U.S. Department of Transportation
Federal Highway Administration

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

November 3, 2010

In Reply Refer To:
HSSD/CC-109

Mr. Gerrit A. Dyke, P.E.
Barrier Systems, Inc.
3333 Vaca Valley Parkway, Suite 800
Vacaville, CA 95688

Dear Mr. Dyke:

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

Name of system: X-TENuator (X-TEN); and,
X-TENuator (X-TEN) with Slider Panel Modification
Type of system: Redirective Non-Gating Crash Cushion
Test Level: TL-3
Testing conducted by: Safe Technologies Inc.
Task Force 13 Designator: SCI23
Date of request: February 25, 2010
Request Initially acknowledged: March 16, 2010
Date of Modification received: July 28, 2010 (letter dated July 23, 2010)
Date of completed Modification received: October 5, 2010

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 should meet the guidelines contained in the NCHRP Report 350 or the American Association of State Highway and Transportation Officials' 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 of longitudinal barriers.

Description
The X-TEN system is a redirective, non-gating crash cushion. The system is designed to safely decelerate an errant vehicle to a safe stop or redirect an errant vehicle away from roadside or median hazards. Enclosure 1 shows assembly of the X-TEN system. Enclosures 2 through 18 illustrate the details of each element used in the system. The system is comprised of an energy

absorbing nose cover, an energy absorbing nose cartridge, dual impact heads and cables, front cable anchors, W-Beam side panels, specially designed posts (Enclosure 8), and an independent backstop. Standard W-Beam block-out spacers (Enclosure 15) attach the side panels to the posts. The block-out spacers are tethered to the posts by wire ropes.

The system is designed to absorb the kinetic energy of the impacting vehicle. When a vehicle hits the system head-on, first energy is absorbed by the nose cover and the nose cartridge (Enclosure 13 and Enclosure 14). As the impact head is pushed back two cables (Enclosure 2) pull through a brake mechanism, dissipating energy. The depth of penetration of a vehicle into the system is dependent upon both the original impact speed and the mass of the impacting vehicle. When hit at an angle along the side beyond the first post, the system is restrained laterally by the W-Beam panels (Enclosure 6 and Enclosure 7) and cables that run the length of the system inside the panels. The front ends of the cables are attached to plates (Enclosure 12 and Enclosure 17) that are bolted to the foundation and the rear ends of the cables terminate in the backstop (Enclosure 4 and Enclosure 5) assembly.

The effective length of X-TEN system is 7.5 m (24 ft. 9 in.) and the effective overall height is 0.792 m (31.19 in.). The width of the system is 0.926 m (36.44 in.).

In addition, the following modifications and subsequent testing as submitted July 23, 2010 are as follows:

a. Anchor Indicator Notches: This modification consists of small triangular notches added on the front cable anchors and backstops to indicate which holes to use when anchoring to a concrete foundation. All holes are used when anchoring onto an asphalt foundation.
b. Cable Retainers: This modification consists of two small holes added to the front cable anchors to permit a plastic tie to be inserted. This plastic tie ‘tacks’ the cable in place in a slot during installation process.
c. Plastic Nose Cartridge: This modification consists of changing the existing energy absorbing nose piece cartridge to a thin-wall polyethylene canister consisting of steel mesh reinforced cardboard tube. This canister is filled with the same substance as the existing cartridge (i.e., polyurethane foam).
d. Plastic Nose Cover: This modification consists of changing existing nose cover design from a riveted multiple piece section to a single piece polyethylene shell section.
e. Cable Length: This modification consisted of changing the length of the existing cables slightly to allow a better fit and improve the release function.
f. Bolted Slider Panel: This modification consists of changing existing slider plate design from a welded section to a bolted section for ease of assembly purposes. The slider panels consist of the front W-Beam side panels that attach to the impact heads in the front of the system and wrap around the rear panels at the mid-point of the system. The original slider panel utilized a formed plate that was welded directly to the W-Beam panel and wrapped around the rear panel that is nested inside at the lapped joint. The welded connection was modified to incorporate a bolted connection. The bolt connection allows the rear panel to be nested inside the slider panel and then bolted in place during system assembly. Prior assembly required feeding the entire rear panel through the slider panel. The bolted connection was designed to be equal to or stronger than the welded connection to ensure equivalent function as was tested. The attached

computational analysis demonstrates that structural capacity of the proposed bolted joint is greater than that of the existing welded connection.

Crash Testing

The X-TEN crash cushion system was successfully crash tested as per NCHRP Report 350 test designations 3-31 through 3-33 and 3-36 through 3-39 by Safe Technologies Inc. In tests 3-31, 3-37, 3-38, and 3-39, the X-TEN system was attached to an Asphalt Concrete (AC) pad set over dense graded aggregate with forty two (42) 20 mm (3/4 inch) all thread studs embedded 400 mm (16 in.) and epoxied in place (Enclosure 19). In test 3-32, test 3-33, and test 3-36, the X-TEN system was attached to a Portland Cement Concrete (PCC) pad with twenty-six (26) 20 mm (3/4 in.) all thread studs embedded 150 mm (6 inch) and epoxied in place (Enclosure 20). Enclosures 21 through 23 summarize the results of test 3-31 through 3-33 respectively and Enclosures 24 through 27 summarize the results of test 3-36 through 3-39.

In addition, the X-TEN with slider panel modification crash cushion submission dated July 23, 2010 proposed the following:

1. One crash test as per NCHRP Report 350 Test 3-31 was conducted.
2. Request for equivalence to original crash testing for following crash tests:
   - During frontal impacts, the slider panel moves rearward, around the rear panel, and knocks the blockouts and panel connections free. When the end of the slider panel reaches the backstop, it interacts with a ramp on the backstop, forcing the nested panels outward and disengaging the cable from the backstop. Test 3-31 was performed on the system to demonstrate acceptable (and equivalent) function of the modified slider (and other system modifications) in the most severe loading of the effected connection. Other frontal impact tests including tests 3-30, 3-32, and 3-33, are not affected as critically by the slider modification as the system is not stroked far enough to engage many of functions of the component.
   - During side impacts, the slider panel provides lateral support to the re-direction of the impacting vehicle and transmits the tension to the rear panel. The slider panel also provides the fit to keep the panels nested properly during reverse side impacts. The original slider panel connection was proven adequate for transmitting longitudinal tension in tests 3-36, 3-37, 3-38, and 3-39. The bolted joint is capable of resisting a higher load, therefore, the modification was determined to not affect the performance of the system in these tests. The dimensional characteristics of the slider panel were maintained to ensure consistent gaps and clearances for proper nesting and resistance to snagging in reverse impacts.
   - For tests 3-36, 3-37, and 3-38, the slider panel connection is not loaded to failure or cause tension loading in excess of the front panel/rear panel joint capacity. While local deformation of the components is evident, research personnel indicate the excess strength of the bolted version of the slider panel does not affect the performance of the system or the occupant risk factors. Additional information can be reviewed in the research crash test report No. STI X-TEN-02.
   - In test 3-39, the front panel/rear panel joint is loaded beyond capacity. When excessive longitudinal forces are transmitted across the joint, the “slider bracket” yields and pulls through the slider panel, allowing the panels to separate. The slider bracket consists of a section of angle iron attached to the rearward panel. The welded

slider panel was not damaged. Therefore, the excess strength of the bolted version of the slider does not affect the performance of the system or the occupant risk factors.

Findings

As stated in your letter dated February 25, 2010, in accordance with NCHRP 350 tests 3-30 through 3-33 and tests 3-36 through 3-39 are to be conducted for test level 3 non-gating crash cushions approval. The system was crash tested under all of these required tests, except for test 3-30. The system described above and shown in Enclosure 1 passed all tests that were conducted. Occupant Impact Velocities (OIV) associated with all tests are below the "preferred" limit and Occupant Ridedown Acceleration (ORA) for all tests except test 3-31 are below the "preferred" limit. The ORA for test 3-31 was calculated 20 G which is the maximum allowable limit according to NCHRP 350.

In addition, you have requested test 3-30 be waived. Your request is accepted on the grounds that test 3-32 is historically more critical than test 3-30. In your letter, you have also requested FHWA acceptance of the following for the X-TEN system:

- The X-TEN system secured to Asphalt Concrete (AC) roadways,
- The X-TEN system secured to Portland Cement Concrete (PCC) foundations,
- The X-TEN system has redirective capacity beginning at the impact head behind the nose cover,
- The X-TEN system can be attached to other roadside barriers by using standard transitions that have been accepted for attaching "W" profile guardrails to rigid barrier systems.

The above additional requests are also accepted. Based on the provided videos of the crash tests conducted on the X-TEN attached to AC roadways or PCC foundations, none of the bolts were pulled out. In these tests either posts collapsed or the bolts sheared. Consequently, we concur that the X-TEN system can be attached to both AC roadways and PCC foundations.

In the crash test videos associated with tests 3-31, 3-32, and 3-33 (in which the test vehicle hits the test article head-on) the test articles confirm that the vehicle is captured when impacting the first post (does not gate through) and confirms the redirective capacity beginning at the impact head behind the nose cover.

Your last request in regards to attaching to other roadside barriers is also accepted on the grounds that attaching the X-TEN system using an appropriate standard connection will not likely degrade the performance of the system.

As requested in your letter dated July 23, 2010, referencing the X-TEN with modified slider plate crash cushion, we concur that modifications (a.) through (e.) inclusive will not adversely degrade the successful crash test performance of the system and are acceptable for use on the NHS system.

In addition and in reference to modification (f.), we concur with your request for equivalence in that a bolted slider plate (vs. original welded detail) does not adversely effect the successful crash test performance of the system and is acceptable for use on the NHS system.

Also, the results of the NCHRP Report 350 Test 3-31 as conducted on the X-TEN with slider panel modification crash cushion was found to successfully meet all Test 3-31 testing criteria. A summary of the crash test is attached.
Therefore, the system described in the requests above and detailed in the enclosed drawings is 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 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-109 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-TEN 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.

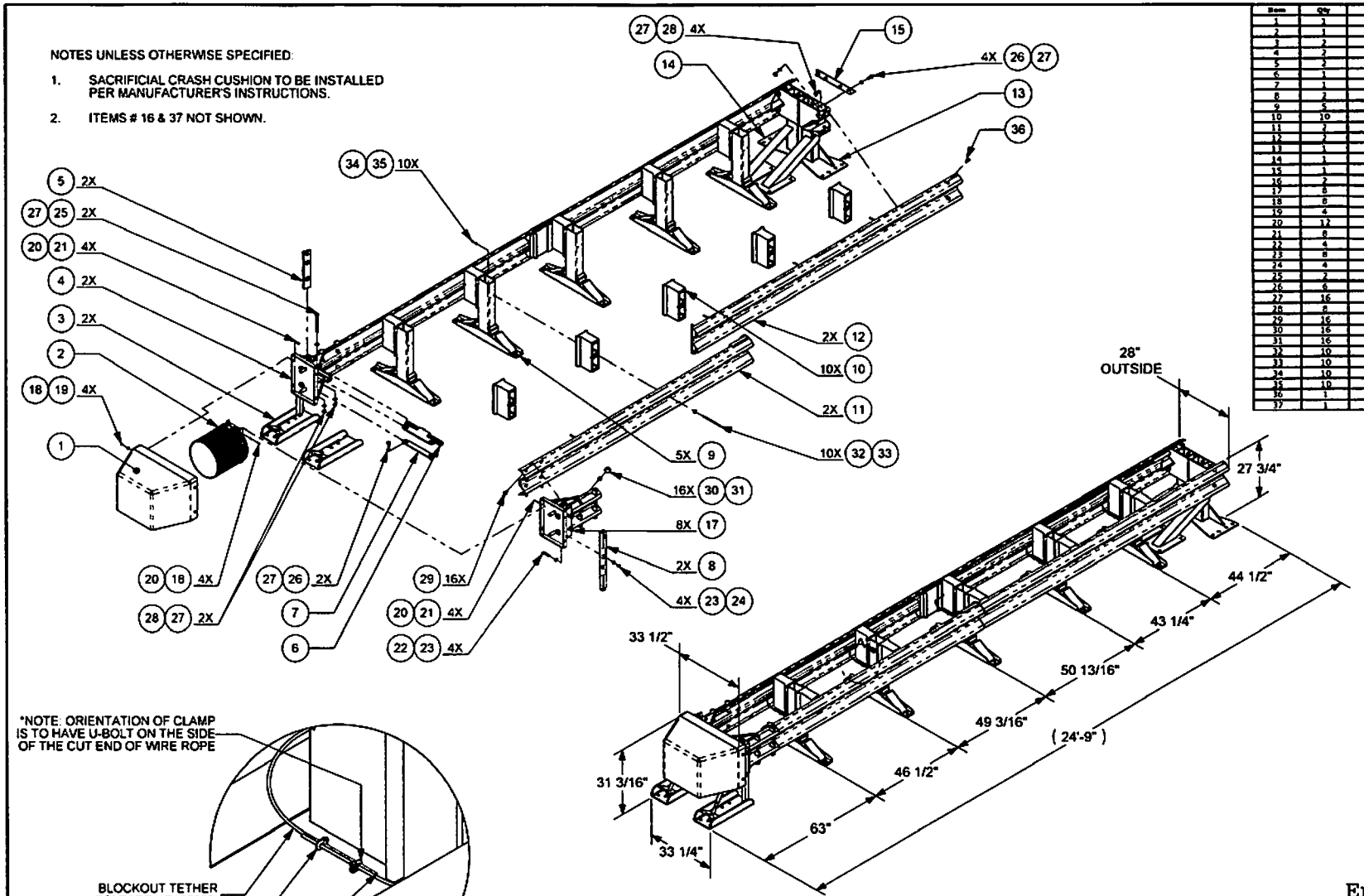
Sincerely yours,

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

29 Enclosures

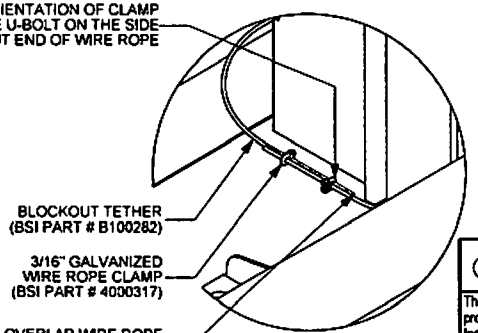
NOTES UNLESS OTHERWISE SPECIFIED:

1. SACRIFICIAL CRASH CUSHION TO BE INSTALLED PER MANUFACTURER'S INSTRUCTIONS.
2. ITEMS # 16 & 37 NOT SHOWN.



Item	Qty	Description	Part #	U/M
1	1	Nose Cover, X-TENuator	B100238	EACH
2	1	FA Nose Cartridge, X-TENuator	B100239	EACH
3	2	Cable Anchor Weldment	B100244	EACH
4	2	Head Unit Weldment, X350	B061073	EACH
5	2	Cable Friction Fit, Head Unit	B061058	EACH
6	1	Upper Head Support Weldment	B100247	EACH
7	1	Lower Head Support Plate	B100250	EACH
8	2	Head Support Leg Weldment	B100251	EACH
9	5	Leaning Post Weldment	B100254	EACH
10	10	W-Beam Composite Blockout 6in.	B090534	EACH
11	2	Front Panel Weldment	B100259	EACH
12	2	Back Panel Weldment	B100263	EACH
13	1	Backstop Weldment, Right	B100266	EACH
14	1	Backstop Weldment, Left	B100267	EACH
15	1	Brace, Backstop, X-TENuator	B100280	EACH
16	2	Cable Assembly, X-TENuator	B100283	EACH
17	8	C-Scr HH M16-2 Sx75mm Gr 5.8	2001615	EACH
18	8	C-Scr HH 1/4-20x1 Gr2 MGal	2000298	EACH
19	4	Wshr Fender 1/4x1.0 ODx.063	2000261	EACH
20	12	Wshr 1/4 Flat Rd Galv	2001446	EACH
21	8	Nut HN 1/4-20 MGal	2000274	EACH
22	4	C-Scr HH 5/8-11x3 1/4 Gr2 MGal	2000259	EACH
23	8	Wshr 5/8 F436 Struct Galv	2000118	EACH
24	4	Nut HN 5/8-11 A563 Gr1 Gal	2000134	EACH
25	2	C-Scr HH 3/4-10x9 Gr5 MGal	2001453	EACH
26	6	C-Scr HH 3/4-10x1 3/4 Gr5 MGal	2000126	EACH
27	16	Wshr 3/4 F436 Flat Rd Struct	2001634	EACH
28	8	Nut HN 3/4-10 MGal	2001705	EACH
29	16	Guardrail Bolt 5/8-11x1 3/4	4001115	EACH
30	16	Guardrail Nut Recessed 5/8-11	4001116	EACH
31	16	PLASTIC NUT PROTECTOR	B080755	EACH
32	10	C-Scr HH 3/8-16x9 Gr5 MGal	2000121	EACH
33	10	Wshr Fender 3/8 x 1.50D x .063	2000096	EACH
34	10	Wshr 3/8 Flat Rd SAE Galv	2001408	EACH
35	10	Nut HN 3/8-16 Gr5 Gal	2000405	EACH
36	1	Kit, X-Tension Shear Bolt	K080123	EACH
37	1	Tether Kit, X-TENuator	K100201	EACH

*NOTE: ORIENTATION OF CLAMP IS TO HAVE U-BOLT ON THE SIDE OF THE CUT END OF WIRE ROPE



DETAIL A
SCALE 1 : 6

Enclosure 1

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:40

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DRAWN BY	02/09/10	JR
APPR'D BY		GAD

TITLE: X-TENUATOR 100kph, NARROW

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .015
Dec .XX± ± .030

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
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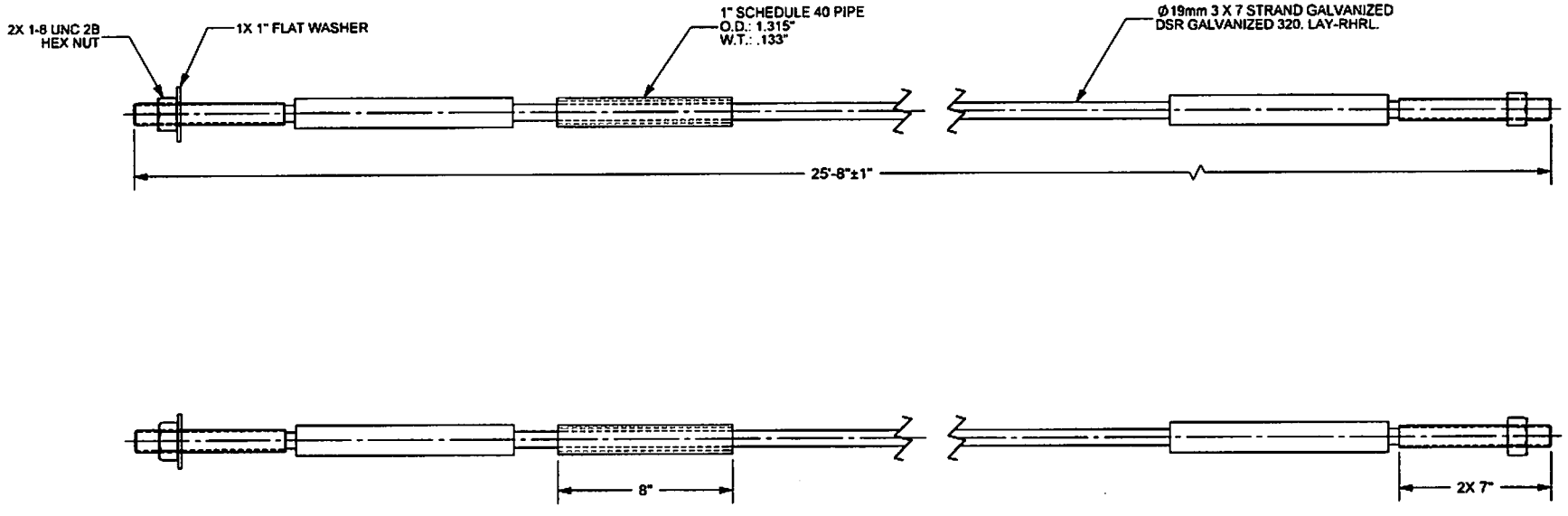
NOTES UNLESS OTHERWISE SPECIFIED:

1. FINISH: GALVANIZED PER ASTM A123



Enclosure 2

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:5

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

TITLE: CABLE ASSEMBLY, X-TENUATOR

SHEET	DRAWING NUMBER	REV
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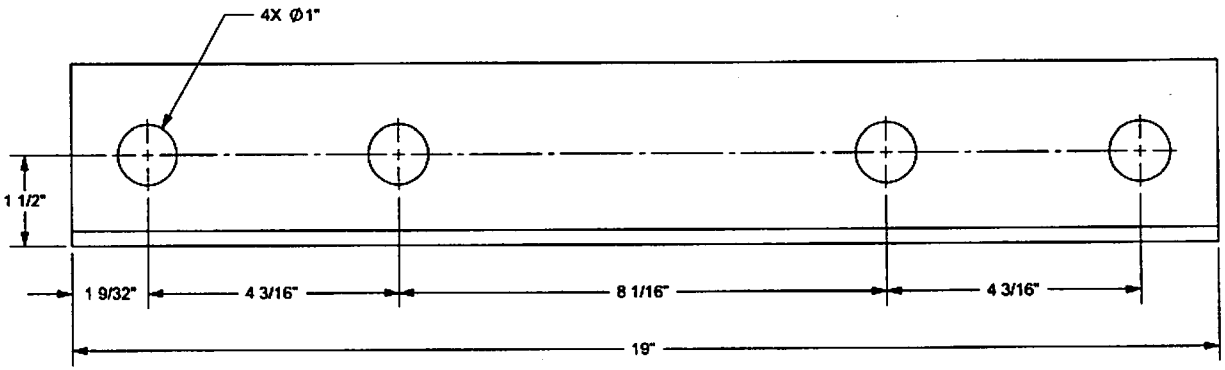
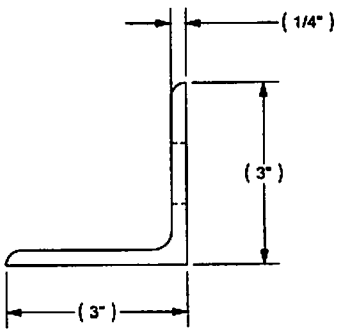
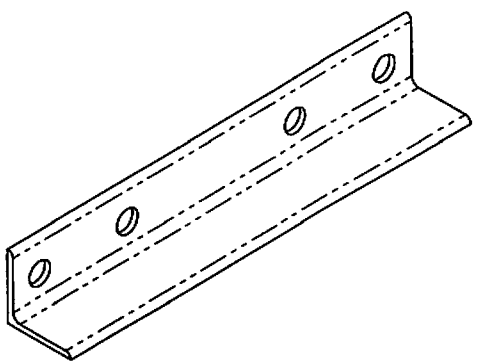
NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123







Enclosure 3

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:2

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .013
Dec .XX± ± .030

TITLE: BRACE, BACKSTOP, X-TENUATOR

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
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NOTES UNLESS OTHERWISE SPECIFIED

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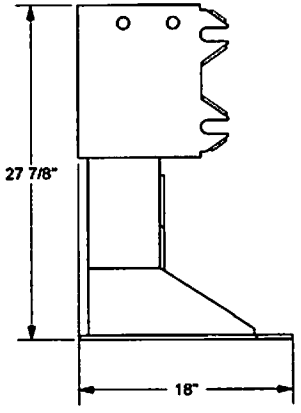
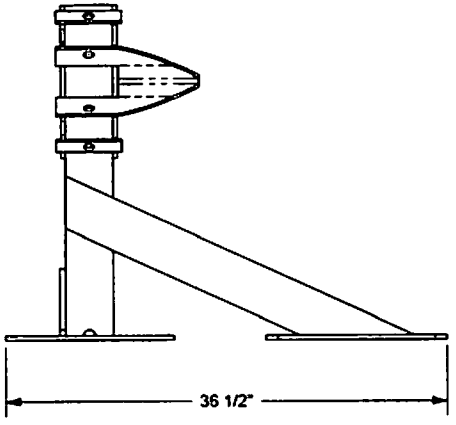
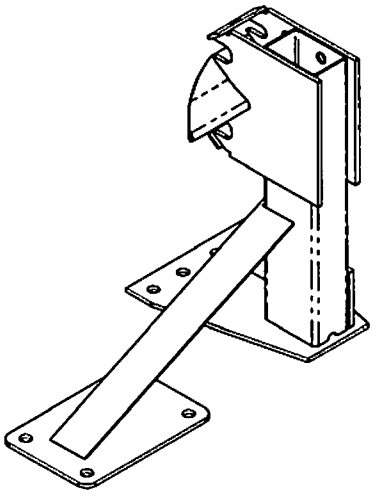
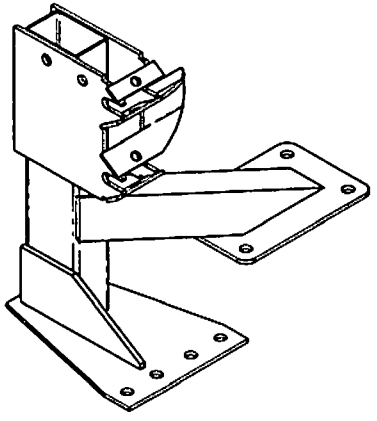
2. FINISH: GALVANIZED PER ASTM A123









Enclosure 4

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:10

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

TITLE
BACKSTOP WELDMENT, LEFT, X-TENUATOR

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
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NOTES UNLESS OTHERWISE SPECIFIED:

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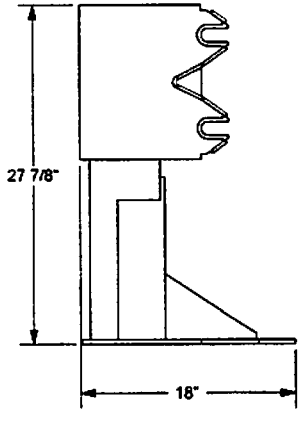
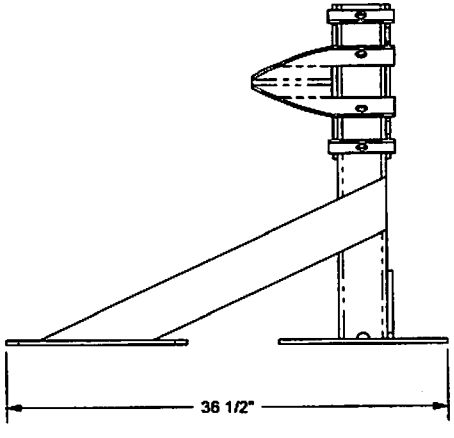
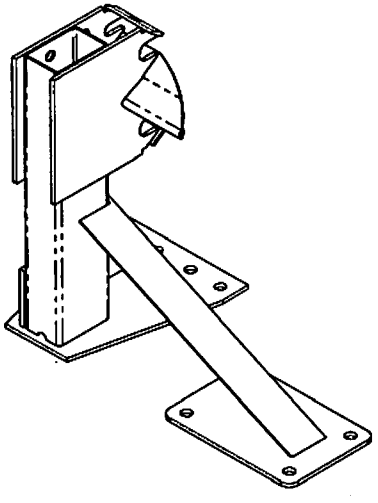
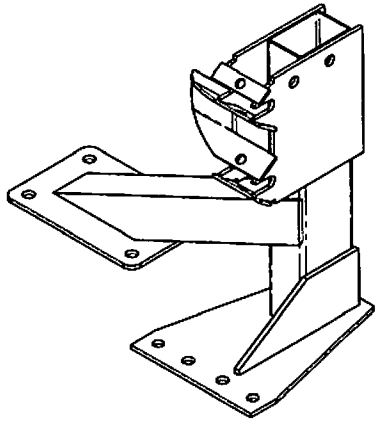
2. FINISH: GALVANIZED PER ASTM A123









Enclosure 5

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:10

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

TITLE: BACKSTOP WELDMENT, RIGHT, X-TENUATOR

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
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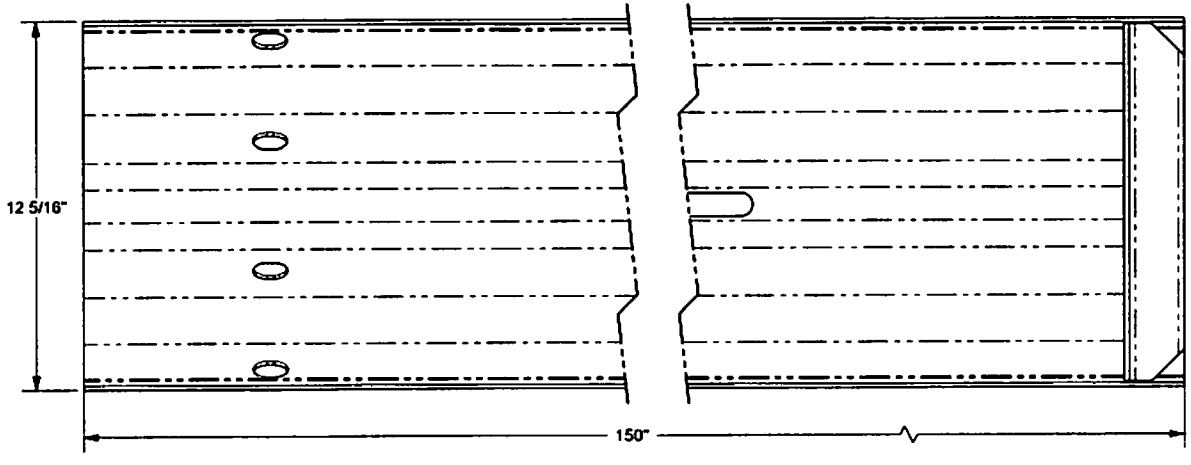
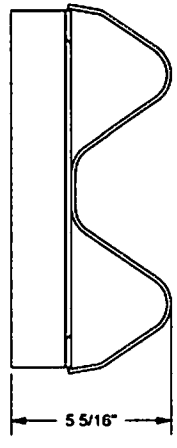
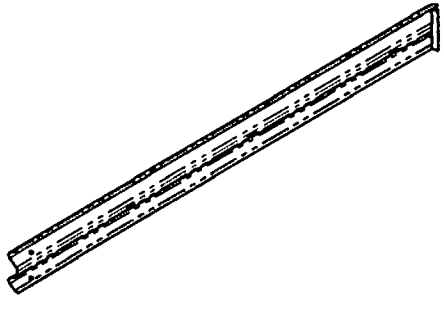
NOTES UNLESS OTHERWISE SPECIFIED

1. MATERIAL ASTM A36 & A606
2. FINISH GALVANIZED PER ASTM A123







Enclosure 6

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:4

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

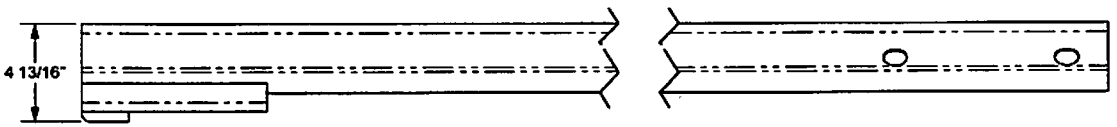
TITLE: BACK PANEL WELDMENT, X-TENUATOR

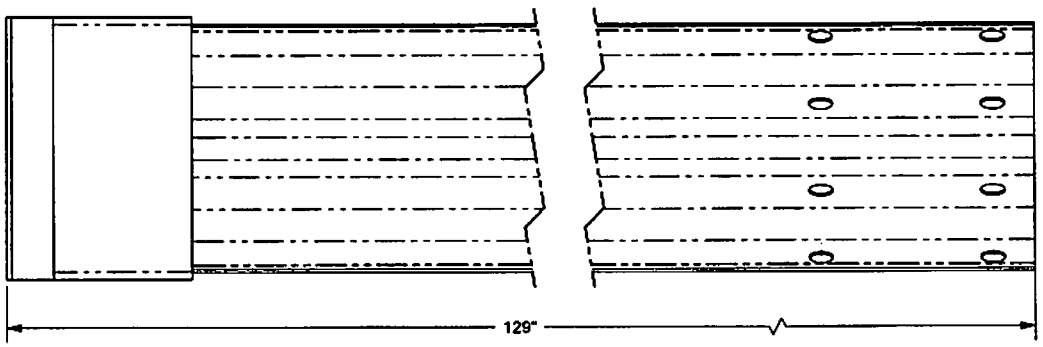
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

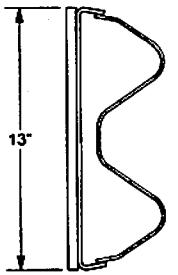
SHEET	DRAWING NUMBER	REV
1 OF 1	B100263-US	0

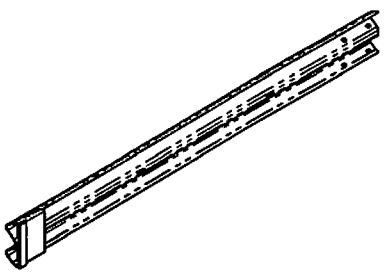
NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIAL: ASTM A36 & A606
2. FINISH: GALVANIZED PER ASTM A123









Enclosure 7

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:6

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

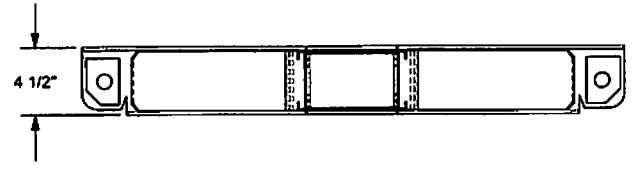
TITLE: FRONT PANEL WELDMENT, X-TENUATOR

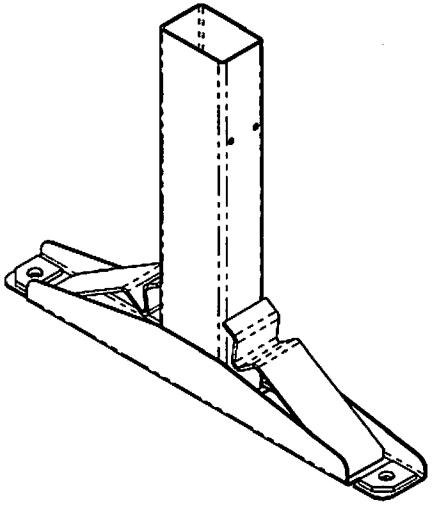
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

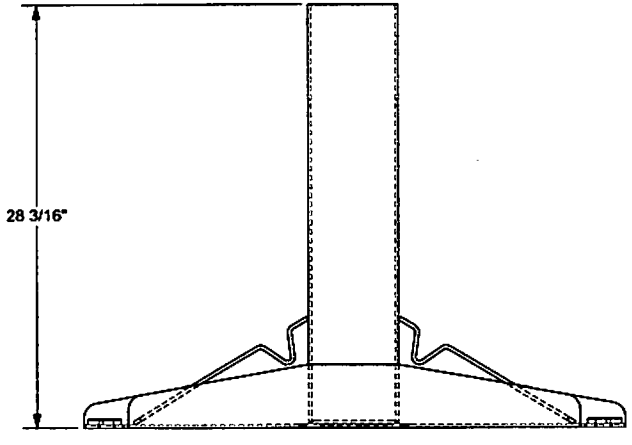
SHEET	DRAWING NUMBER	REV
1 OF 1	B100259-US	0

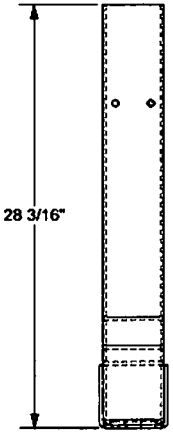
NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123









Enclosure 8

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:8

	DATE	INIT
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance

Angular	±	1/2°
Fractional	±	1/16"
Dec .XXX=	±	.010
Dec .XX=	±	.030

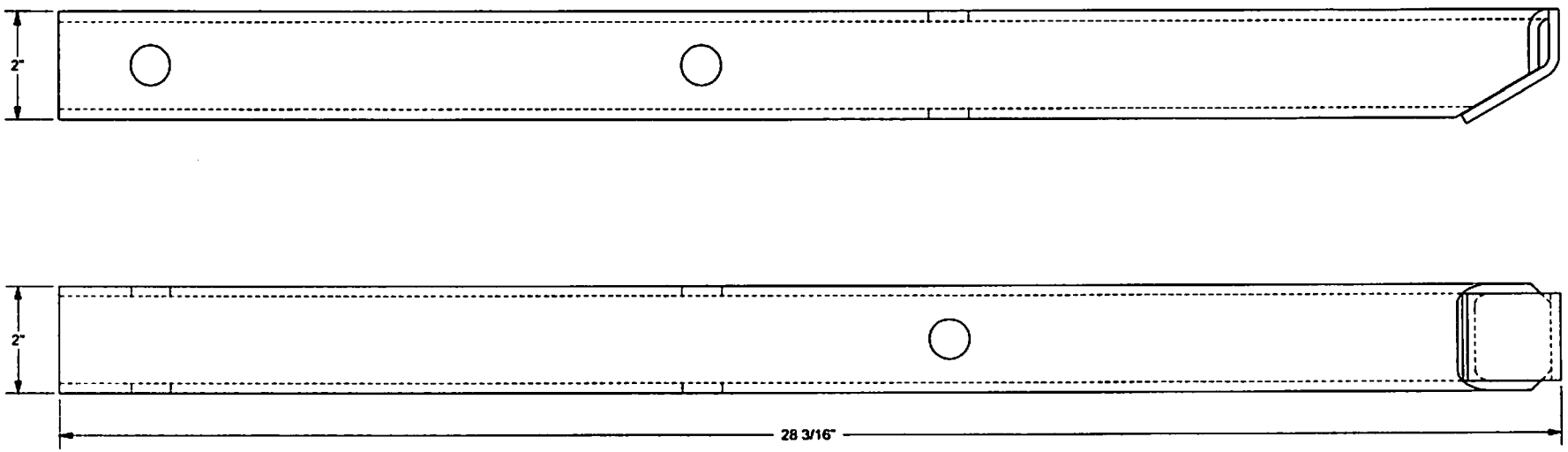
TITLE: LEANING POST WELDMENT, X-TENUATOR

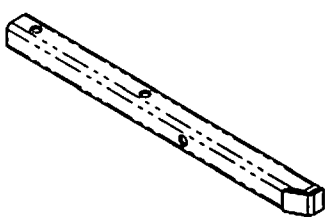
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B100254-US	0

NOTES UNLESS OTHERWISE SPECIFIED

1. MATERIAL ASTM A36
2. FINISH GALVANIZED PER ASTM A123





Enclosure 9

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:2

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

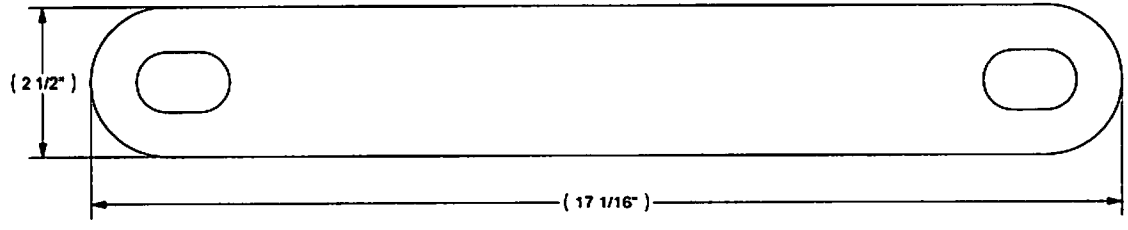
TITLE:
HEAD SUPPORT LEG WELDMENT, X-TENUATOR

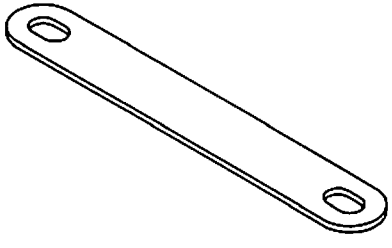
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B100251-US	0

NOTES UNLESS OTHERWISE SPECIFIED

1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123





Enclosure 10

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:2

	DATE	INIT
DRAWN BY	02/09/10	JR
APP'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XX± ± .010
Dec .XX± ± .030

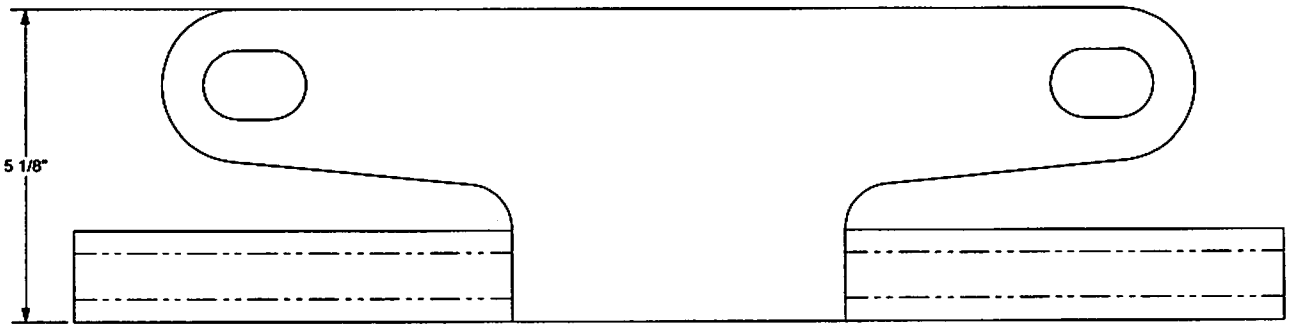
TITLE:
LOWER HEAD SUPPORT PLATE, X-TENUATOR

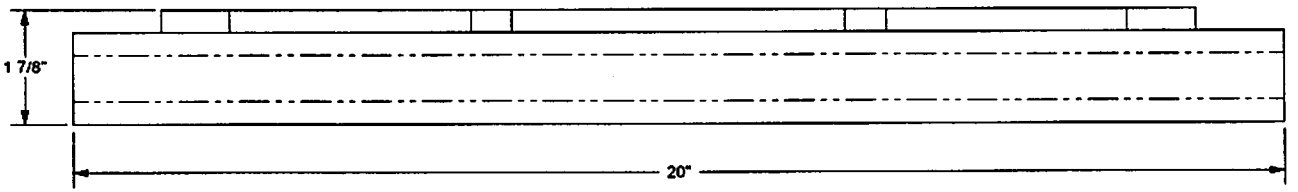
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

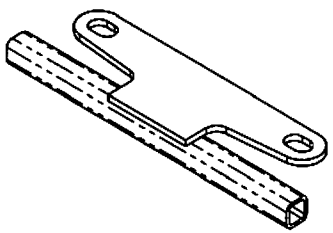
SHEET	DRAWING NUMBER	REV
1 OF 1	B100250-US	0

NOTES UNLESS OTHERWISE SPECIFIED

1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123







Enclosure 11

REV.	CHANGES	DATE	BY	RECD	NEXT ASSY.	ITEM

SCALE: 1:2

	DATE	INIT
DRAWN BY	02/09/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

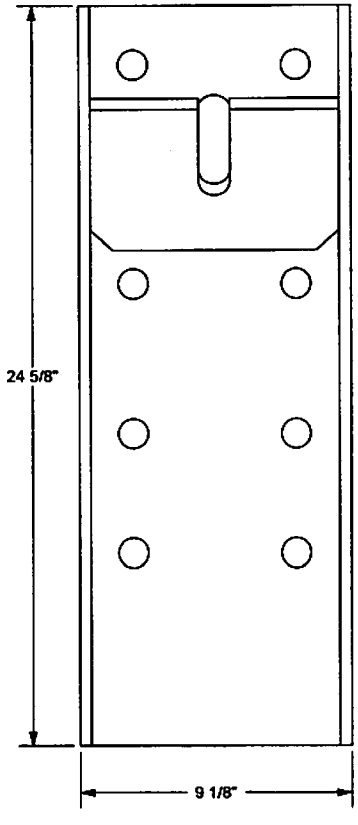
TITLE:
UPPER HEAD SUPPORT WELDMENT, X-TENUATOR

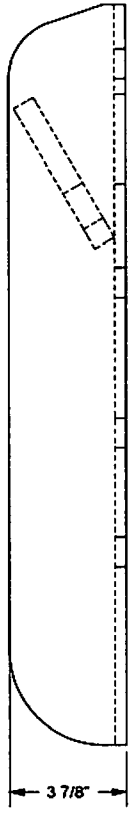
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

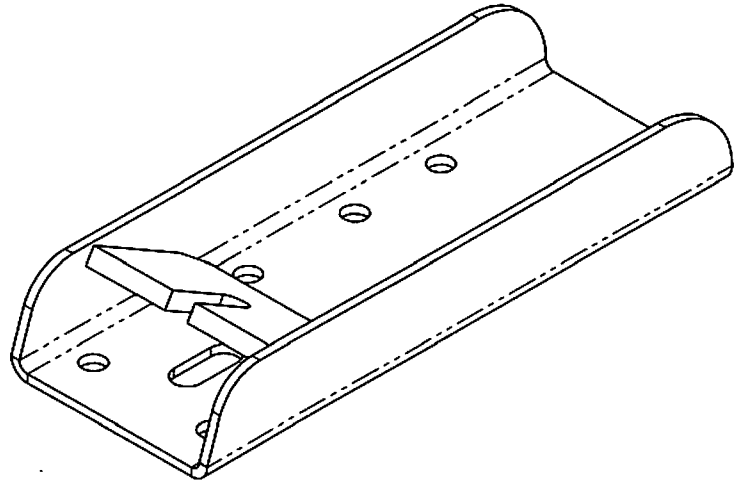
SHEET	DRAWING NUMBER	REV
1 OF 1	B100247-US	0

NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123







Enclosure 12

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:4

	DATE	INIT.
DRAWN BY	02/09/10	JR
APPR'D BY		

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

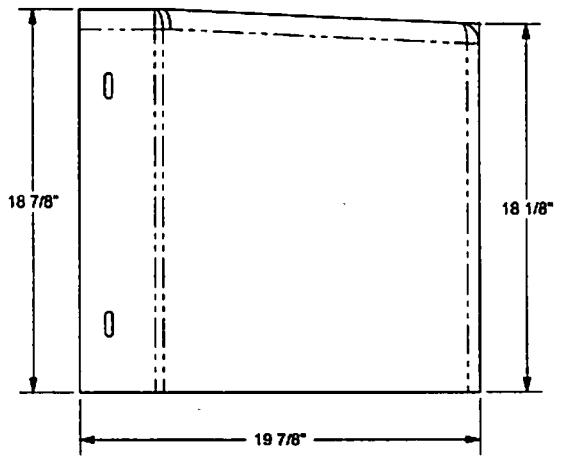
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

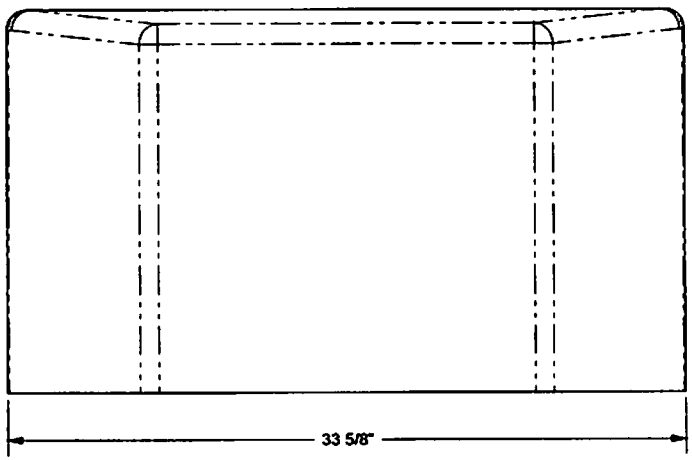
TITLE: CABLE ANCHOR WELDMENT, X-TENUATOR

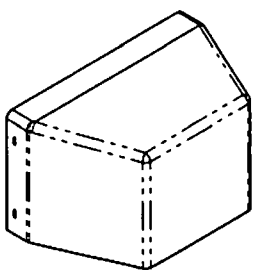
SHEET	DRAWING NUMBER	REV
1 OF 1	B100244-US	0

NOTES UNLESS OTHERWISE SPECIFIED

1. MATERIAL POLYETHYLENE







Enclosure 13

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:6

	DATE	INIT
DRAWN BY	02/08/10	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

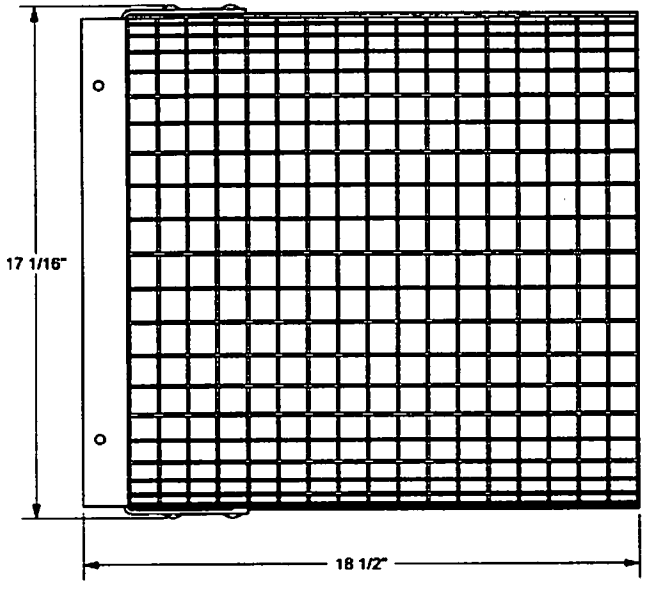
TITLE: NOSE COVER, X-TENUATOR

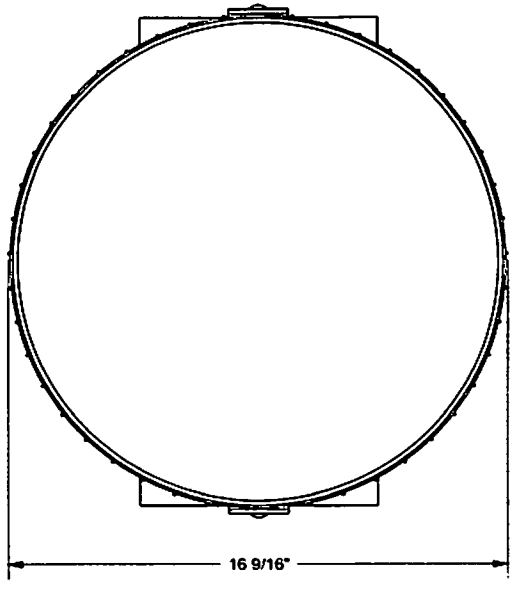
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

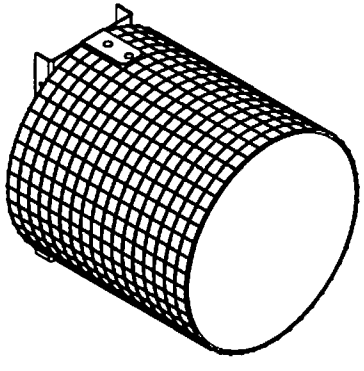
SHEET	DRAWING NUMBER	REV
1 OF 1	B100238-US	0

NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIALS ASTM A36, STEEL MESH, POLYURETHANE FOAM
2. FINISH GALVANIZED PER ASTM A123







Enclosure 14

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:4

	DATE	INIT.
DRAWN BY	02/02/10	JS
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

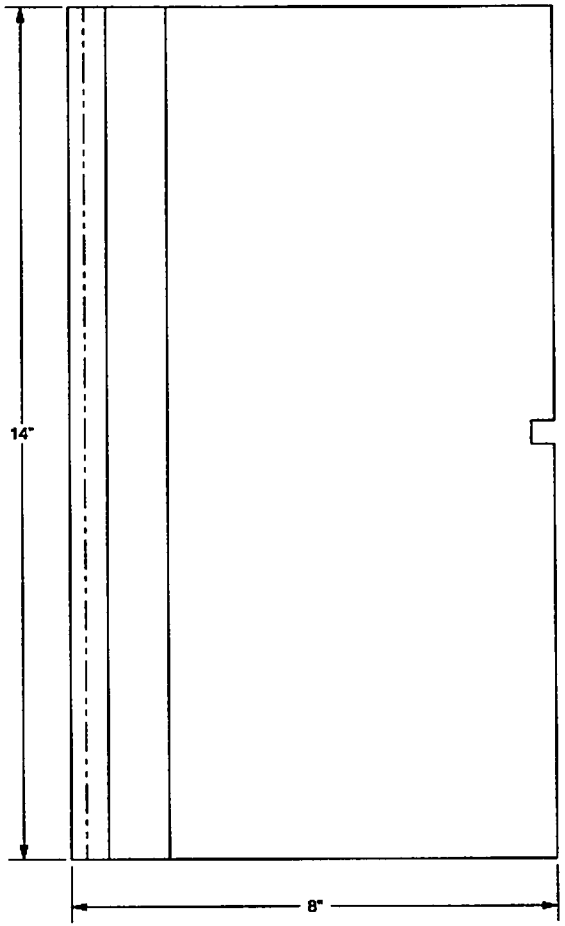
TITLE:
EA NOSE CARTRIDGE, X-TENUATOR

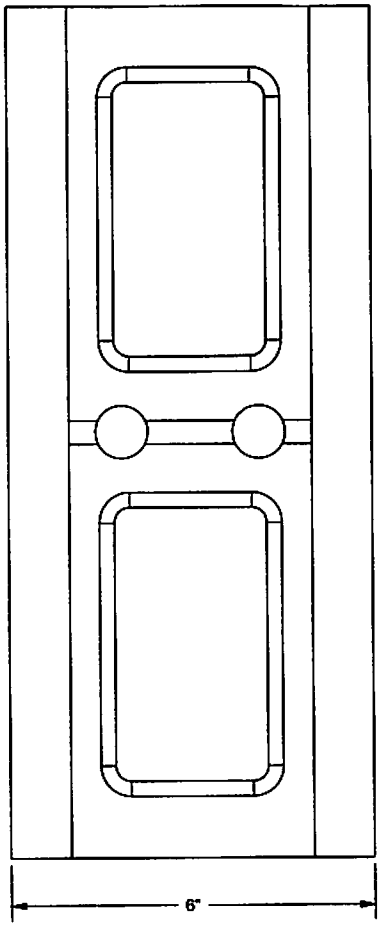
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

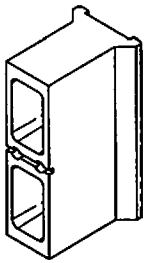
SHEET	DRAWING NUMBER	REV
1 OF 1	B100239-US	0

NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIAL: POLYETHYLENE







Enclosure 15

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:2

	DATE	INIT.
DRAWN BY	05/20/09	JR
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

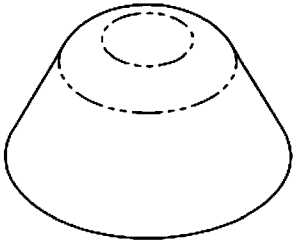
TITLE:
W-BEAM COMPOSITE
BLOCKOUT 8in, XT110

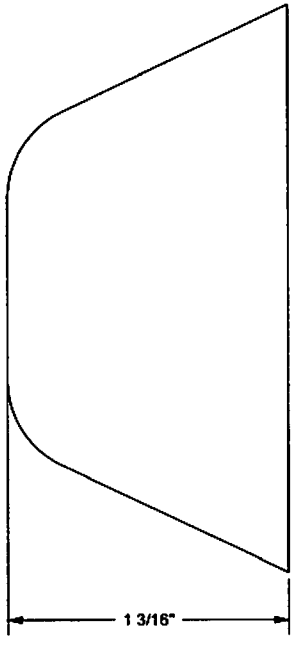
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

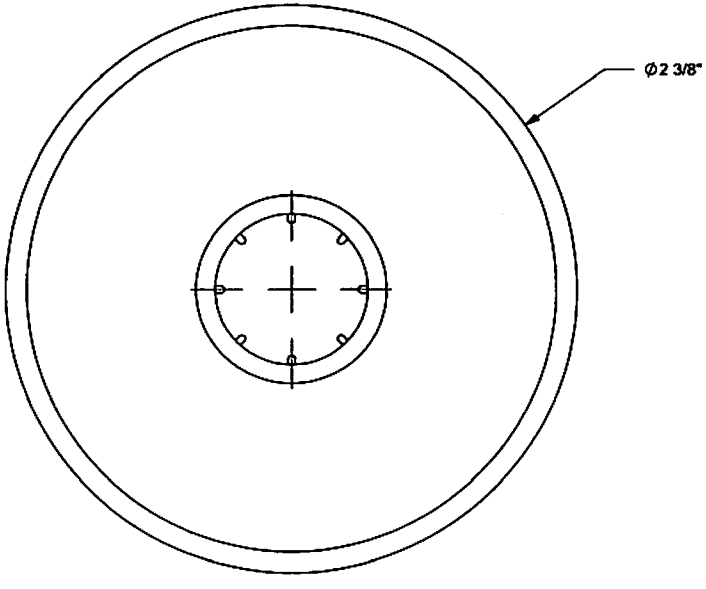
SHEET	DRAWING NUMBER	REV
1 OF 1	B090534-US	0

NOTES UNLESS OTHERWISE SPECIFIED

1. MATERIAL: GLASS REINFORCED NYLON







Enclosure 16

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 2:1

	DATE	INIT.
DRAWN BY	10/27/08	JR
APPR'D BY		

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .013
Dec .XX± ± .030

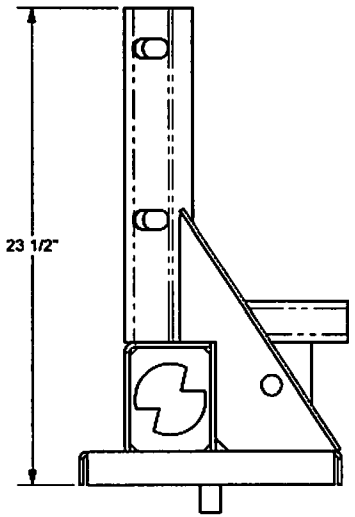
TITLE: PLASTIC NUT PROTECTOR

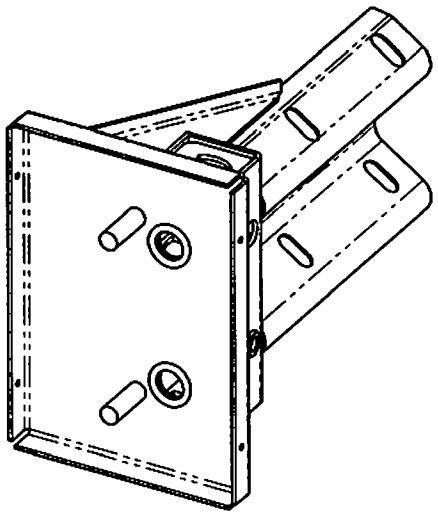
BARRIER SYSTEMS
A LINSAY TRANSPORTATION SOLUTIONS COMPANY

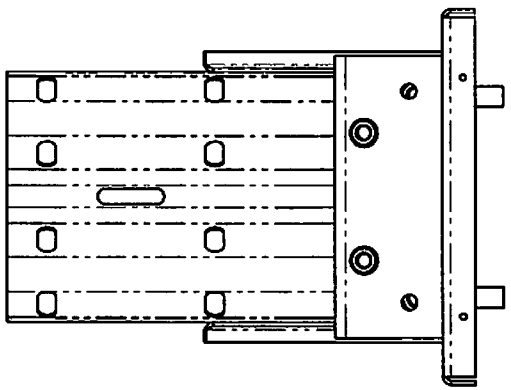
SHEET	DRAWING NUMBER	REV
1 OF 1	B080755-US	0

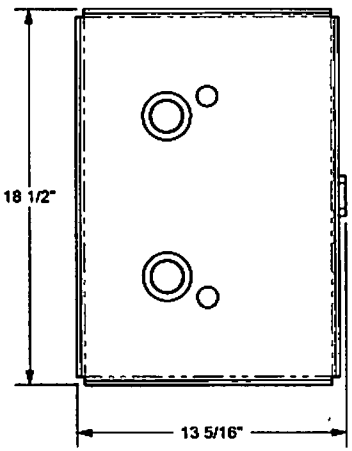
NOTES UNLESS OTHERWISE SPECIFIED:

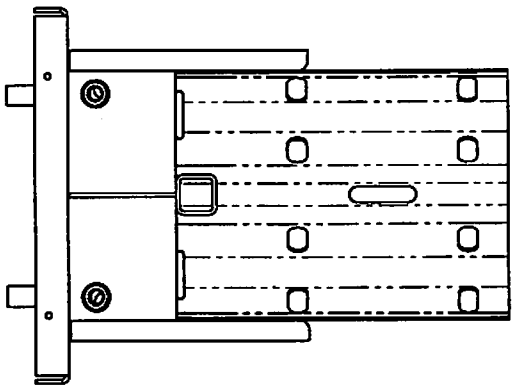
1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123











Enclosure 17

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:6

	DATE	INIT
DRAWN BY	10/23/06	AEM
APPR'D BY		GAD

Standard Tolerance: Angular ± 1/2°; Fractional ± 1/16"; Dec .XXX± ± .013; Dec .XX± ± .030

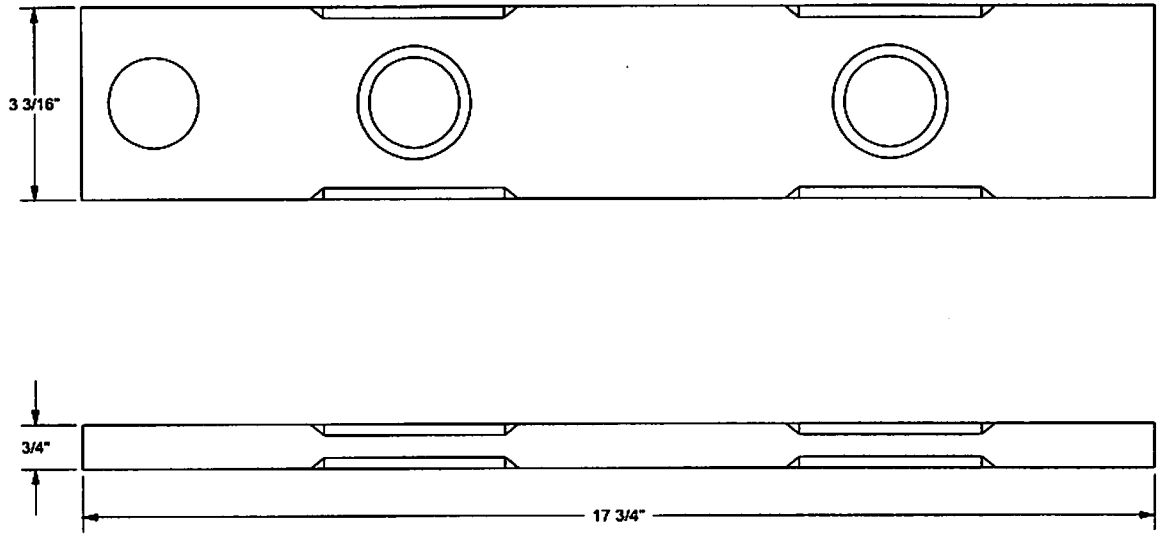
TITLE: HEAD UNIT WELDMENT, X350

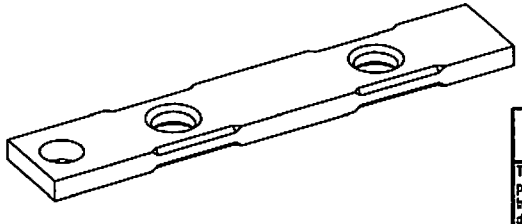
BARRIER SYSTEMS — A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B061072-US	E

NOTES UNLESS OTHERWISE SPECIFIED:

1. MATERIAL: ASTM A36
2. FINISH: GALVANIZED PER ASTM A123





Enclosure 18

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM

SCALE: 1:2

	DATE	INIT
DRAWN BY	10/20/06	AEM
APPR'D BY		GAD

Standard Tolerance
Angular ± 1/2°
Fractional ± 1/16"
Dec .XXX± ± .010
Dec .XX± ± .030

TITLE: CABLE FRICTION PLATE, HEAD UNIT

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B061058-US	B

NOTES UNLESS OTHERWISE SPECIFIED

1. ASPHALT OVER SUBBASE:
   MINIMUM 6" [150 mm] ASPHALTIC CONCRETE (AC)
   OVER 6" [150 mm] COMPACTED DGA SUBBASE.
   ANCHORAGE
   3/4" X 8 1/4" [20mm X 210mm] GALVANIZED ANCHORS
   WITH 6" [150mm] EMBEDMENT.

2. ASPHALT ONLY
   MINIMUM 8" [200 mm] ASPHALTIC CONCRETE (AC).
   ANCHORAGE
   3/4" X 16" [20mm X 430mm] GALVANIZED ANCHORS WITH
   16" [410mm] EMBEDMENT.

3. ASPHALT OVER P.C. CONCRETE:
   ANCHORAGE
   3/4" [20mm] GALVANIZED ANCHORS WITH MINIMUM 6" [150mm]
   EMBEDMENT IN PCC. - USE PCC ANCHOR LOCATIONS
   OR
   IF 6" [150mm] EMBEDMENT IN PCC IS NOT POSSIBLE USE
   3/4" X 16" [20mm X 460mm] GALVANIZED ANCHORS WITH
   16" [410mm] EMBEDMENT. - USE PCC ANCOR LOCATIONS

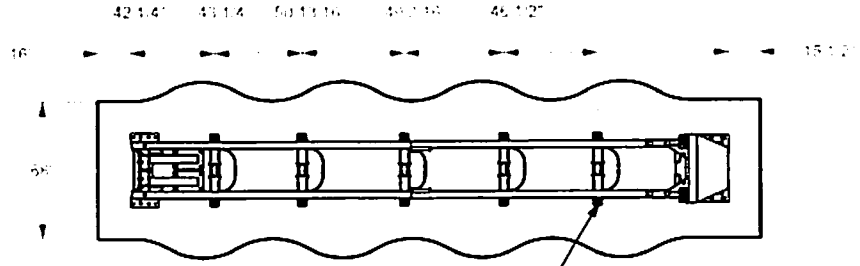
4. MATERIAL:
   COMPACTED SUBBASE (DGA)
   6" [150 mm] MINIMUM DEPTH, 95%
   COMPACTION, CLASS 2 AGGREGATE.

SIEVE SIZE	%PASSING
3"	100
2 1/2"	90-100
No. 4	40-90
No. 200	0-25

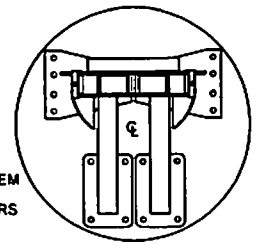
PORTLAND CEMENT CONCRETE (PCC)
STONE AGGREGATE CONCRETE MIX, 4000 PSI
[28MPa] MINIMUM COMPRESSIVE STRENGTH
(SAMPLING PER ASTM C31-84 OR ASTM C42-84A,
TESTING PER ASTM C39-84).

ASPHALTIC CONCRETE (AC):
AR-4000 A.C. (PER ASTM D3381 '83) , 75" MAXIMUM,
MEDIUM (TYPE A OR B) AGGREGATE

SIEVE SIZE	%PASSING
1"	100
3/4"	95-100
3/8"	65-80
No. 4	46-54
No. 8	36-40
No. 30	18-21
No. 200	3-8

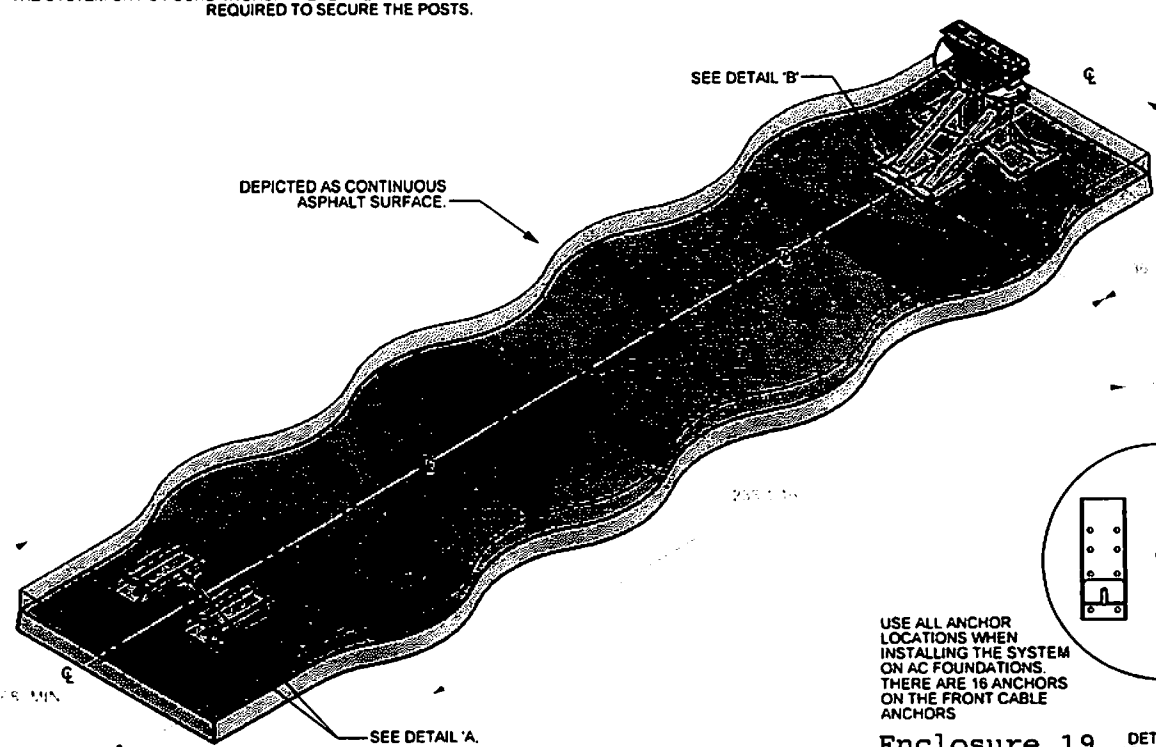


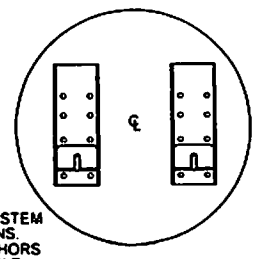
USE ALL 42 ANCHOR LOCATIONS WHEN INSTALLING THE SYSTEM ON AC FOUNDATIONS. THERE ARE 10 ANCHORS REQUIRED TO SECURE THE POSTS.



USE ALL ANCHOR LOCATIONS WHEN INSTALLING THE SYSTEM ON AC FOUNDATIONS. THERE ARE 16 ANCHORS ON THE BACKSTOP ASSEMBLY.

DETAIL B
SCALE 1 : 25





USE ALL ANCHOR LOCATIONS WHEN INSTALLING THE SYSTEM ON AC FOUNDATIONS. THERE ARE 16 ANCHORS ON THE FRONT CABLE ANCHORS

DETAIL A
SCALE 1 : 25

Enclosure 19

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
0	NEW DWG, SEE ER# 820	2/25/10	AEM			

SCALE: 1:30

	DATE	INIT.
DRAWN BY	2/25/10	AEM
APPR'D BY		GAD

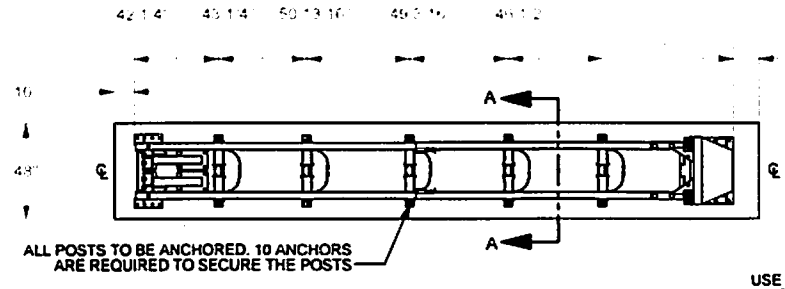
TITLE:
X-TENUATOR FOUNDATION PAD
ASPHALTIC CONCRETE (AC)

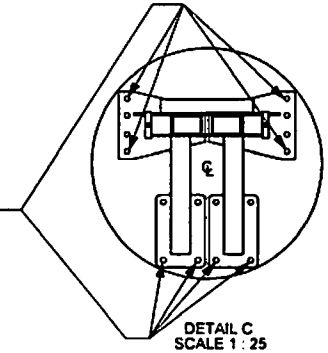
BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B100304	0

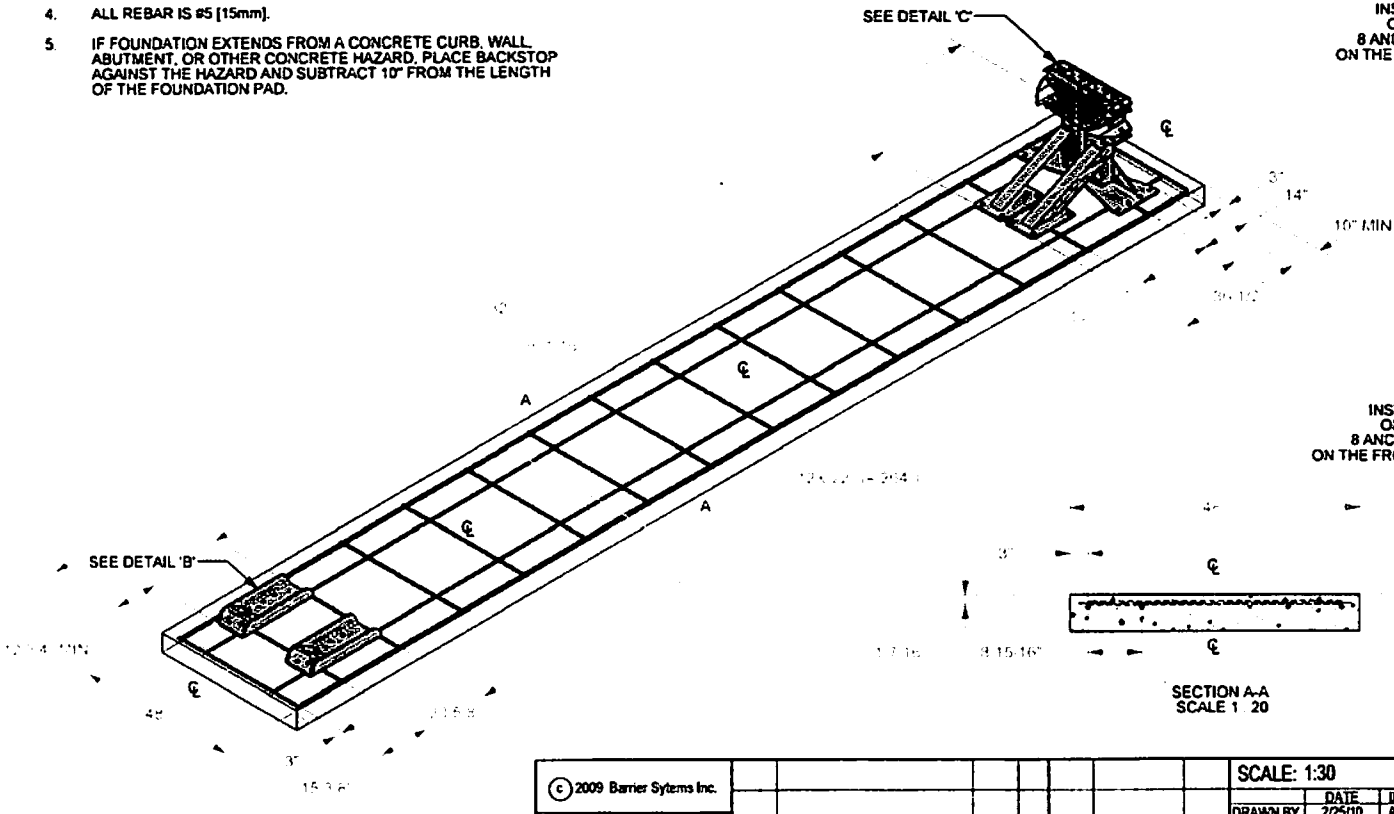
NOTES: UNLESS OTHERWISE SPECIFIED

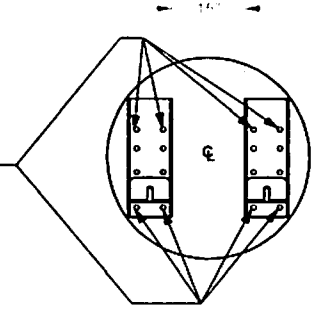
1. MINIMUM 6" PCC PAD OR 8" NONREINFORCED PCC PAD.
   USE PCC PAD ANCHOR LOCATIONS
   ANCHORAGE:
   3/4" X 8 1/4" [20mm X 210mm] GALVANIZED ANCHOR
   WITH 6" [150mm] EMBEDMENT.
2. MATERIAL:
   STONE AGGREGATE CONCRETE MIX, 4,000PSI
   MINIMUM COMPRESSIVE STRENGTH (SAMPLING PER ASTM C31-84 OR ASTM C42-84A, TESTING PER ASTM C39-84).
3. THE REINFORCEMENT SHOWN IS RECOMMENDED TO ENSURE ADEQUATE FOUNDATION INTEGRITY FOR PROPER IMPACT PERFORMANCE. VARIATIONS MAYBE REVIEWED AND DETERMINATIONS MADE AS TO EQUIVALENCE BY PROJECT ENGINEER.
4. ALL REBAR IS #5 [15mm].
5. IF FOUNDATION EXTENDS FROM A CONCRETE CURB, WALL, ABUTMENT, OR OTHER CONCRETE HAZARD, PLACE BACKSTOP AGAINST THE HAZARD AND SUBTRACT 10" FROM THE LENGTH OF THE FOUNDATION PAD.





DETAIL C
SCALE 1 : 25





DETAIL B
SCALE 1 : 25

SECTION A-A
SCALE 1 : 20

Enclosure 20

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
0	NEW DWG, SEE ER# 820	2/25/10	AEM			

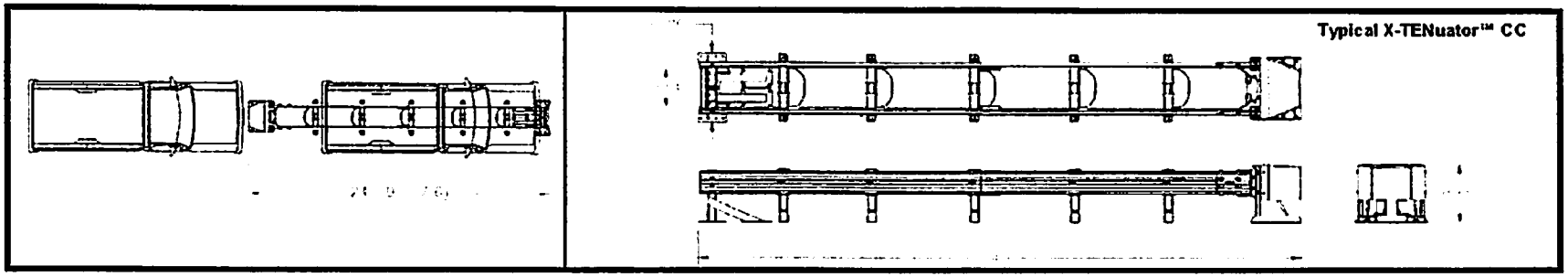
SCALE: 1:30

	DATE	INIT.
DRAWN BY	2/25/10	AEM
APPR'D BY		GAD

TITLE: X-TENUATOR FOUNDATION PAD PCC CONCRETE

BARRIER SYSTEMS
A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B100303	0



General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-31
Test No.	STI Test # SCC20
Date	1/7/2010

Test Article

Type	Redirective, non-gating, crash cushion
Name	X-TENuator Crash Cushion
Dimensions	Length: 7.5 meters (24' 8")
Size and/or dimension and material of key elements	Height: 792 mm (31.19") Width: 926 mm (36.44")

Test Vehicle

Type	Production Model
Designation	2000P
Model	2001 Chevrolet 3/4 Ton Pickup
Mass (kg)	
Curb	2196
Test Inertial	2020.5
Dummy(s)	0
Gross Static	2020.5

Impact Conditions

Speed (km/h)	98.5
Angle (deg)	0
Impact Severity (kJ)	724.4

Exit Conditions

Speed (km/h)	n/a
Angle (deg)	n/a

Occupant Risk Values

Impact velocity (m/s)	
x-direction	7
y-direction	0.1
Ridedown Acceleration (g's)	
x-direction	20
y-direction	3

Test Article Deflection (mm)

Dynamic	578
Permanent	443

Vehicle Damage

Exterior	
VDS	FD-1
CDC	12FCEW1
Interior	
OCDI	FS0000000

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

Maximum Roll Angle (before capture)	6
Maximum Pitch angle (before capture)	8
Maximum Yaw Angle (at separation)	8

Figure 6. Summary of Results, X-TENuator™ Test # SCC20

General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-32
Test No	STI Test # SCC17
Date	11/19/2009

Test Article

Type	Redirective, non-gating, crash cushion
Name	X-TENuator Crash Cushion
Dimensions	Length: 7.5 meters (24' 9")
Size and/or dimension and material of key elements	Height: 792 mm (31.19")
	Width: 926 mm (36.44")

Test Vehicle

Type	Production Model
Designation	820C
Model	1987 Honda CRX
Mass (kg)	
Curb	757
Test Inertial	801
Dummy(s)	75
Gross Static	876

Impact Conditions

Speed (km/h)	103
Angle (deg)	15
Impact Severity (kJ)	22

Exit Conditions

Speed (km/h)	9.4
Angle (deg)	n/a

Occupant Risk Values

Impact velocity (m/s)	
x-direction	12
y-direction	2
Ridedown Acceleration (g's)	
x-direction	11
y-direction	7

Test Article Deflection (mm)

Dynamic	71
Permanent	47

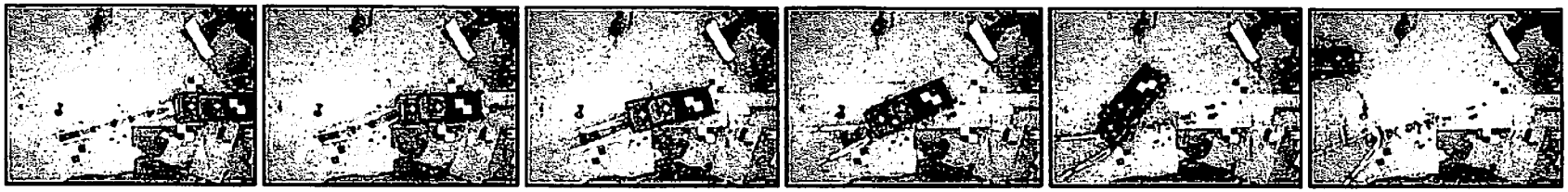
Vehicle Damage

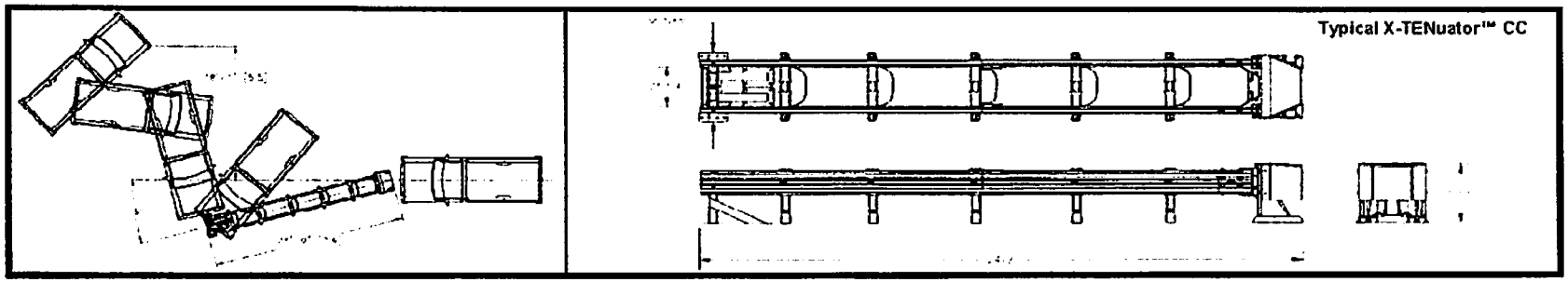
Exterior	
VDS	FD-4
CDC	12FCEW3
Interior	
OCDI	FS0010000

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

Maximum Roll Angle (before capture)	47
Maximum Pitch angle (before capture)	8
Maximum Yaw Angle (at separation)	117

Figure 1. Summary of Results, X-TENuator™ Test # SCC17

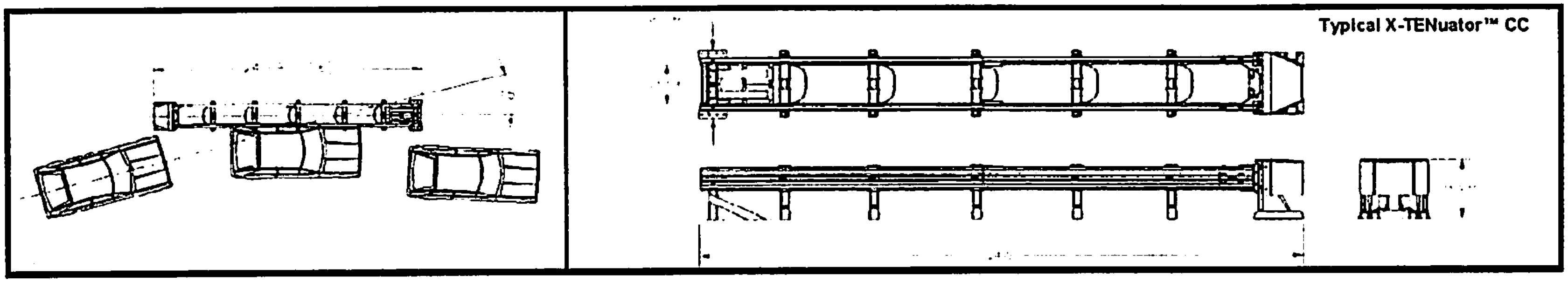




General Information		**Exit Conditions**	
Test Agency	SAFE TECHNOLOGIES, INC.	Speed (km/h)	n/a
Test Designation	NCHRP Report 350 3-33	Angle (deg)	n/a
Test No	STI Test #SCC25	**Occupant Risk Values**	
Date	2/11/2010	Impact velocity (m/s)	
Test Article		x-direction	8
Type	Redirective, non-gating, crash cushion	y-direction	1
Name	X-TENuator Crash Cushion	Ridedown Acceleration (g's)	
Dimensions	Length 7.5 meters (24' 9")	x-direction	12
Size and/or dimension and material of key elements	Height 792 mm (31 19") Width 926 mm (36 44")	y-direction	6
		Test Article Deflection (mm)	
Test Vehicle		Dynamic	2360
Type	Production Model	Permanent	2360
Designation	2000P	**Vehicle Damage**	
Model	2004 Chevrolet 3/4 ton pickup	Exterior	
Mass (kg)		VDS	FC-2
Curb	2166	CDC	12FCEW2
Test Inertial	2025	Interior	
Dummy(s)	n/a	OCDI	FS0000000
Gross Static	2025	**Post-Impact Vehicular behavior (deg - gyro @ c.g)**	
Impact Conditions		Maximum Roll Angle	44
Speed (km/h)	99	Maximum Pitch angle	7
Angle (deg)	15	Maximum Yaw Angle	232
Impact Severity (kJ)	770.3		

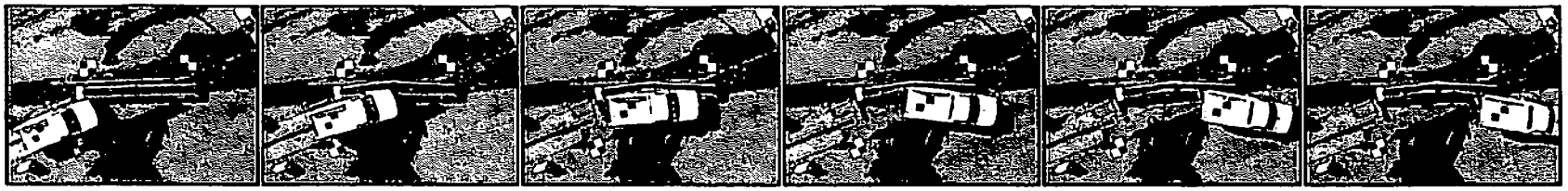
Figure 26. Summary of Results, X-TENuator™ Test # SCC25

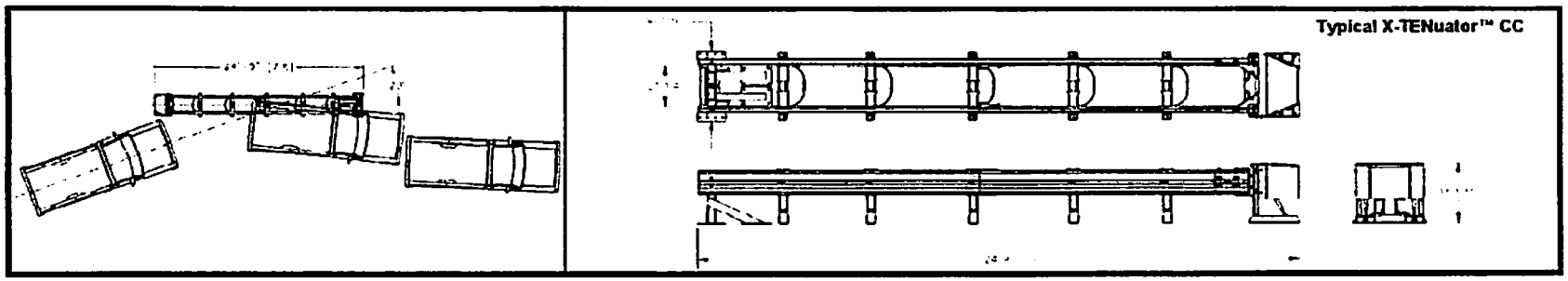
t=0 000 sec | t= 100 sec | t= 200 sec | t=.300 sec | t= 400 sec | t= 450 sec



General Information		**Exit Conditions**	
Test Agency	SAFE TECHNOLOGIES, INC.	Speed (km/h)	76
Test Designation	NCHRP Report 350 3-36	Angle (deg)	4
Test No	STI Test # SCC23	**Occupant Risk Values**	
Date	1/29/2010	Impact velocity (m/s)	
Test Article		x-direction	3
Type	Redirective, non-gating, crash cushion	y-direction	6
Name	X-TENuator Crash Cushion	Ridedown Acceleration (g's)	
Dimensions	Length 7 5 meters (24' 9")	x-direction	3
Size and/or dimension and material	Height 792 mm (31 19")	y-direction	7
of key elements	Width 926 mm (36 44")		
		Test Article Deflection (mm)	
Test Vehicle		Dynamic	84
Type	Production Model	Permanent	64
Designation	820C	**Vehicle Damage**	
Model	1987 Honda CRX	Exterior	
Mass (kg)		VDS	FL-2
Curb	819	CDC	11FLEN2
Test Inertial	820 5	Interior	
Dummy(s)	75	OCDI	FL0000000
Gross Static	897 5	**Post-Impact Vehicular behavior (deg - gyro @ c.g)**	
Impact Conditions		Maximum Roll Angle (before capture)	8
Speed (km/h)	97	Maximum Pitch angle (before capture)	3
Angle (deg)	15	Maximum Yaw Angle (at separation)	24 3
Impact Severity (kJ)	20		

Figure 21. Summary of Results, X-TENuator™ Test # SCC23





General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-37
Test No	STI Test # SCC22
Date	1/21/2010

Test Article

Type	Redirective, non-gating, crash cushion
Name	X-TENuator Crash Cushion
Dimensions	Length: 7.5 meters (24' 9")
Size and/or dimension and material of key elements	Height: 792 mm (31.19")
	Width: 926 mm (36.44")

Test Vehicle

Type	Production Model
Designation	2000P
Model	2003 Chevrolet 3/4 Ton Pickup
Mass (kg)	
Curb	2191
Test Inertial	2037
Dummy(s)	0
Gross Static	2037

Impact Conditions

Speed (km/h)	101
Angle (deg)	20
Impact Severity (kJ)	90.3

Exit Conditions

Speed (km/h)	86
Angle (deg)	11

Occupant Risk Values

Impact velocity (m/s)	
x-direction	4
y-direction	5
Ridedown Acceleration (g's)	
x-direction	10
y-direction	11

Test Article Deflection (mm)

Dynamic	371
Permanent	312

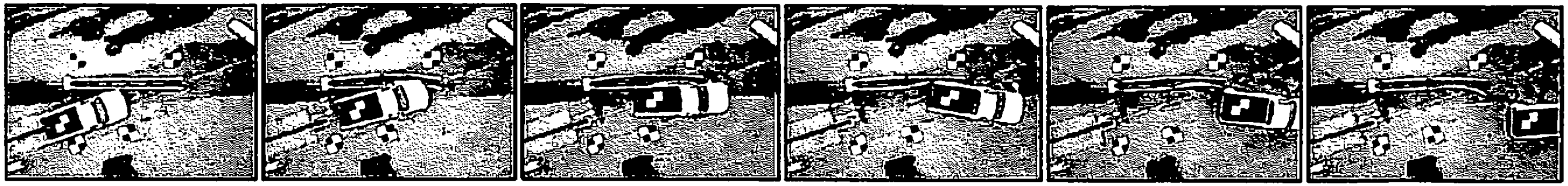
Vehicle Damage

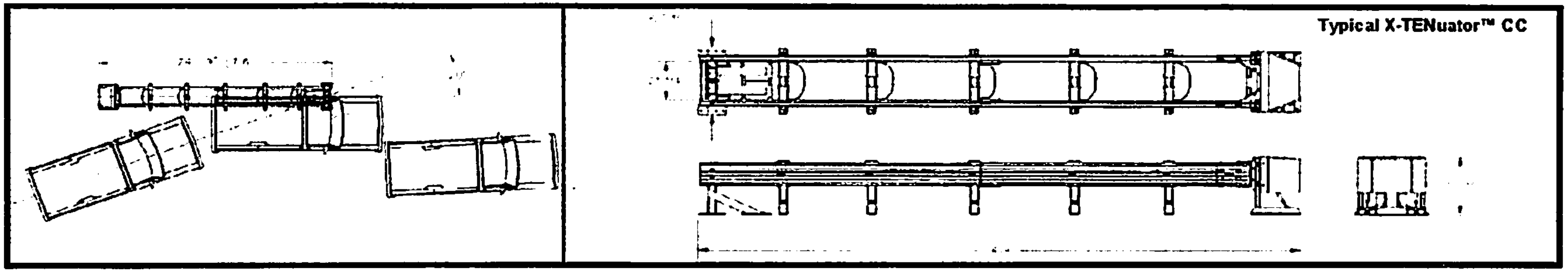
Exterior	
VDS	FL-4
CDC	11FLEW4
Interior	
OCDI	FL0000000

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

Maximum Roll Angle (before capture)	16
Maximum Pitch angle (before capture)	11
Maximum Yaw Angle (at separation)	35.5 (after capture)

Figure 16. Summary of Results, X-TENuator™ Test # SCC22





General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-38
Test No.	STI Test # SCC21
Date	1/14/2010

Test Article

Type	Redirective, non-gating, crash cushion
Name	X-TENuator Crash Cushion
Dimensions	Length: 7.5 meters (24' 9")
Size and/or dimension and material	Height: 792 mm (31.19")
of key elements	Width 926 mm (36.44")

Test Vehicle

Type	Production Model
Designation	2000P
Model	2003 Chevrolet 3/4 Ton Pickup
Mass (kg)	
Curb	2170
Test Inertial	2040
Dummy(s)	0
Gross Static	2040

Impact Conditions

Speed (km/h)	98.5
Angle (deg)	20
Impact Severity (kJ)	89.3

Exit Conditions

Speed (km/h)	78
Angle (deg)	10.5

Occupant Risk Values

Impact velocity (m/s)	
x-direction	5
y-direction	5
Ridedown Acceleration (g's)	
x-direction	12
y-direction	19

Test Article Deflection (mm)

Dynamic	374
Permanent	170

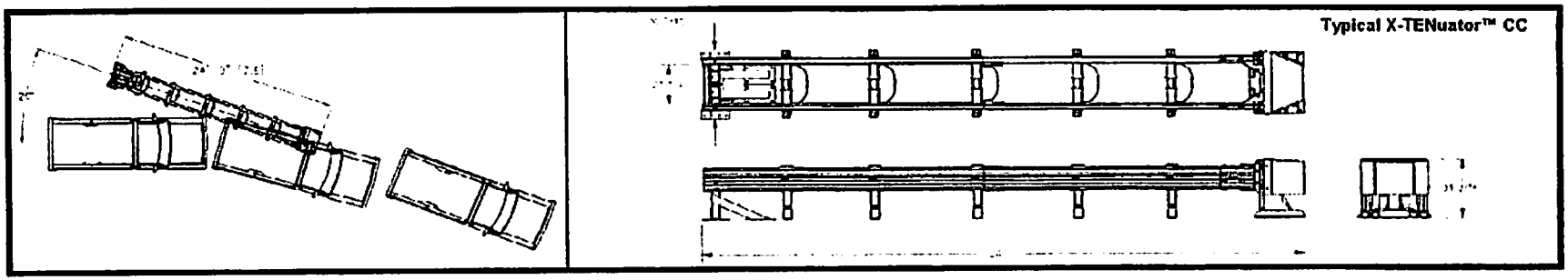
Vehicle Damage

Exterior	
VDS	FL-5
CDC	11FLEN5
Interior	
OCDI	FL0000000

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

Maximum Roll Angle (before capture)	23
Maximum Pitch angle (before capture)	7
Maximum Yaw Angle (at separation)	125 (after capture)

Figure 11. Summary of Results, X-TENuator™ Test # SCC21



General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-39
Test No.	STI Test # SCC26
Date	2/16/2010

Test Article

Type	Redirective, non-gating, crash cushion
Name	X-TENuator Crash Cushion
Dimensions	Length: 7.5 meters (24' 9")
Size and/or dimension and material of key elements	Height: 792 mm (31.19")
	Width: 926 mm (36.44")

Test Vehicle

Type	Production Model
Designation	2000P
Model	2004 GMC 3/4 ton pickup
Mass (kg)	
Curb	2228
Test Inertial	2035
Dummy(s)	n/a
Gross Static	2035

Impact Conditions

Speed (km/h)	99
Angle (deg)	20
Impact Severity (kJ)	89.5

Exit Conditions

Speed (km/h)	70
Angle (deg)	4

Occupant Risk Values

Impact velocity (m/s)	
x-direction	5
y-direction	5
Ridedown Acceleration (g's)	
x-direction	12
y-direction	10

Test Article Deflection (mm)

Dynamic	520
Permanent	430

Vehicle Damage

Exterior	
VDS	FL-3
CDC	11FFEE3
Interior	
OCDI	LF0000000

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

Maximum Roll Angle	7
Maximum Pitch angle	6
Maximum Yaw Angle	24 (after capture)

Figure 31. Summary of Results, X-TENuator™ Test # SCC26

X-TENuator Slider Panel Modification

Barrier Systems, Inc.
Gerrit Dyke, P.E.
Updated 10-4-10

Following certification testing of the X-TENuator Crash Cushion and subsequent submittal to FHWA for acceptance, the "slider panels" were modified to enable easier assembly of the system. The "slider panels" consist of the front W-Beam side panels that attach to the impact heads in the front of the system and wrap around the rear panels at the mid-point of the system. The original slider panel utilized a formed plate that was welded directly to the W-Beam panel and wrapped around the rear panel that is nested inside at the lapped joint (see Figure 1 below). The welded connection was modified to incorporate a bolted connection. The bolt connection allows the rear panel to be nested inside the slider panel and then bolted in place during system assembly (see Figure 2 below). Prior assembly required feeding the entire rear panel through the slider panel.

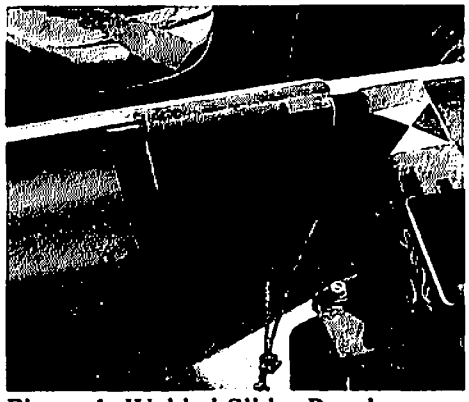


Figure 1: Welded Slider Panel

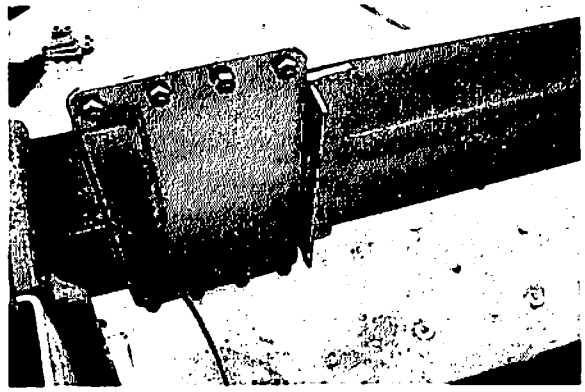


Figure 2: Bolted Slider Panel

The bolted connection was designed to be equal to or stronger than the welded connection to ensure equivalent function as was tested and submitted to FHWA for acceptance. The calculations below demonstrate the structural capacity of the bolted joint is greater than the welded connection.

Slider Panel Analysis:

Material Properties: $\sigma_{A36} := 36000 \cdot psi$

1/2" Grade 5 Bolt: $\sigma_{g5} := 120000 \cdot psi$ $A_{0.5} := .1416 \cdot in^2$

Welded Connection

$l_w := 9.31 \cdot in$

$w_w := .1875 \cdot in$

$A_w := l_w \cdot w_w$ $A_w = 1.746\,in^2$

$F_w := A_w \cdot \sigma_{A36}$ $\boxed{F_w = 6.284 \times 10^4\,lbf}$

Bolted Connection

$n := 4$

$F_{0.5} := A_{0.5} \cdot \sigma_{g5}$ $F_{0.5} = 1.699 \times 10^4\,lbf$

$F_b := n \cdot F_{0.5}$ $\boxed{F_b = 6.797 \times 10^4\,lbf}$

In frontal impacts, the slider panel moves rearward, around the rear panel, and knocks the blockouts and panel connections free. When the end of the slider panel reaches the backstop, it interacts with a ramp on the backstop, forcing the nested panels outward and disengaging the cable from the backstop. Test 3-31 was performed on the system to demonstrate acceptable (and equivalent) function of the modified slider (and other system modifications) in the most severe loading of the effected connection. Other frontal impact tests including tests 3-30, 3-32, and 3-33, are not affected as critically by the slider modification as the system is not stroked far enough to engage many of functions of the component.

During side impacts, the slider panel provides lateral support to the re-direction of the impacting vehicle and transmits the tension to the rear panel. The slider panel also provides the fit to keep the panels nested properly during reverse side impacts. The original slider panel connection was proven adequate for transmitting longitudinal tension in tests 3-36, 3-37, 3-38, and 3-39. The bolted joint is capable of resisting a higher load, therefore, the modification was determined to not affect the performance of the system in these tests. The dimensional characteristics of the slider panel were maintained to ensure consistent gaps and clearances for proper nesting and resistance to snagging in reverse impacts.

In tests 3-36, 3-37, and 3-38, the slider panel connection is not loaded to failure or cause tension loading in excess of the front panel/rear panel joint capacity. While local deformation of the components is evident, the excess strength of the bolted version of the slider panel does not affect the performance of the system or the occupant risk factors. Figures 3 and 4 below illustrate the post impact condition of the slider panel and rear panel for tests 3-37 and 3-38. Test 3-36 shows very minor to no damage to the side panels.

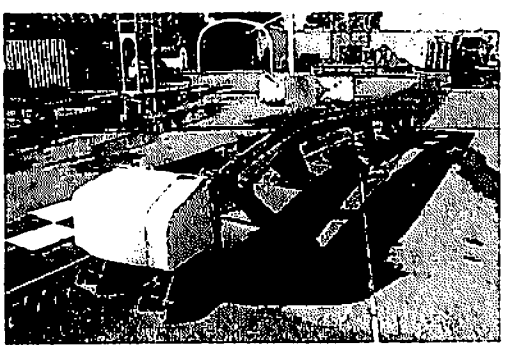


Figure 3: Post Impact 3-37

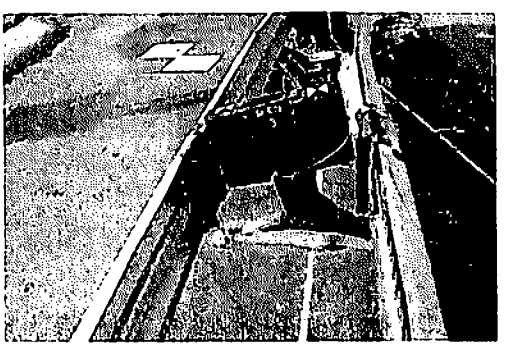


Figure 4: Post Impact 3-38

In test 3-39, the front panel/rear panel joint is loaded beyond capacity. When excessive longitudinal forces are transmitted across the joint, the "slider bracket" yields and pulls through the slider panel, allowing the panels to separate. The slider bracket consists of a section of angle iron attached to the rearward panel. The welded slider panel was not damaged. Therefore, the excess strength of the bolted version of the slider does not

affect the performance of the system or the occupant risk factors. Figure 5 below illustrates the failure mode of the joint.

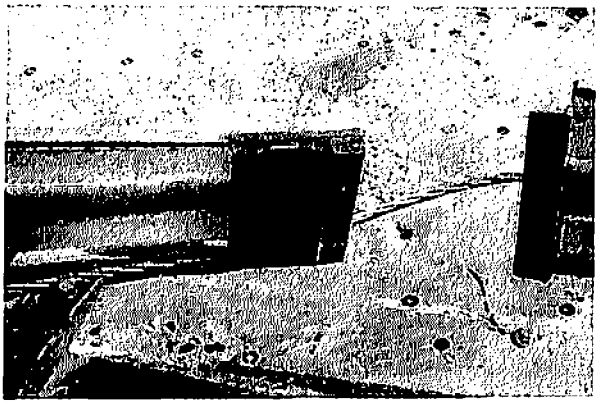


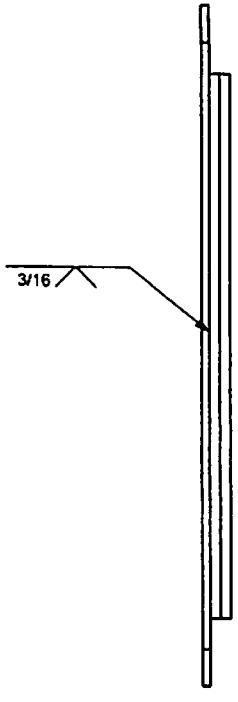
Figure 5: Post Impact 3-39

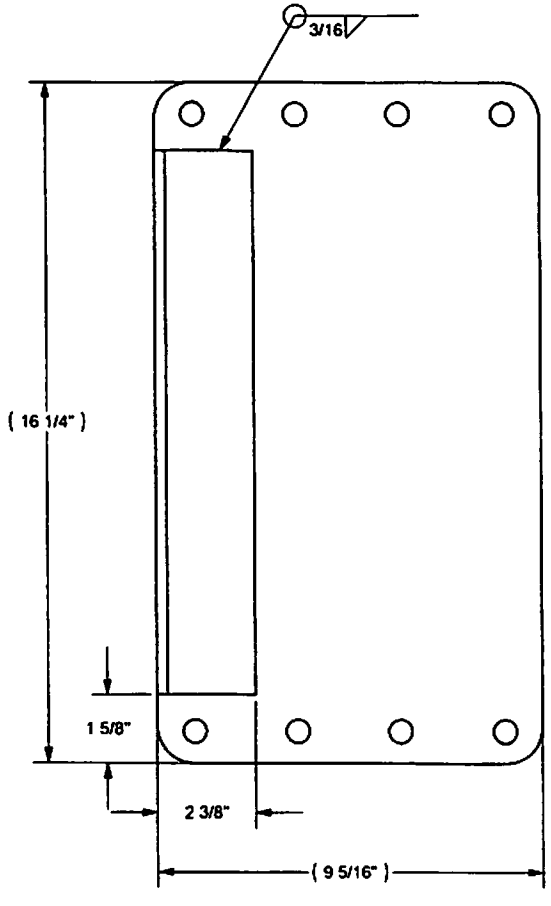
System and component drawings are attached to this document.

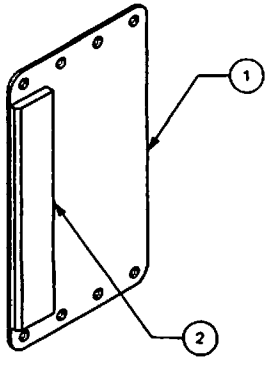
Item	Qty	Description	Part #	U/M
1	1	Slider Brace Plate, Front	B100347	EACH
2	1	Slider Plate, Front Panel	B100262	EACH

NOTES UNLESS OTHERWISE SPECIFIED:

1. HOLES TO BE FREE OF WELD SPLATTER.
2. FINISH TO BE HOT DIPPED GALVANIZED PER ASTM A123.







REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
0	SEE ER # 815	03/16/10	JR			

SCALE: 1:3

	DATE	INIT
DRAWN BY	03/16/10	JR
APPR'D BY		GAD

Standard Tolerance: Angular ± 1/2° | Fractional ± 1/16" | Dec .XXX± .010 | Dec .XX± .030

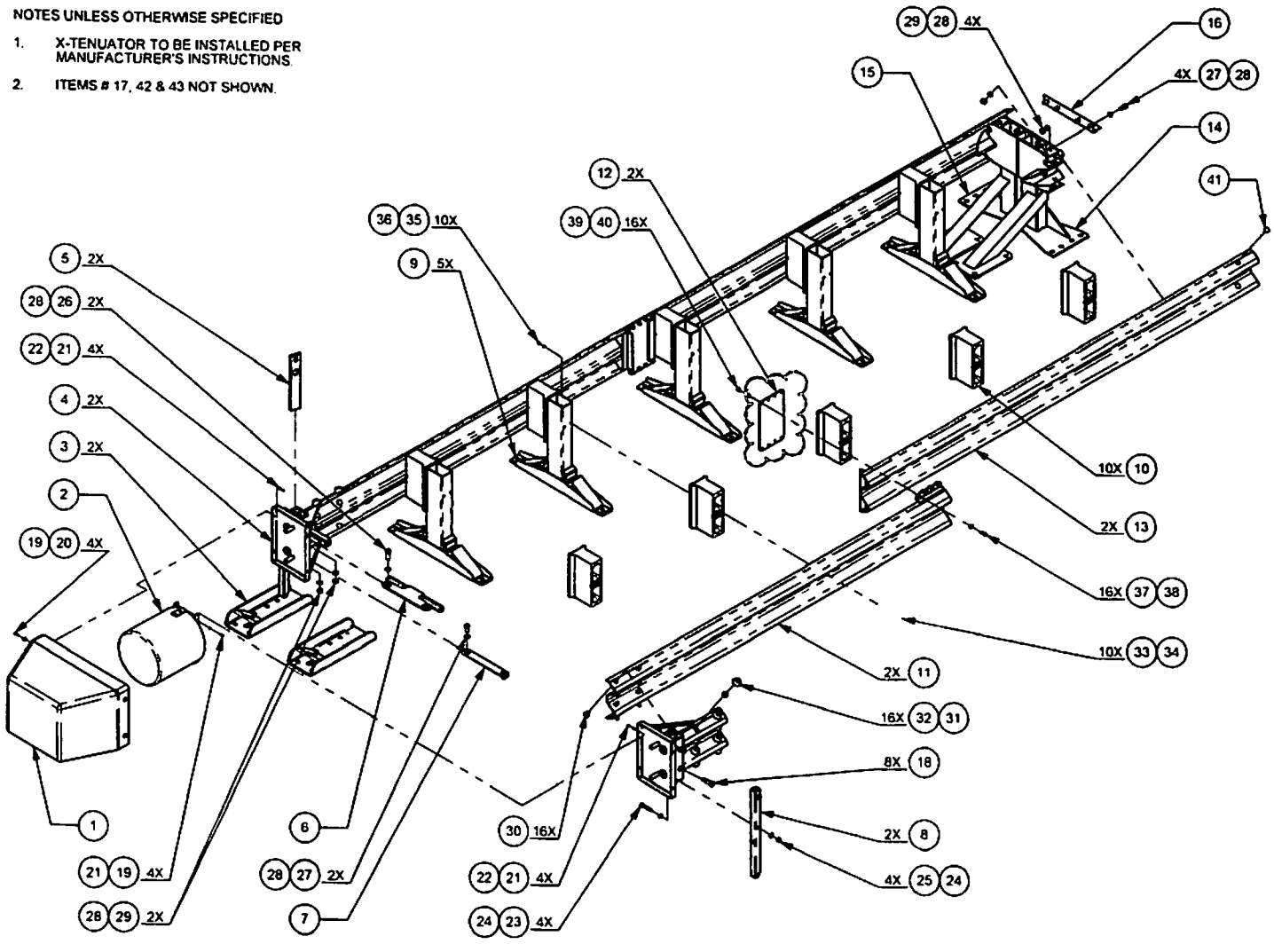
TITLE: SLIDER BRACE WELDMENT, FRONT PANEL

BARRIER SYSTEMS — A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B100346	0

NOTES UNLESS OTHERWISE SPECIFIED

1. X-TENUATOR TO BE INSTALLED PER MANUFACTURER'S INSTRUCTIONS.
2. ITEMS # 17, 42 & 43 NOT SHOWN.



Item	Qty	Description	Part #	U/M
1	1	Nose Cover, X-TENuator	B1002238	EACH
2	1	EA Nose Cartridge, X-TENuator	B1002239	EACH
3	2	Cable Anchor Weldment,	B1002244	EACH
4	2	Head Unit Weldment, X350	B0610072	EACH
5	2	Cable Friction Plate,	B1003468	EACH
6	1	Upper Head Support Weldment,	B1002247	EACH
7	1	Lower Head Support Plate,	B1002250	EACH
8	2	Head Support Leg Weldment,	B1002251	EACH
9	5	Leaning Post Weldment,	B1002254	EACH
10	10	W-Beam Composite Blockout 8in,	B0909534	EACH
11	2	Front Panel Weldment,	B1002259	EACH
12	2	Slider Brace Weldment, Front	B1003466	EACH
13	2	Back Panel Weldment,	B1002263	EACH
14	1	Backstop Weldment, Right	B1002266	EACH
15	1	Backstop Weldment, Left	B1002267	EACH
16	1	Brace, Backstop, X-TENuator	B1002280	EACH
17	2	Cable Assembly, X-TENuator	B1002281	EACH
18	8	C-Scr HH M20-2.5x75mm Gr 5.8	2000615	EACH
19	10	C-Scr HH 1/4-20x1 Gr2 MGal	2000258	EACH
20	6	Washr Fender 1/4x1.0 ODx.063	2000263	EACH
21	14	Washr 1/4 Flat Rd Galv	2001446	EACH
22	10	Nut HN 1/4-20 MGal	2000274	EACH
23	4	C-Scr HH 5/8-11x3 1/4 Gr2 MGal	2000250	EACH
24	8	Washr 5/8 F436 Struct Galv	2000118	EACH
25	4	Nut HN 5/8-11 A563 Gr2 GvI	2000134	EACH
26	2	C-Scr HH 3/4-10x2 1/2 Gr5 MGal	2001633	EACH
27	6	C-Scr HH 3/4-10x2 1/4 Gr5 MGal	2000398	EACH
28	16	Washr 3/4 F436 Flat Rd Struct.	2001634	EACH
29	8	Nut HN 3/4-10 MGal	2001705	EACH
30	16	Guardrail Bolt 5/8-11x 1 1/4	4001115	EACH
31	16	Guardrail Nut Recessed 5/8-11	4001116	EACH
32	16	PLASTIC NUT PROTECTOR	B0807553	EACH
33	10	C-Scr HH 3/8-16x9 Gr5 MGal	2000121	EACH
34	10	Washr Fender 3/8 x 1.500 x .063	2000096	EACH
35	15	Washr 3/8 Flat Rd SAE Galv	2001409	EACH
36	15	Nut HN 3/8-16 Gr5 Gal	2000405	EACH
37	16	C-Scr HH 1/2-13x1 1/4 Gr5 MGal	2000279	EACH
38	16	Washr 1/2 Flat Rd SAE Galv	2001408	EACH
39	16	Washr SL 1/2 MGal	2000280	EACH
40	16	Nut HN 1/2-13 Gr5 MGal	2000305	EACH
41	1	Kit, X-Tension Shear Bolt,	K0801123	EACH
42	1	Tether Kit, X-TENuator	K1002011	EACH
43	2	Cable Tie 15x1/4 dia UV Blk	4002138	EACH

REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
A	ADDED METRIC DIMENSIONS	09/13/10	JAF			
0	SEE ER # 815	02/09/10	JR			

SCALE: 1:30

	DATE	INIT
DRAWN BY	02/09/10	JR
APPR'D BY		CAD

Standard Tolerance: Angular ± 1/2° | Fractional ± 1/16" | Dec XXX± ± .010 | Dec .XX± ± .030

TITLE: X-TENUATOR 100kph, NARROW

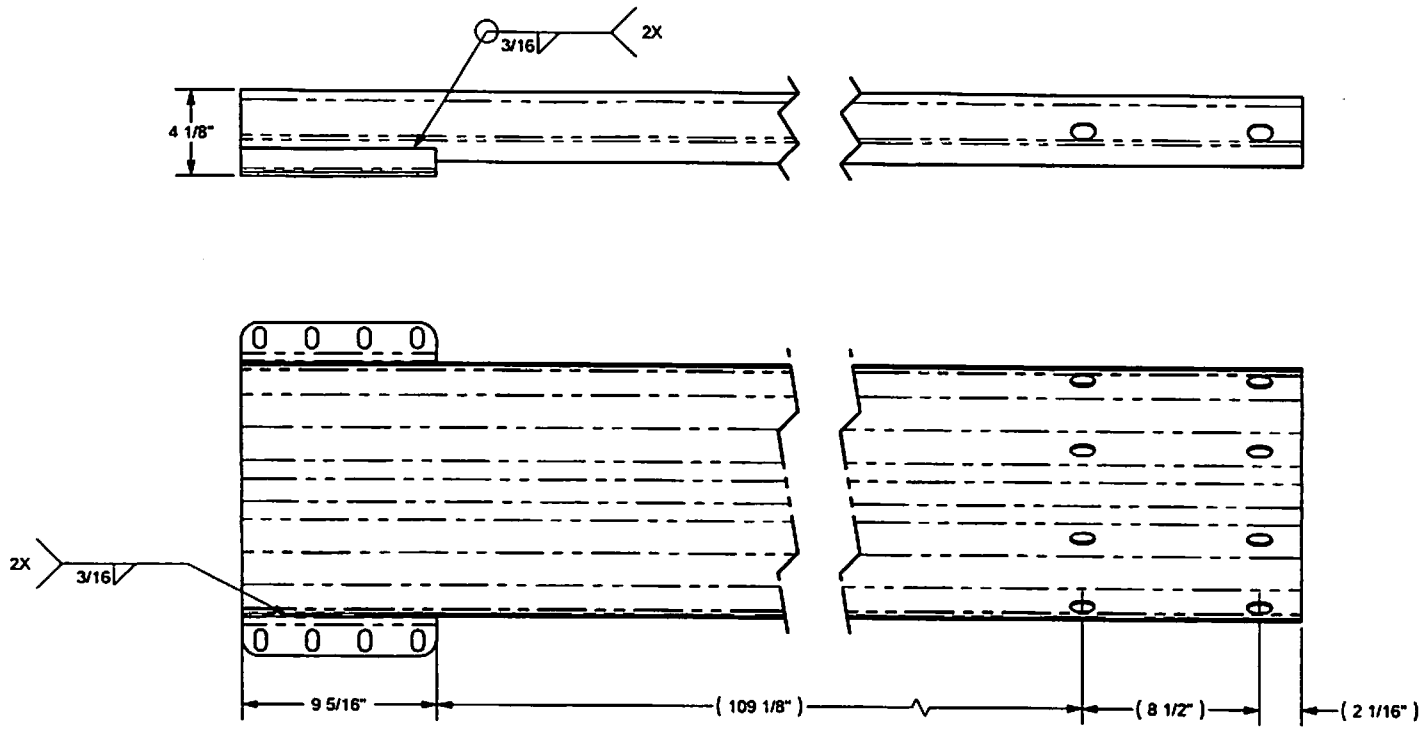
BARRIER SYSTEMS — A LINDSAY TRANSPORTATION SOLUTIONS COMPANY

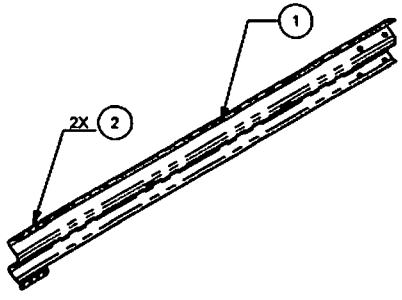
SHEET	DRAWING NUMBER	REV
1 OF 4	XTEN100N	A

Item	Qty	Description	Part #	U/M
1	1	Front Panel	B100260	EACH
2	2	Slider Brace Tab, Front Panel	B100261	EACH

NOTES UNLESS OTHERWISE SPECIFIED:

1. PART TO BE GALVANIZED PER ASTM A123.





REV.	CHANGES	DATE	BY	REQ'D	NEXT ASSY.	ITEM
0	SEE ER # 815	02/09/10	JR			

SCALE: 1:6

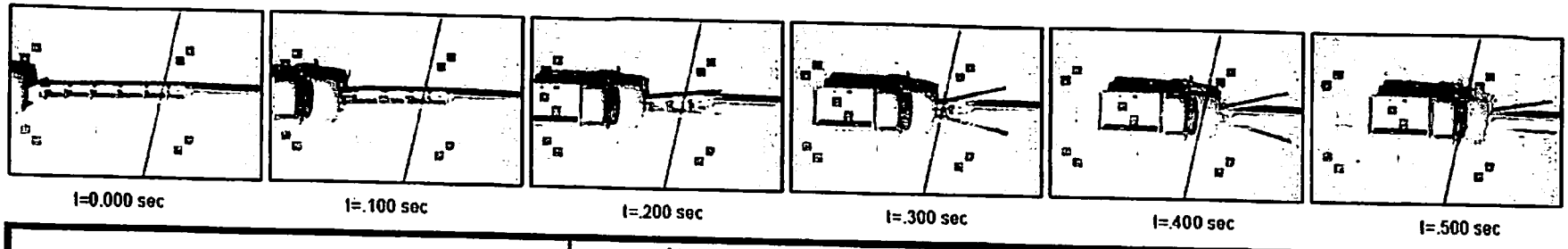
	DATE	IND
DRAWN BY	02/09/10	JR
APPRD BY		GAD

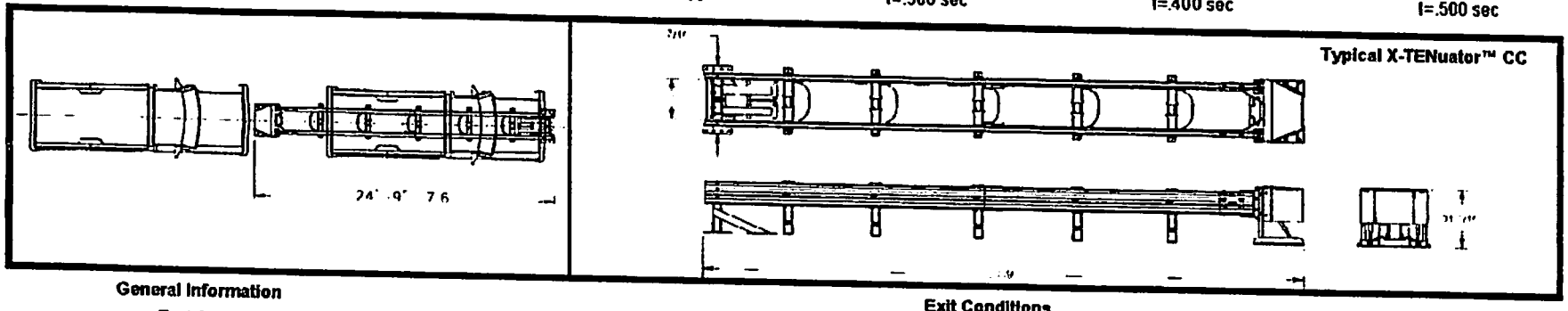
Standard Tolerance: Angular ± 1/2° | Fractional ± 1/16" | Dec .XXX± .010 | Dec .XX± .030

TITLE: FRONT PANEL WELDMENT, X-TENUATOR

BARRIER SYSTEMS — A RUBICON TRANSPORTATION SOLUTIONS COMPANY

SHEET	DRAWING NUMBER	REV
1 OF 1	B100259	0





General Information

Test Agency	SAFE TECHNOLOGIES, INC.
Test Designation	NCHRP Report 350 3-31
Test No.	STI Test # SCC27
Date	6/14/2010

Test Article

Type	Redirective, non-gating, crash cushion
Name	X-TENuator Crash Cushion
Dimensions	Length: 7.5 meters (24' 9")
Size and/or dimension and material of key elements	Height: 792 mm (31.19") Width: 926 mm (36.44")

Test Vehicle

Type	Production Model
Designation	2000P
Model	2000 Chevrolet 3/4 Ton Pickup
Mass (kg)	
Curb	2195
Test Inertial	2026
Dummy(s)	0
Gross Static	2026

Impact Conditions

Speed (km/h)	100
Angle (deg)	0
Impact Severity (kJ)	773.8

Exit Conditions

Speed (km/h)	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	18.5
y-direction	4

Test Article Deflection (mm)

Dynamic	1250
Permanent	1230

Vehicle Damage

Exterior	
VDS	FD-1
CDC	12FCEW1
Interior	
OCDI	FS0000000

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

Maximum Roll Angle (before capture)	3
Maximum Pitch angle (before capture)	6
Maximum Yaw Angle (at separation)	9

Figure 1. Summary of Results, X-TENuator™ Test # SCC27