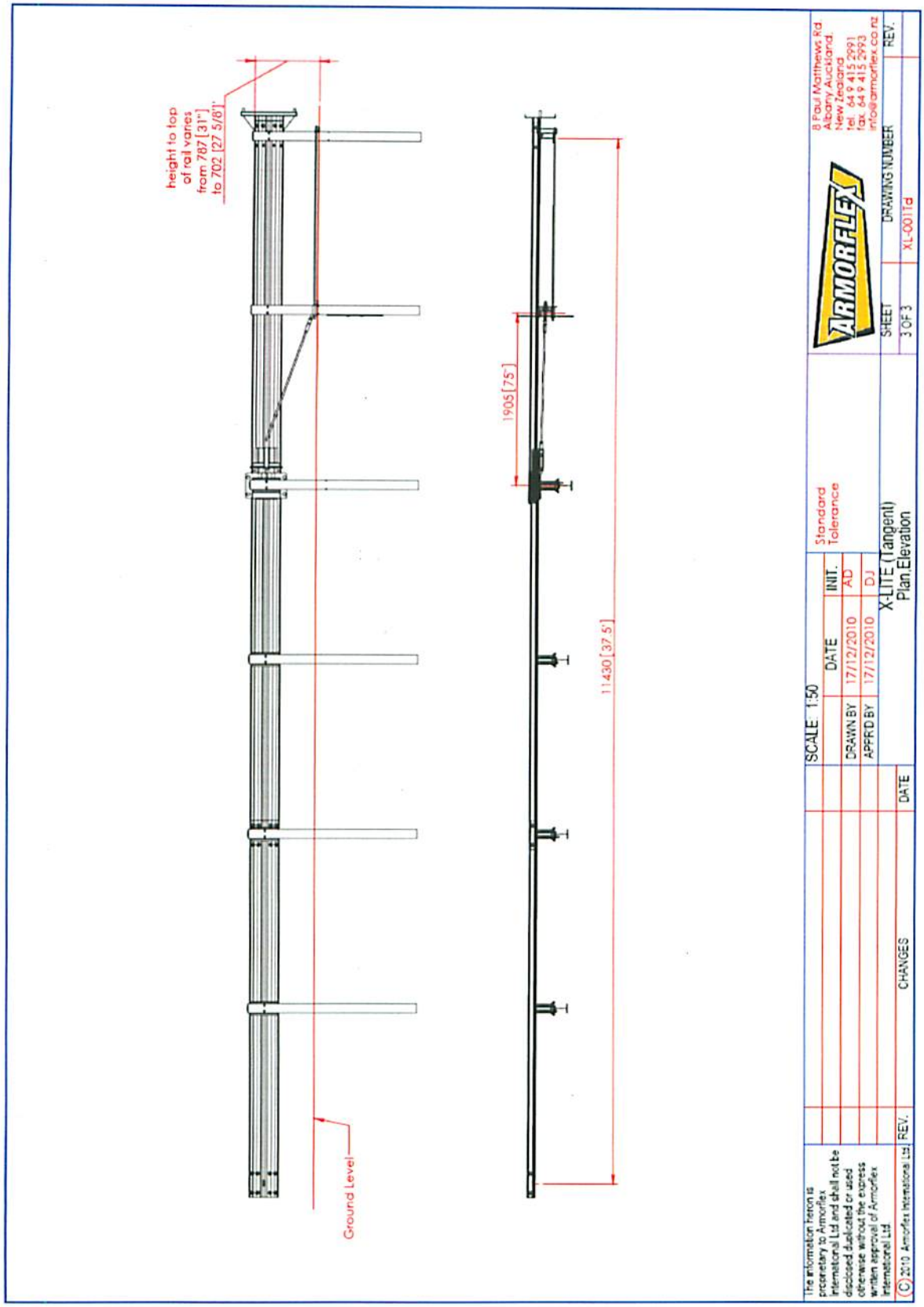
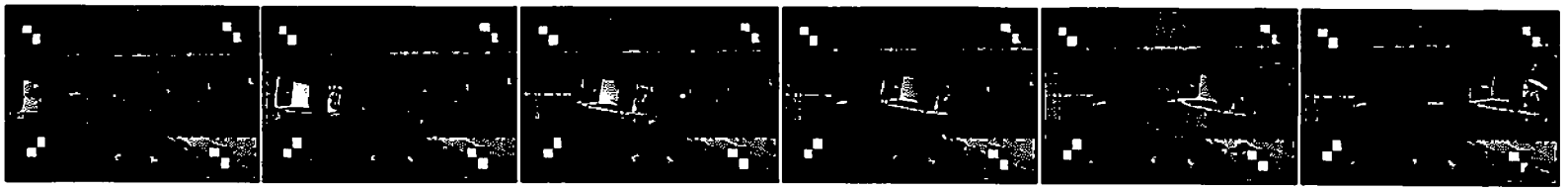
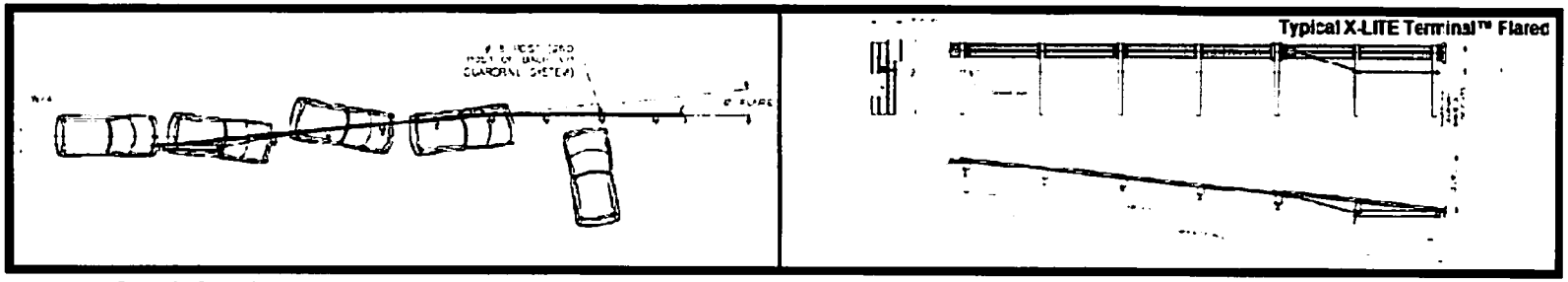


Enclosure 2 (3 of 3)

Enclosure 3





General Information

Test Agency ..... SAFE TECHNOLOGIES, INC.
Test Designation ..... NCHRP Report 350 3-30
Test No. ..... STI Test # XTL09
Date 10/20/2010

Test Article

Type ..... End Terminal
Name ..... X-LITE Terminal Flared
Dimensions ..... Length: 11.9 m (39.0 ft)
Size and/or dimension and material of key elements ..... Height: 702 mm (27.6 in) - 787 mm (31.0 in)
Width: 747 mm (29.4 in)

Test Vehicle

Type ..... Production Model
Designation 8200
Model ..... 1987 Honda CRX
Mass (kg)
Curb 811
Test Inertial 820
Dummy(s) 75
Gross Static 895

Impact Conditions

Speed (kph) 30
Angle (deg) ..... 3 (8° with 8° flare)
Impact Severity (kJ) 302.0

Exit Conditions

Speed (kph) ..... N/A
Angle (deg) ..... N/A

Occupant Risk Values

Impact Velocity (m/s)
x-direction 6
y-direction 0
Ridedown Acceleration (g's)
x-direction 16
y-direction 9

Test Article Deflection (mm)

Dynamic ..... N/A
Permanent ..... N/A

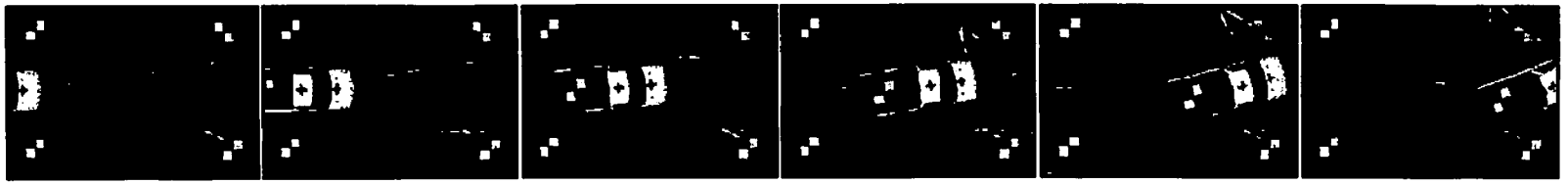
Vehicle Damage

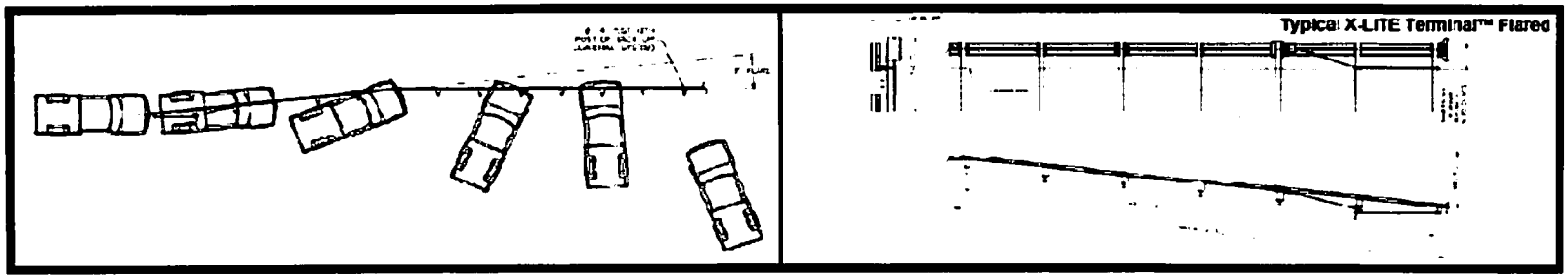
Exterior
VDS 12-FC-3
CDC 12FCEN2
Interior
OCDI FS000C000

Post-Impact Vehicular Behavior (deg - gyro @ c.g)

Maximum Roll Angle ..... 2°
Maximum Pitch Angle 17
Maximum Yaw Angle 112

Enclosure 4





General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-31
Test No.	STI Test # XTL10
Date	10/21/2010

Test Article

Type	End Terminal
Name	X-LITE Terminal Flared
Dimensions	Length: 11.9 m (39.0 ft)
Size and/or dimension and material of key elements	Height: 702 mm (27.6 in) - 787 mm (31.0 in); Width: 747 mm (29.4 in)

Test Vehicle

Type	Production Model
Designation	2000P
Model	2000 Chevrolet 3/4 Ton Pickup
Mass (kg)	
Curb	2198
Test Inertial	2030
Dummy(s)	N/A
Gross Static	2030

Impact Conditions

Speed (kph)	100
Angle (deg)	0 (6° with 6° flare)
Impact Severity (kJ)	778.5

Exit Conditions

Speed (kph)	N/A
Angle (deg)	N/A

Occupant Risk Values

Impact Velocity (m/s)	
x-direction	3
y-direction	0
Ridedown Acceleration (g's)	
x-direction	10
y-direction	10

Test Article Deflection (mm)

Dynamic	N/A
Permanent	N/A

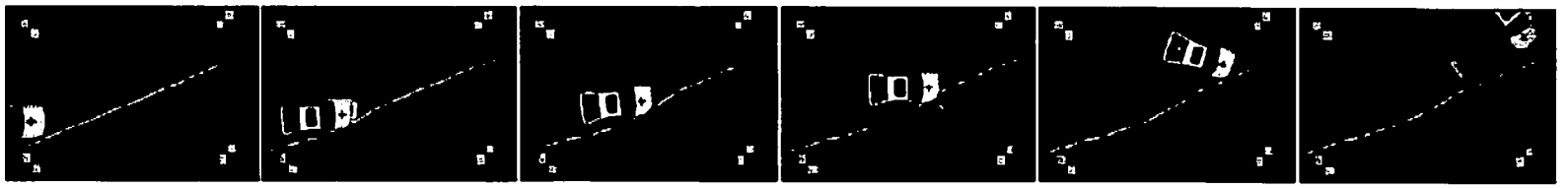
Vehicle Damage

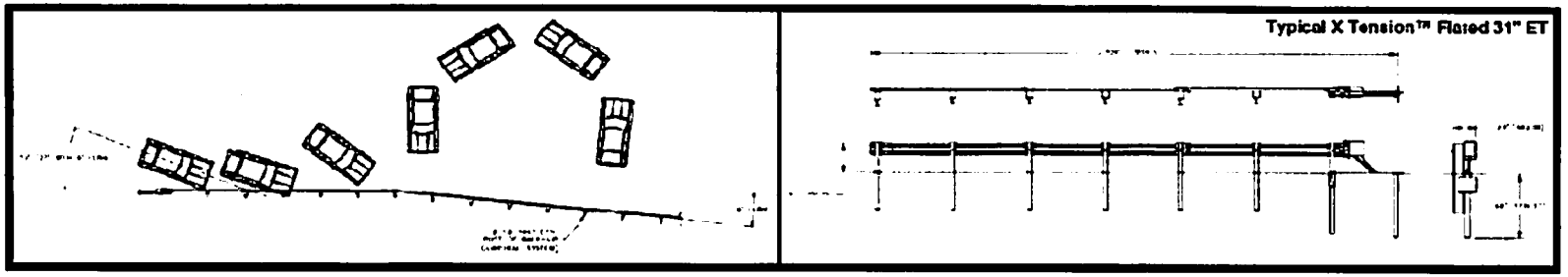
Exterior	
VDS	12-FC-1
CDC	12FCEN1
Interior	
OCD	F80000000

Post-Impact Vehicular Behavior (deg - gyro @ c.g.)

Maximum Roll Angle	13
Maximum Pitch Angle	2
Maximum Yaw Angle	134

Enclosure 5





General Information

Test Agency..... SAFE TECHNOLOGIES, INC.
Test Designation..... NCHRP Report 350 3-34
Test No..... STI Test # XTF01
Date..... 10/22/2010

Test Article

Type ..... End Terminal
Name ..... X-Tension Flared 31"
Dimensions ..... Length: 13.2 m (43.3 ft)
Size and/or dimension and material ..... Height: 787 mm (31.0 in)
of key elements ..... Width: 584 mm (23.0 in)

Test Vehicle

Type ..... Production Model
Designation 820C
Model ..... 1997 Honda CRX
Mass (kg)
Curb 823
Test Inertial 830
Dummy(s) 75
Gross Static 905

Impact Conditions

Speed (kph) 99
Angle (deg) ..... 15 (21° with 6° flare)
Impact Severity (kJ) 21.1

Exit Conditions

Speed (kph) 50
Angle (deg) ..... 16 (22° with 6° flare)

Occupant Risk Values

Impact Velocity (m/s)
x-direction 6
y-direction 5
Ridedown Acceleration (g's)
x-direction 9
y-direction 8

Test Article Deflection (mm)

Dynamic 570
Permanent 320

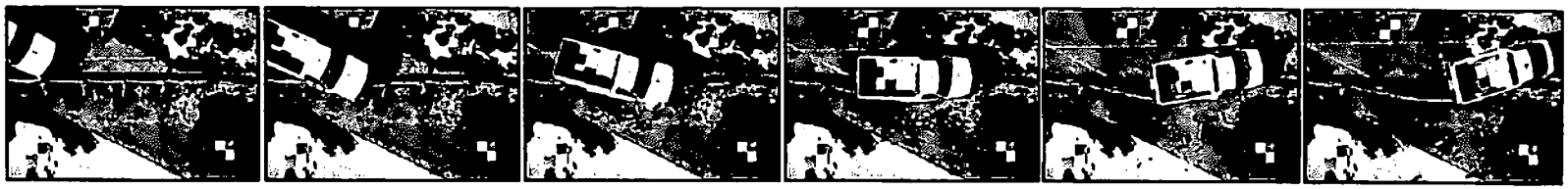
Vehicle Damage

Exterior
VDS 1-RFQ-4
CDC 01FREN1
Interior
OCDI RF0000000

Post-Impact Vehicular Behavior (deg - gyro @ c.g.)

Maximum Roll Angle 22
Maximum Pitch Angle 12
Maximum Yaw Angle 76

Enclosure 6



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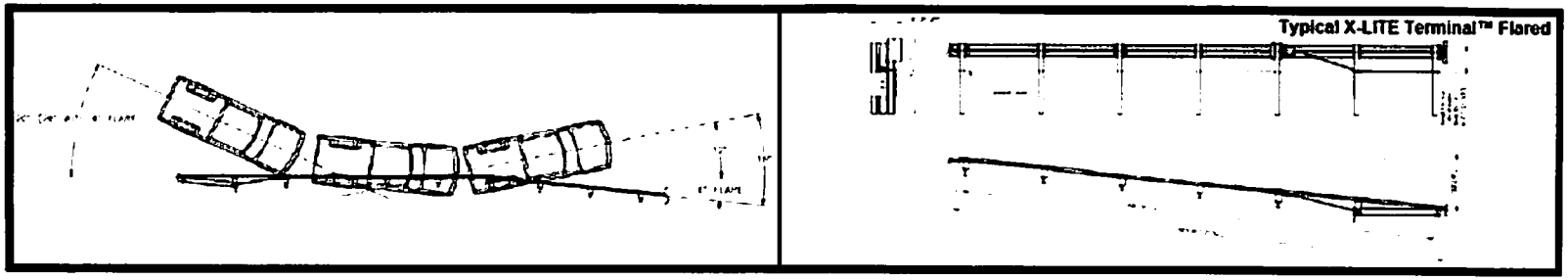


General Information

Test Agency ..... SAFE TECHNOLOGIES, INC.
Test Designation ..... NCHRP Report 350 3-35
Test No ..... STI Test # XTL04
Date 9/28/2010

Test Article

Type ..... End Terminal
Name ..... X-LITE Terminal Flared
Dimensions ..... Length: 11.9 m (39.0 ft)
Size and/or dimension and material ..... Height: 702 mm (27.6 in) - 787 mm (31.0 in)
of key elements ..... Width: 747 mm (29.4 in)

Test Vehicle

Type ..... Production Model
Designation 2000P
Model ..... 1992 GMC 3/4 Ton Pickup
Mass (kg)
Curb 1976
Test Inertial 1975
Dummy(s) ..... N/A
Gross Static 1975

Impact Conditions

Speed (kph) 99
Angle (deg) ..... 20 (26° with 6° flare)
Impact Severity (kJ) 87.4

Exit Conditions

Speed (kph) 56
Angle (deg) ..... 12 (18° with 6° flare)

Occupant Risk Values

Impact Velocity (m/s)
x-direction 6
y-direction 4
Ridedown Acceleration (g's)
x-direction 8
y-direction 9

Test Article Deflection (mm)

Dynamic 690
Permanent 600

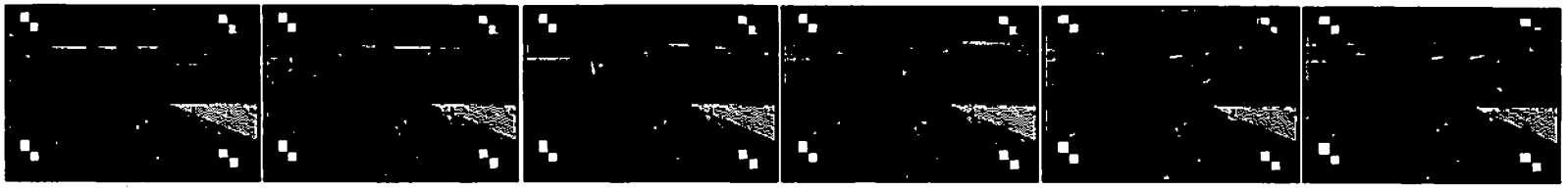
Vehicle Damage

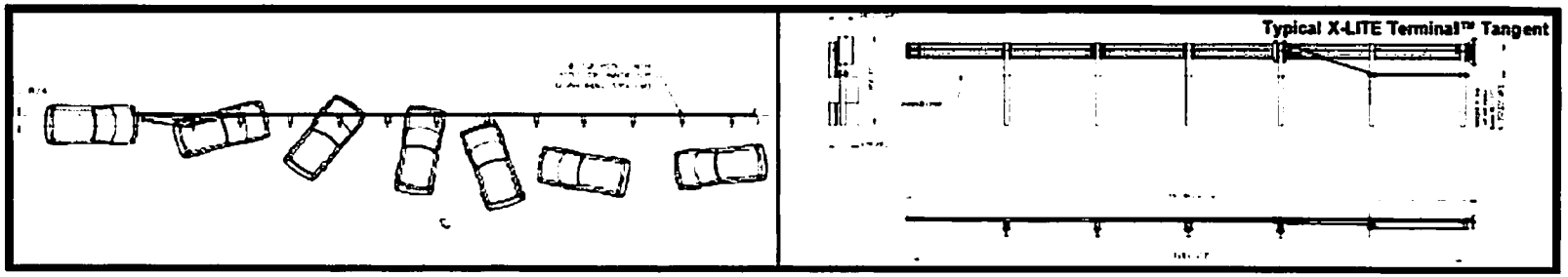
Exterior
VDS 1-RFQ-3
CDC 01FREN1
Interior
OCDI RF1001000

Post-Impact Vehicular Behavior (deg - gyro @ c.g)

Maximum Roll Angle 16
Maximum Pitch Angle 22
Maximum Yaw Angle 43

Enclosure 7





General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-30
Test No	STI Test # XTL12
Date	10/28/2010

Test Article

Type	End Terminal
Name	X-LITE Terminal Tangent
Dimensions	Length: 11.9 m (39.0 ft)
Size and/or dimension and material of key elements	Height: 702 mm (27.6 in) - 787 mm (31.0 in) Width: 610 mm (24.0 in)

Test Vehicle

Type	Production Model
Designation	820C
Model	1985 Honda CRX
Mass (kg)	
Curb	799
Test Inertial	815
Dummy(s)	75
Gross Static	890

Impact Conditions

Speed (kph)	99
Angle (deg)	0
Impact Severity (kJ)	310.0

Exit Conditions

Speed (kph)	N/A
Angle (deg)	N/A

Occupant Risk Values

Impact Velocity (m/s)	
x-direction	7
y-direction	0
Ridedown Acceleration (g's)	
x-direction	14
y-direction	7

Test Article Deflection (mm)

Dynamic	N/A
Permanent	N/A

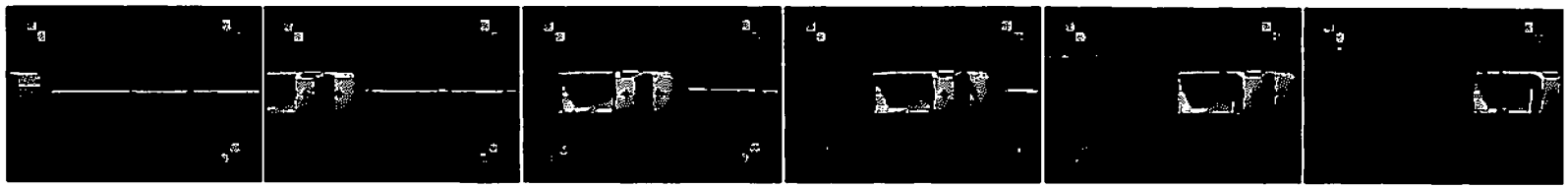
Vehicle Damage

Exterior	
VDS	12-FL-3
CDC	12FLEN1
Interior	
OCDI	LF0001000

Post-Impact Vehicular Behavior (deg - gyro @ c.g)

Maximum Roll Angle	51
Maximum Pitch Angle	19
Maximum Yaw Angle	209

Enclosure 8



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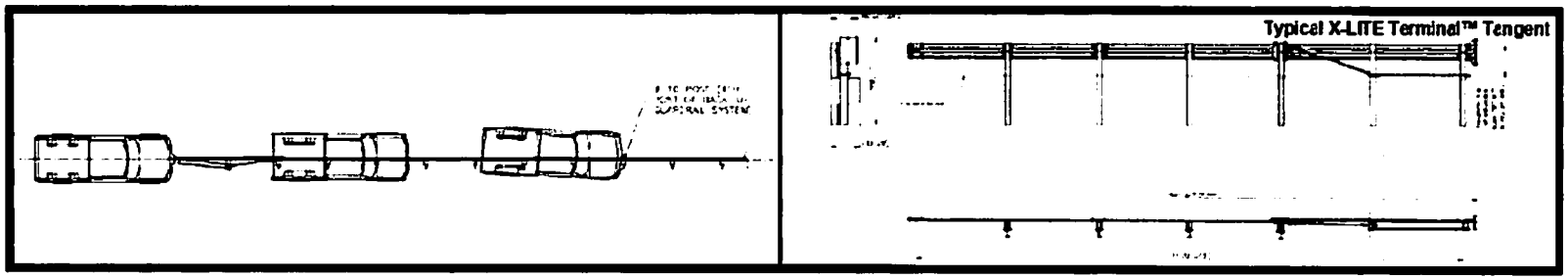

General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-31
Test No.	STI Test # XTL14
Date	11/3/2010

Test Article

Type	End Terminal
Name	X-LITE Terminal Tangent
Dimensions	Length 11.9 m (39.0 ft)
Size and/or dimension and material of key elements	Height 702 mm (27.6 in) 787 mm (31.0 in) Width 610 mm (24.0 in)

Test Vehicle

Type	Production Model
Designation	2000P
Model	2001 Chevrolet 3/4 Ton Pickup
Mass (kg)	
Curb	2146
Test Inertial	2030
Dummy(s)	N/A
Gross Static	2030

Impact Conditions

Speed (kph)	101
Angle (deg)	0
Impact Severity (kJ)	790.8

Exit Conditions

Speed (kph)	N/A
Angle (deg)	N/A

Occupant Risk Values

Impact Velocity (m/s)	
x-direction	4
y-direction	1
Ridedown Acceleration (g's)	
x-direction	13
y direction	3

Test Article Deflection (mm)

Dynamic	N/A
Permanent	N/A

Vehicle Damage

Exterior	
VDS	12-FC-1
CDC	12FCEN1
Interior	
OCDI	FS0000000

Post-Impact Vehicular Behavior (deg - gyro @ c.g)

Maximum Roll Angle	10
Maximum Pitch Angle	18
Maximum Yaw Angle	12