



U.S. Department
of Transportation
**Federal Highway
Administration**

September 17, 2008

1200 New Jersey Avenue, SE.
Washington, DC 20590

In Reply Refer To: HSSD/CC-88B

Mr. John C. Durkos
V.P. Technical Support and Marketing
Road Systems, Inc.
3616 Howard County Airport
Big Spring, TX 79720

Dear Mr. Durkos:

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

Name of devices: Sequential Kinking Terminal (SKT), and
Flared Energy Absorbing Terminal (FLEAT) with 2 Breakaway Posts
Type of devices: W-Beam Guardrail Terminals
Test Level: NCHRP Report 350 Test Level 3
Testing conducted by: Midwest Roadside Safety Facility
Date of request: April 22, 2008

You requested that we find these devices acceptable for use on the NHS under the provisions of 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 FHWA Memorandum "Action: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description

The SKT and FLEAT have been successfully crash tested and accepted by the FHWA, most recently in FHWA Acceptance Letters CC-88, dated March 8, 2005, and CC-88A, dated June 1, 2008. The use of one anchor post, seven additional breakaway posts and subsequent transition to standard line posts were the same in these two w-beam guardrail terminals. Recent full scale crash tests have demonstrated that an 820C vehicle can safely ride down full strength W6x9 steel line posts. Your present request is to replace the last six breakaway posts in these terminals with these standard W6x9 line posts.

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Crash Testing

In order to evaluate the safety performance of these new designs, three full-scale crash tests were conducted on the revised FLEAT terminal design. NCHRP recommends a total of up to 7 full-scale crash tests for gating guardrail terminals. We concur that only 3 of these tests are needed to verify the safety performance of the proposed new terminal designs, as summarized below.

Test 3-30 involves an 820C vehicle striking the end of the terminal at a speed of 100 km/hr with $\frac{1}{4}$ offset and an angle of 0° . Because this test may allow the small car to strike a full strength line post, it is necessary for verification of the safety performance of the new terminals. Previous testing has shown that the small car engages more guardrail posts during tests of the FLEAT than during tests of the SKT. Hence, this test should be conducted on the FLEAT terminal in order to maximize the risk of failure.

Test 3-31 involves a 2000P vehicle striking the end of the terminal at 100 km/h and 0° . Numerous full-scale crash tests have shown that the 2000P vehicle is capable of riding down full strength guardrail posts. Further, the results of test 3-30 will provide a much better indication of the consequences of a vehicle striking an unmodified line post. Thus, Test 3-31 is not necessary for evaluating the performance of the new terminal designs.

Test 3-32 requires an 820C vehicle striking the end of the terminal at 100 km/h and an angle of 15° . Historically the third post in a tangent energy absorbing terminal has not been broken during this impact. The only thing that changed upstream of post #3 from the system that was approved previously is upper post #1. However, the behavior of this post will be more thoroughly explored in test 3-30 than in test 3-32. Therefore, we concur there is no need to conduct this test.

Test 3-33 incorporates the same impact conditions as test 3-32 with a 2000P vehicle. This test is not necessary for the same reasons that Test 3-31 is not required.

Test 3-34 involves an 820C vehicle striking the terminal at its critical impact point at a speed of 100 km/h and an angle of 15° . Because the vehicle can snag on posts 3 and 4 during this impact the new terminals need to be evaluated under this test condition. The flare of the FLEAT terminal effectively increases the impact angle for this test by approximately 6° . This test should be conducted. The increased effective impact angle makes testing of the FLEAT terminal more critical than a test of the SKT.

Test 3-35 examines the safety performance of the terminal for impacts at the beginning of the length-of-need. This test involves a 2000P striking at the beginning of length-of-need. The flare on the end of the FLEAT produces a more critical impact and this test should also be conducted on this terminal.

Test 3-39 involves a 2000P vehicle impacting the midpoint of the terminal in a reverse direction at a speed of 100 km/h and an angle of 20° . As mentioned above the 2000P test vehicle has been shown to be capable of riding down a full strength line post without posing serious threats to the occupants. Hence this test is also considered to be unnecessary.

The test data summary sheets for the three recommended crash tests, FLT2P-1 (Test 3-35), FLT2P-2 (Test 3-34), and FLT2P-3 (Test 3-30) are enclosed for reference. In test FLT2P-3 there was a small hole in the floor pan caused when the nearly-stopped vehicle came to rest on the end of a guardrail post that was under the vehicle. We concur that this does not pose a significant risk to vehicle occupants. Otherwise, all occupant risk parameters of NCHRP Report 350 were within recommended guidelines. We concur that this testing shows acceptable performance for both FLEAT and SKT terminals when modified as described.

Findings

The modified FLEAT and SKT terminals described above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when acceptable to a highway agency.

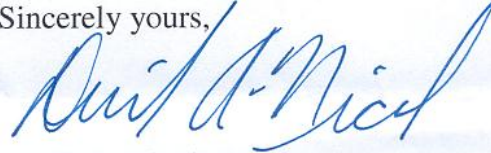
Please note the following standard provisions that apply to FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the devices 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 device 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 device 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-88B 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 FLEAT and SKT end terminals are patented products and considered proprietary. If proprietary devices 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.

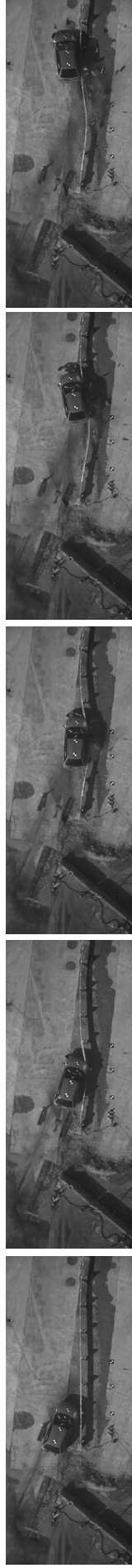
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented device for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate device, and the FHWA is neither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

Sincerely yours,

A handwritten signature in blue ink, appearing to read "David A. Nicol". The signature is fluid and cursive, with the first name "David" being more prominent.

David A. Nicol
Director, Office of Safety Design
Office of Safety

Enclosures



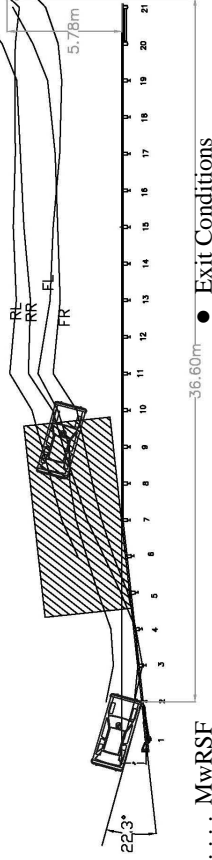
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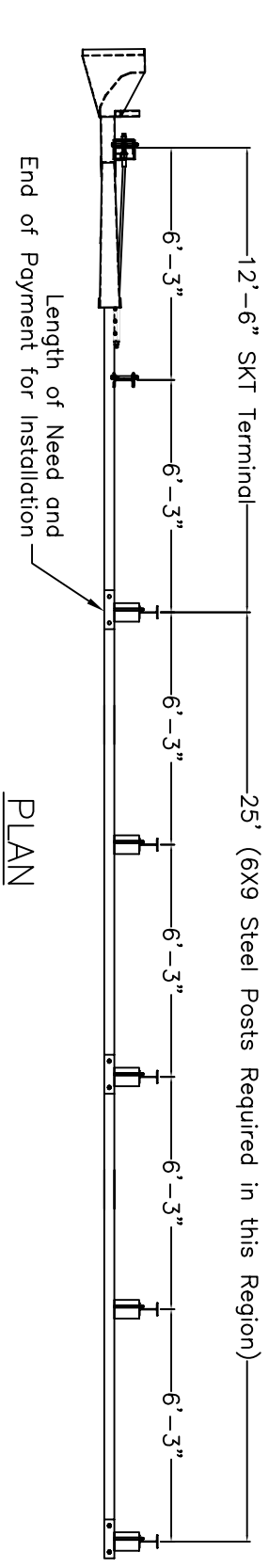


● Test Agency	MwRSF	● Exit Conditions	Speed	64.1 km/h
● Test Number	FLT2P-2		Angle	13.5 degrees
● Date	2/13/2008		Exit Box Criterion	Pass
● NCHRP 350 Test Designation	3-34	● Post-Impact Trajectory	Vehicle Stability	Satisfactory
● Appearance	Two Post FLEAT End Terminal		Stopping Distance	36.6 m downstream
● Total Length	38.1 m			5.8 m traffic-side
● Key Element - Steel W-beam				
Thickness	2.67 mm			
Top Mounting Height	706 mm			
● Key Element - Breakaway Steel Posts			● Occupant Impact Velocity (EDR-3)	
Post No. 1	HP-1		Longitudinal	-5.89 m/s < 12 m/s
Post No. 2	HP2A top and HP3B bottom		Lateral	-5.58 m/s < 12 m/s
Spacing	1,905 mm		● Occupant Ride Down Deceleration (EDR-3)	
● Key Element - Steel Posts			Longitudinal	-7.59 g's < 20 g's
Post Nos. 3-19	W152x13.4 by 1,829 mm long		Lateral	-8.65 g's < 20 g's
Spacing	1,905 mm		● Occupant Impact Velocity (DTS)	
● Key Element - Wood Spacer Blocks			Longitudinal	-5.61 m/s < 12 m/s
Post Nos. 3-19	152 mm x 203 mm x 362 mm long routed		Lateral	-5.90 m/s < 12 m/s
● Type of Soil	Grading B-AASHTO M 147-65 (1990)		● Occupant Ride Down Deceleration (DTS)	
● Test Vehicle			Longitudinal	-8.60 g's < 20 g's
Type/Designation	820C		Lateral	-11.00 g's < 20 g's
Make and Model	2000 Chevrolet Metro		● Test Article Damage	Moderate
Curb	844 kg		● Test Article Deflections	
Test Inertial	841 kg		Permanent Set	464 mm
Gross Static	914 kg		Dynamic	592 mm
● Impact Conditions			Working Width	804 mm
Speed	100.0 km/h		● Vehicle Damage	Moderate
Angle	22.3 degrees		VDS	1-RFQ-4
Impact Location	Centerline of post no. 2		CDC	01-RDEW9
			Maximum Deformation	102 mm

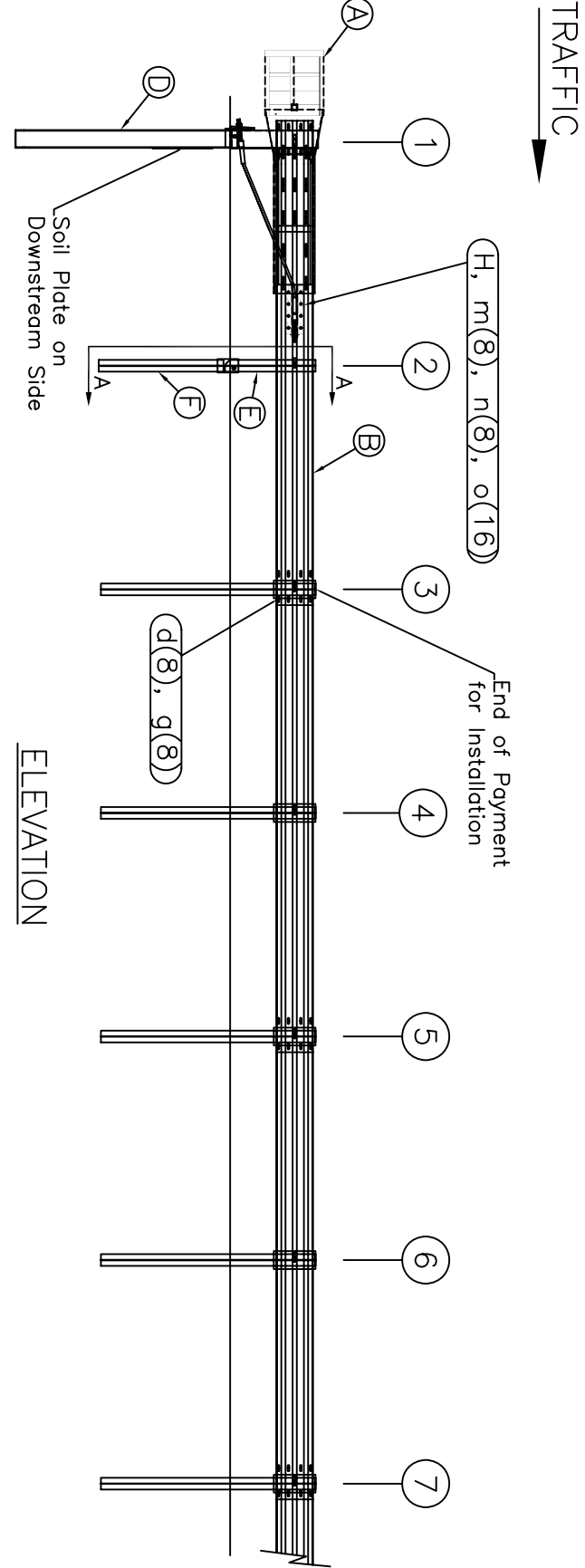


• Test Agency	MwRSF
• Test Number	FLT2P-3
• Date	3/11/2008
• NCHRP 350 Test Designation	3-30
• Appearance	Two Post FLEAT End Terminal
• Total Length	38.1 m
• Key Element - Steel W-beam	
Thickness	2.67 mm
Top Mounting Height	706 mm
• Key Element - Breakaway Steel Posts	
Post No. 1	HP-1
Post No. 2	HP2A top and HP3B bottom
Spacing	1,905 mm
• Key Element - Steel Posts	
Post Nos. 3-19	W152x13.4 by 1,829 mm long
Spacing	1,905 mm
• Key Element - Wood Spacer Blocks	
Post Nos. 3-19	152 mm x 203 mm x 362 mm long routed
• Type of Soil	Grading B-AASHTO M 147-65 (1990)
• Test Vehicle	
Type/Designation	820C
Make and Model	2000 Chevrolet Metro
Curb	832 kg
Test Inertial	834 kg
Gross Static	906 kg
• Impact Conditions	
Speed	96.6 km/h
Angle	0.8 degrees
Impact Location	FLEAT End Terminal Impact Head

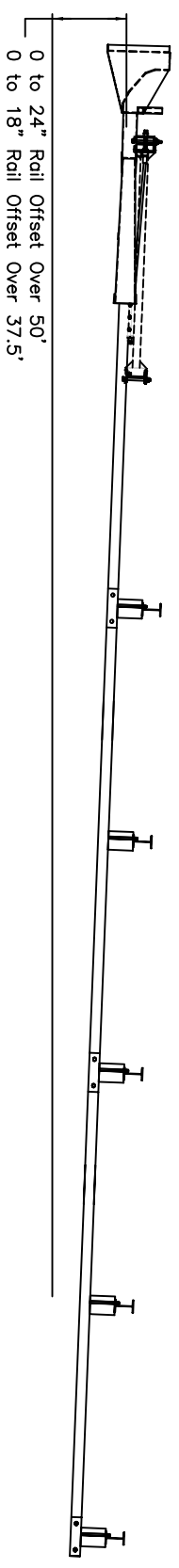
• Exit Conditions	
Speed	n/a
Angle	n/a
Exit Box Criterion	n/a
• Post-Impact Trajectory	
Vehicle Stability	Satisfactory
Stopping Distance	5.26 m downstream
• Occupant Impact Velocity (EDR-3)	
Longitudinal	-7.71 m/s < 12 m/s
Lateral	0.08 m/s < 12 m/s
• Occupant Ride Down Deceleration (EDR-3)	
Longitudinal	-13.25 g's < 20 g's
Lateral	-5.16 g's < 20 g's
• Occupant Impact Velocity (DTS)	
Longitudinal	-7.60 m/s < 12 m/s
Lateral	0.31 m/s < 12 m/s
• Occupant Ride Down Deceleration (DTS)	
Longitudinal	-14.14 g's < 20 g's
Lateral	-6.26 g's < 20 g's
• Test Article Damage	Moderate
• Test Article Deflections	
Permanent Set	n/a
Dynamic	6,998 mm
Working Width	2.2 m non-traffic side by
	8.7 m downstream
• Vehicle Damage	Moderate, floorboard penetration
VDS	12-FD-5
CDC	12-FDEW4
Maximum Deformation	13 mm



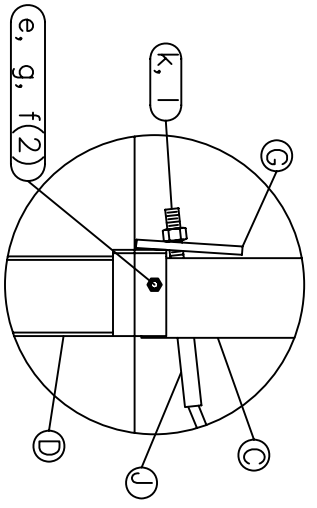
PLAN



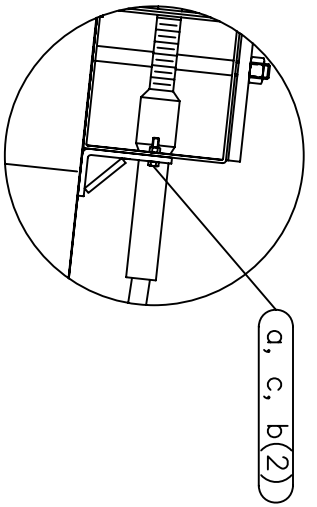
ELEVATION



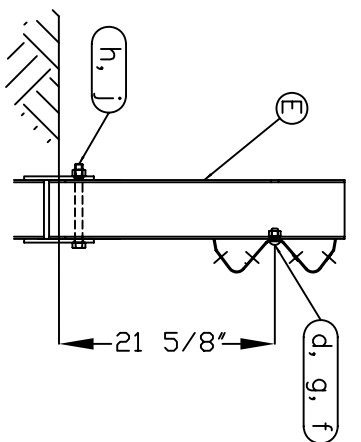
OPTIONAL FLARED INSTALLATION
25:1 maximum flare rate



Post #1 Connection Detail



Impact Head Connection Detail




SECTION A-A
Post #2

ITEM QTY		BILL OF MATERIALS		ITEM NO.
A	1	IMPACT HEAD		S3000
B	1	W-BEAM GUARDRAIL END SECTION, 12 Ga.		SF1303
C	1	FIRST POST TOP (6x6 $\frac{1}{2}$ " Tube)		TPHP1A
D	1	FIRST POST BOTTOM (6" W6x15)		TPHP1B
E	1	SECOND POST ASSEMBLY TOP		HP2A
F	1	SECOND POST ASSEMBLY BOTTOM		HP3B
G	1	BEARING PLATE		E750
H	1	CABLE ANCHOR BOX		S760
J	1	BCT CABLE ANCHOR ASSEMBLY		E770
HARDWARE (ALL DIMENSIONS IN INCHES)				
a	2	5/16 x 1 HEX BOLT GRD 5		B5160104A
b	4	5/16 WASHER		W0516
c	2	5/16 HEX NUT		N0516
d	9	5/8 Dia. x 1 1/4 SPLICE BOLT (POST #2)		B580122
e	1	5/8 Dia. x 9 HEX BOLT GRD 5		B580904A
f	3	5/8 WASHER		W050
g	10	5/8 Dia. H.G.R NUT		N050
h	1	3/4 Dia. x 8 1/2 HEX BOLT GRD A449		B340854A
j	1	3/4 Dia. HEX NUT		N030
k	2	1 ANCHOR CABLE HEX NUT		N100
l	2	1 ANCHOR CABLE WASHER		W100
m	8	CABLE ANCHOR BOX SHOULDER BOLT		SB58A
n	8	1/2 A325 STRUCTURAL NUT		N055A
o	16	1 1/16 OD x 9/16 ID A325 STR. WASHER		W050A

GENERAL NOTES:

1. All bolts, nuts, cable assemblies, cable anchors and bearing plates shall be galvanized.
2. The lower sections of the Posts 1&2 shall not protrude more than 4 in above the ground (measured along a 5' cord).
3. Site grading may be necessary to meet this requirement.
3. The lower sections of the hinged posts should not be driven with the upper post attached. If the post is placed in a drilled hole, the backfill material must be satisfactorily compacted to prevent settlement.
4. When competent rock is encountered, a 10" Ø post hole, 20 in. deep cored into the rock surface may be used if approved by the engineer for posts 1&2. Granular material will be placed in the bottom of the hole, approximately 2.5" deep to provide drainage. The first two posts can be field cut to length. Placed in the hole and backfilled with suitable backfill. The soil plate on post 1 may be trimmed if required.
5. A site evaluation should be considered if there is less than 25' between the outlet side of the terminal and any adjacent driving lane.
6. The breakaway cable assembly must be taut. A locking device (vice grips or channel lock pliers) should be used to prevent the cable from twisting when tightening nuts.



Road Systems, Inc.

Big Spring, TX
Phone: 432-263-2435
or Phone: 330-346-0721

SKT Terminal
Metric Height

2 Post System

Drawing Name: SKT2P-S

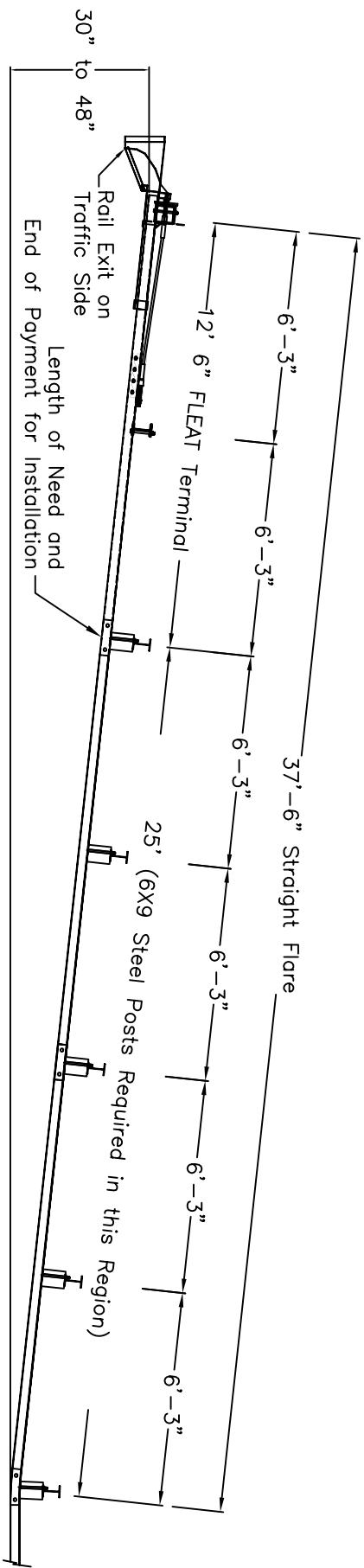
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Rev: 0

Sheet: 1

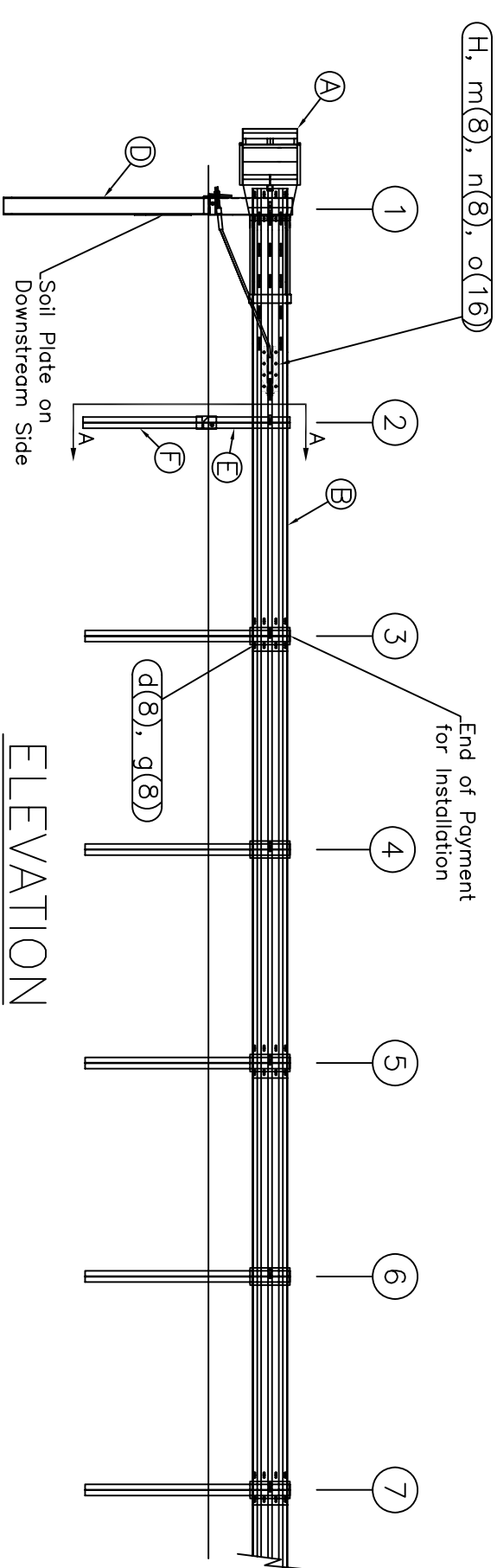
Date: 04/17/08

By: JRR

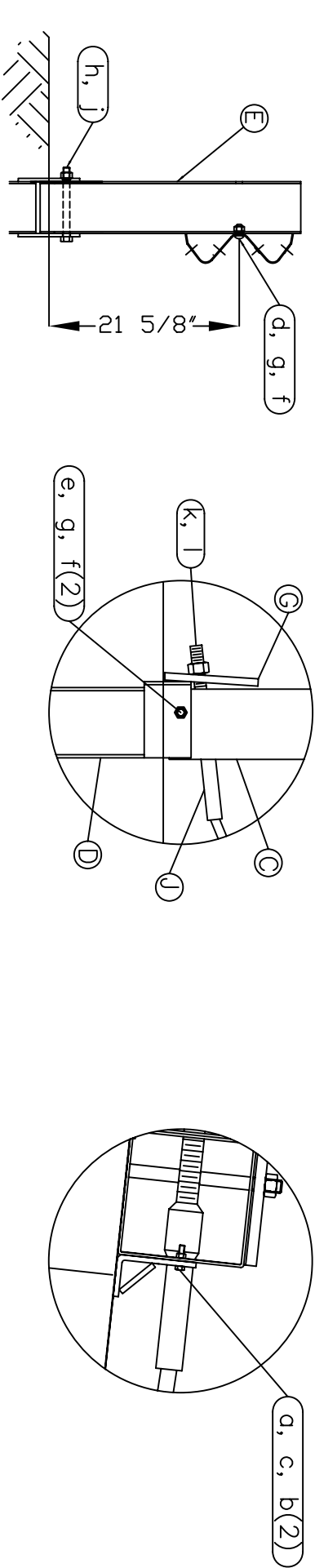


PLAN

TRAFFIC



ELEVATION



SECTION A-A

Post #2


Post #1 Connection Detail

Impact Head Connection Detail

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c	2	5/16 HEX NUT		N0516
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e	1	5/8 Dia. x 9 HEX BOLT GRD 5		B580904A
f	3	5/8 WASHER		W050
g	10	5/8 Dia. H.G.R NUT		N050
h	1	3/4 Dia. x 8 1/2 HEX BOLT GRD A449		B340854A
j	1	3/4 Dia. HEX NUT		N030
k	2	1 ANCHOR CABLE HEX NUT		N100
l	2	1 ANCHOR CABLE WASHER		W100
m	8	CABLE ANCHOR BOX SHOULDER BOLT		SB58A
n	8	1/2 A325 STRUCTURAL NUT		N055A
o	16	1 1/16 OD x 9/16 ID A325 STR. WASHER		W050A

GENERAL NOTES:

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Big Spring, TX

Phone: 432-263-2435

or Phone: 330-346-0721

FLEAT Terminal

Metric Height

2 Post System

Drawing Name:

FLT2P-S

Scale:

None

Rev:

0

Sheet:

1

Date:

04/17/08

By:

JRR