



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

December 10, 2009

In Reply Refer To:  
HSSD/CC-88C

Mr. John C. Durkos  
Vice President 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 the Federal Highway Administration's (FHWA) acceptance of two modified roadside safety devices for use on the National Highway System (NHS).

Name of devices:	SKT-SP-MGS and FLEAT-SP-MGS W-Beam Guardrail Terminals for the Midwest Guardrail System
Type of device:	Midwest W-Beam Guardrail Terminals
Test Level:	NCHRP Report 350 Test Level 3
Testing conducted by:	N/A
Date of request:	May 29, 2009
Date acknowledged:	June 29, 2009

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. The FHWA Memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

### Description

The Sequential Kinking Terminal (SKT) and Flared Energy Absorbing Terminal (FLEAT) have been successfully crash tested and accepted by the FHWA, most recently in FHWA Acceptance Letters CC-88, dated March 8, 2005, CC-88A, dated June 1, 2008, and CC-88B, dated September 17, 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. In our letter CC-88B we concurred in your request to replace the last six breakaway posts in these terminals with these standard W6x9 line posts. Your present request is for the use of the SKT-SP (Standard Post) and FLEAT-SP terminals with two breakaway posts for use with the 31-inch high Midwest Guardrail System.

### **Analysis**

The NCHRP 350 guidelines recommend a total of up to 7 full-scale crash tests needed to verify the safety performance of the proposed new terminal designs. However, for the SKT-SP-MGS and FLEAT-SP-MGS terminals with two breakaway posts for use with the MGS guardrail system under consideration, you asserted that no additional crash tests are needed. The rationale for that opinion is summarized as follows.

Test 3-30 involves an 820C vehicle striking the end of the terminal at a speed of 100 km/hr with 1/4 offset and an angle of 0 degree. Previous testing has shown that the increase of the mounting height from the standard metric height to the MGS guardrail system has minimal effect on the performance of the SKT and FLEAT terminals for this test. Even with the increased mounting height, the bottom of the impact head is still well below the vehicle bumper height, thus the axial loading on the rail section is little affected. This test was successfully conducted for the FLEAT-SP terminal with two breakaway posts for the standard metric height guardrail system and also on the MGS FLEAT terminal. You believed that the impact performance of the terminals would be little changed for the proposed systems and this test is not deemed necessary for evaluating the performance of the new terminal designs.

Test 3-31 involves a 2000P vehicle striking the end of the terminal at 100 km/h and 0 degree. The higher mounting height of the MGS guardrail system would have no effect on this test given the c.g. height of the 2000P test vehicle. In terms of the effect of the standard line posts starting at post 3, numerous full-scale crash tests have shown that the 2000P vehicle is capable of riding down full strength guardrail posts. This test was conducted on the MGS SKT terminal. Furthermore, the results of test 3-30 would provide a much better indication of the consequences of a vehicle striking an unmodified line post. Thus, Test 3-31 is not deemed to be 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 degrees. As with test 3-30, the increase of the mounting height from the standard metric height to the MGS guardrail system would have minimal effect on the performance of the SKT and FLEAT terminals for this test. Therefore, you asserted 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 deemed 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 degrees. This test was successfully conducted with the terminals at standard metric height and MGS height. The higher mounting height would increase the probability of the vehicle snagging on posts 3 and 4. On the other hand, the increased blockout depth would reduce the potential for snagging. Previous testing of the terminals for both standard

metric height and MGS guardrail systems did not show the increased mounting height to adversely affect the impact performance of the terminals. Additionally, testing the FLEAT-SP two breakaway post system and the FLEAT-MGS flared guardrail system has shown that snagging is not a significant issue. Thus, it is believed that this test is also not necessary.

Test 3-35 involves a 2000P vehicle impacting the terminal at the beginning of the length-of-need at a speed of 100 km/h and an angle of 20 degrees. This is essentially a strength test of the anchorage system. This test was conducted on the FLEAT-SP two breakaway post system and the FLEAT-MGS flared guardrail system. Since the anchorage design of the terminals remains unchanged, the increase in mounting height should have minimal effect on this test and you contend there is no need to conduct this test 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 degrees. As mentioned above, the mounting height of the guardrail should have minimal effect on this test given the c.g. height of the 2000P test vehicle. Hence this test is also considered to be unnecessary.

The SKT-SP-MGS and FLEAT-SP-MGS terminal drawings (enclosed for reference) with two breakaway posts for use with the MGS guardrail system show an end panel that is 3 feet, 1 1/2 inches longer for a total length of 15 feet-7 1/2 inches long in order to begin the MGS mid-span splice configuration. The end panel spans from post 1 to midspan between posts 3 and 4. The remaining W-Beam panels are all 12 feet, 6 inches long. You noted that you received a request to provide alternate lengths of the end terminal rail sections for the SKT-SP-MGS and FLEAT-SP-MGS systems so that the rail sections can be handled more easily in the field during installation/repair and also for inventory standardization with the metric height terminals. The proposed alternate design is to use a 12 foot-6 inch end rail section that spans from post 1 to post 3, followed by a special 9 foot-4 1/2 inch rail section that spans from post 3 to mid-span between posts 4 and 5, and standard 12 foot-6 inch rail sections from there on.

In your request you stated that these proposed alternate rail section lengths should not adversely affect the safety performance of the SKT-SP-MGS and FLEAT-SP-MGS terminals for a number of reasons. First, the rail splices remain at mid-span in accordance with the MGS design. Moving the splice from mid-span between posts 3 and 4 to between posts 4 and 5 should have little or no effect on the rail strength. Secondly, the critical test for rail strength is NCHRP Report 350 Test 3-35. Given that the point of impact for this test is at post 3, which is the beginning of length-of-need, the splice at post 3 should not pose any problem as has been demonstrated in previous crash tests. Finally, this rail configuration is used in another existing MGS terminal accepted by FHWA without any known in-service problems.

In summary, you concluded that no additional crash tests are required to verify the performance of both the SKT-SP-MGS and FLEAT-SP-MGS terminals with two breakaway posts for the MGS guardrail system with either the 15 feet-7 1/2 inches long or the 12 foot-6 inch long end rail section. You asked that the optional length end rail sections be applicable to all SKT and FLEAT MGS terminals. We concur in these requests.

## Findings

The modified FLEAT-SP-MGS and SKT-SP-MGS 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-88C 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,

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

Enclosures

FHWA:HSSD:NArtimovich:tb:61331:11/19/09

File: s://directory folder/nartimovich/CC88C\_RoadSystemsMGSfinal.doc

cc: HSSD (Reader, HSA; Chron File, HSSD; NArtimovich, HSSD; WLongstreet, HSSD;  
MMcDonough, HSSD)



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

December 10, 2009

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Type of device: Midwest W-Beam Guardrail Terminals  
Test Level: NCHRP Report 350 Test Level 3  
Testing conducted by: N/A  
Date of request: May 29, 2009  
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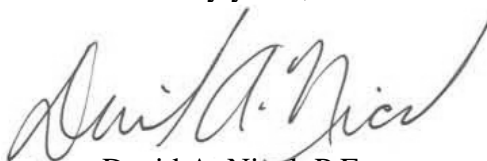
**Findings**

The modified FLEAT-SP-MGS and SKT-SP-MGS 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.

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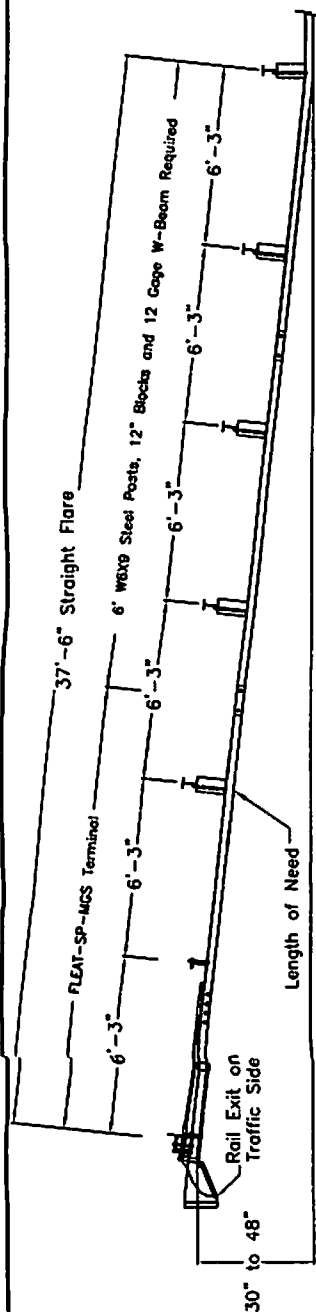
Sincerely yours,



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

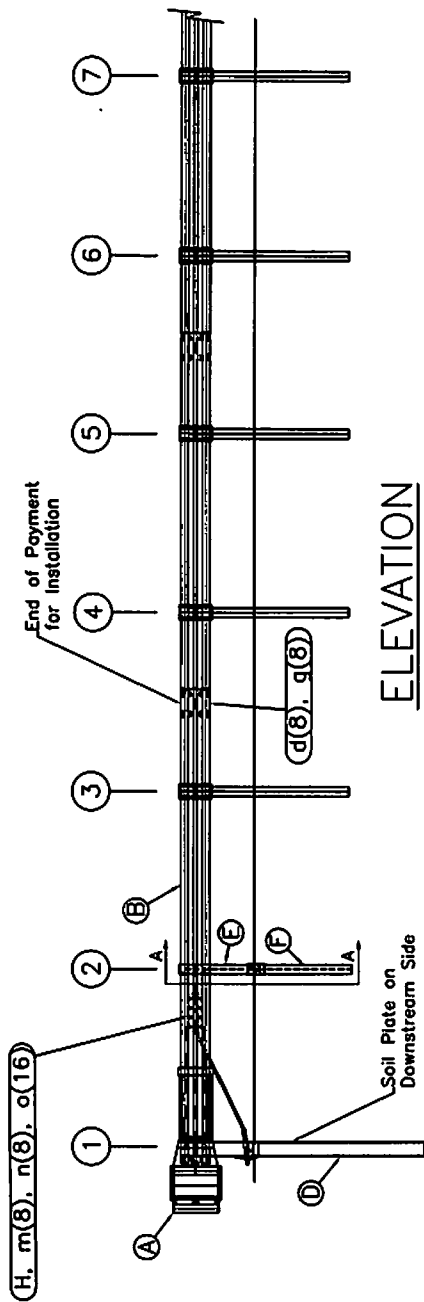
Enclosures

ITEM	QTY	DESCRIPTION	ITEM NO.
A	1	IMPACT HEAD	F3000
B	1	W-BEAM GUARDRAIL END SECTION, 12 Ga.	WGS-87103
C	1	FIRST POST TOP (6" X 6" Tube)	TPHP1A
D	1	FIRST POST BOTTOM (6" X 6" Tube)	TPHP1B
E	1	SECOND POST ASSEMBLY TOP	UHP2A
F	1	SECOND POST ASSEMBLY BOTTOM	UHP3B
G	1	BEARING PLATE	E750
H	1	CABLE ANCHOR BOX	S760
J	1	BCT CABLE ANCHOR ASSEMBLY	E770

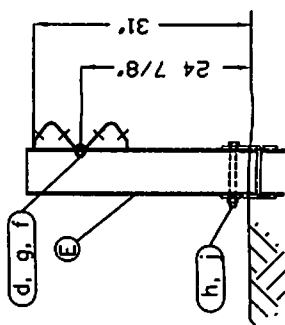
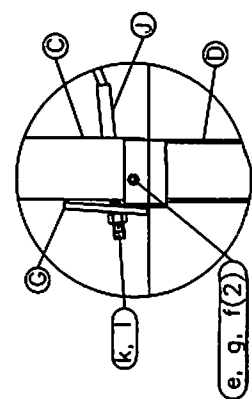
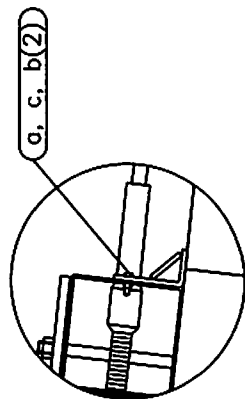


PLAN

TRAFFIC



ELEVATION



SECTION A-A

Post #2

Post #1 Connection Detail

Impact Head Connection Detail

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). 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 12" Ø post hole, 20 in. deep corod into the rock surface may be used if approved by the engineer for post 1. Granular material will be placed in the bottom of the hole, approximately 2.5' deep to provide drainage. The first post can be field cut to length, placed in the hole and backfilled with suitable backfill. The soil plate may be trimmed if required.
5. The breakaway cable assembly must be taut. A locking device (Vico grips or channel lock pliers) should be used to prevent the cable from twisting when tightening nuts.

**RST**  
Road Systems, Inc.  
Big Spring, TX  
Phone: 432-263-2435  
or Phone: 800-346-0721

FLEAT-SP-MGS Terminal Midwest Guardrail System 31" Top of Rail		Sheet: 1
Drawing Name: FLT-SP-S-MGS	Scale: None	Date: 05/28/09
		By: JRR
		Rev: 0

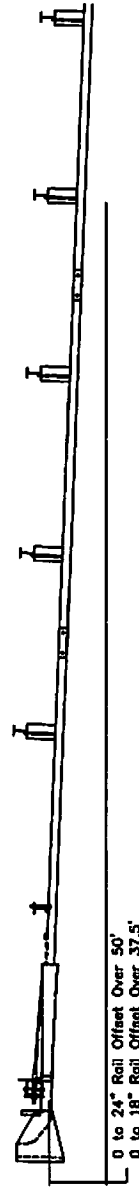
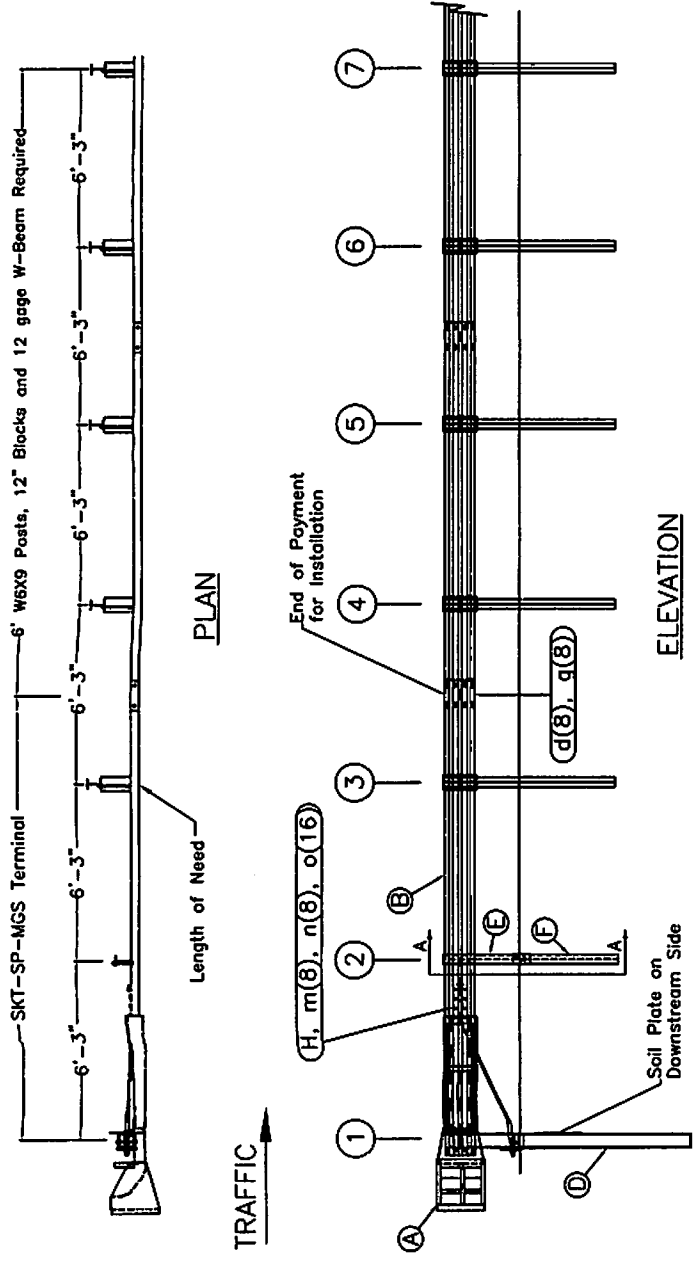
ITEM NO.	ITEM QTY	BILL OF MATERIALS
A	1	IMPACT HEAD
B	1	W-BEAM GUARDRAIL END SECTION, 12 Ga.
C	1	FIRST POST TOP (6"x6"x1 Tube)
D	1	FIRST POST BOTTOM (6" Wx15)
E	1	SECOND POST ASSEMBLY TOP
F	1	SECOND POST ASSEMBLY BOTTOM
G	1	BEARING PLATE
H	1	CABLE ANCHOR BOX
I	1	BCT CABLE ANCHOR ASSEMBLY
J	1	BCT CABLE ANCHOR ASSEMBLY
HARDWARE (ALL DIMENSIONS IN INCHES)		
a	2	5/16 x 1 HEX BOLT GRD 5
b	4	5/16 WASHER
c	2	5/16 HEX NUT
d	9	5/8 Dia. x 1 1/4 SPLICE BOLT (POST #2)
e	1	5/8 Dia. x 9 HEX BOLT GRD 5
f	3	5/8 WASHER
g	10	5/8 Dia. H.G.R. NUT
h	1	3/4 Dia. x 8 1/2 HEX BOLT GRD A440
i	1	3/4 Dia. HEX NUT
j	2	1 ANCHOR CABLE HEX NUT
k	2	1 ANCHOR CABLE WASHER
l	2	1 ANCHOR CABLE WASHER
m	8	CABLE ANCHOR BOX SHOULDER BOLT
n	8	1/2 A325 STRUCTURAL NUT
o	16	1 1/16 OD x 9/16 ID A325 STR. WASHER
		W050A

GENERAL NOTES:

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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. 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.
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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.

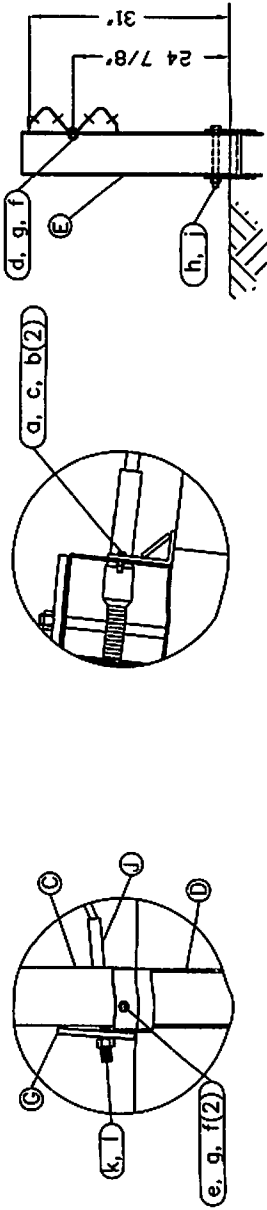
**RS&I**  
 Road Systems, Inc.  
 11111 1st St. N.  
 Minneapolis, MN 55412-2435  
 Tel: 612-835-2435  
 Fax: 612-835-2435

Sheet:	1
Date:	05/28/09
By:	JRR
Rev:	0
Drawing Name:	SKT-SP-S-MGS
Scale:	None
SKT-SP-MGS Terminal Midwest Guardrail System 31" Top of Rail	



OPTIONAL FLARED INSTALLATION

25:1 maximum flare rate



Post #1 Connection Detail

Impact Head Connection Detail

SECTION A-A  
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