U.S. Department
of Transportation
Federal Highway Administration

October 27, 2006

400 Seventh St., S.W.
Washington, D.C. 20590

In Reply Refer To:
HSA-10/B-137A1

Mr. Bill Neusch
President
Gibraltar
320 Southland Road
Burnet, TX 78611

4 CABLE DESIGN

Dear Mr. Neusch:

Your test level 4 (TL-4) Gibraltar cable barrier was formally accepted for use on the National Highway System in my September 9, 2005, acceptance letter, B-137A. The tested design, as described in that letter, consisted of cables placed 20 inches, 30 inches, and 39 inches above the ground line. In your October 13, 2006, letter to Mr. Richard Powers of my staff, you requested the Federal Highway Administration's acceptance of a modified version of this design which added a fourth cable between the bottom two at a height of 25 inches. The resultant 4-cable design has the lower three cables at the same heights as your TL-3 design while retaining the top cable at the tested TL-4 height of 39 inches. The addition of the fourth cable requires a modified "hairpin" and lockplate to retain the cables at the proper heights. Since the terminal remains the same, it will also be necessary to "anchor" the added cable. You have proposed to do this by tapering the 25-inch high cable down to the bottom (20-inch) cable between the first line post and the last terminal post and connecting the two cables with a series of four cable clamps (Crosby Type) spaced 4.5 inches apart along the 20-inch high bottom cable.

The modified Gibraltar Cable Barrier as described above remains an National Cooperative Highway Research Program Report 350 TL-4 median barrier when the posts are set on alternate sides of the cables or a TL-4 roadside barrier when the cables are all on the traffic side of the C-posts. Although the additional cable can logically be expected to reduce the design deflection of the barrier, it is not currently possible to assign a specific number to this reduction without benefit of a crash test.

Sincerely yours,

/original signed by/

John R. Baxter, P.E.
Director, Office of Safety Design

U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Avenue, SE.
Washington, DC 20590

February 8, 2008

In Reply Refer To: HSSD/B-137D

Mr. Bill Neusch
President
Gibraltar
320 Southland Road
Burnet, TX 78611

4 CABLE ANCHOR

Dear Mr. Neusch:

Thank you for your letter of October 19, 2007, requesting a modification to the anchorage of your company's 4-cable barrier. Your original test level 4 (TL-4) Gibraltar cable barrier was formally accepted for use on the National Highway System (NHS) in the September 9, 2005, Federal Highway Administration (FHWA) acceptance letter B-137A. The tested design, as described in that letter, consisted of cables placed 20 inches, 30 inches, and 39 inches above the ground line.

In our October 27, 2006, letter B-137A1 we accepted your 4-cable design having the lower three cables at the same heights as your TL-3 design while retaining the top cable at the tested TL-4 height of 39 inches. The addition of the fourth cable required a modified "hairpin" and lock plate to retain the cables at the proper heights. In order to "anchor" the added cable you tapered that 25-inch high cable down to the bottom (20-inch) cable between the first line post and the last terminal post and connected the two cables with a series of four cable clamps. Because of concerns raised over this splicing treatment, especially on downstream terminals, you have proposed to anchor each of the four cables separately.

The modified anchor is shown on the enclosed drawings for reference and features the fourth cable attached directly to the anchor post foundation plate instead of being cable clamped to the bottom cable. You also added a fourth J-bolt to each terminal post to accommodate the fourth cable. We concur in this modification and find it acceptable for use with your four-cable barrier.

The modified Gibraltar Cable Barrier as described above remains a National Cooperative Highway Research Program (NCHRP) Report 350 TL-4 median barrier when the posts are set on alternate sides of the cables or a TL-4 roadside barrier when the cables are all on the traffic side of the C-posts.

Although the barrier performed well under ideal test impact conditions when originally crash tested, the likelihood of passenger car underrides of any cable system may increase as the post spacing increases, particularly when the barrier is installed on non-level or slightly irregular terrain and the cables are not restrained from lifting at each post. Consequently, some transportation agencies have limited post spacing to approximately 6m (20 feet) for cable barriers. The dynamic deflection of the barrier is likely to increase when it is installed along the convex sides of horizontal curves, and when distances between anchorages exceed the 350-foot test length.

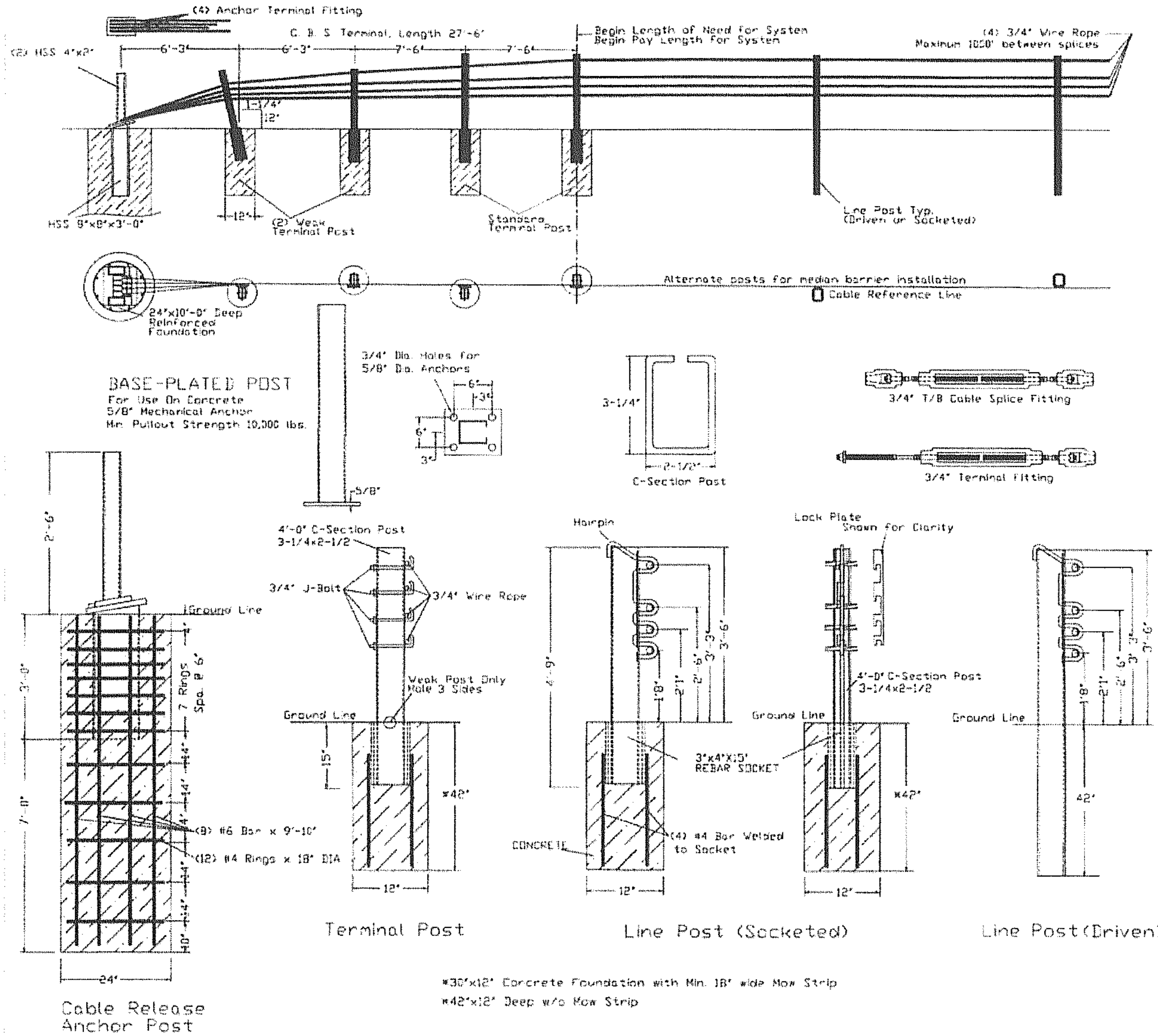
Please note the following standard provisions that apply to the FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the device(s).
- 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, it reserves the right to modify or revoke its 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 they will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance, designated as number B-137C, shall not be reproduced except in full. This letter, and the test documentation upon which this letter is based, is public information. All such letters and documentation may be reviewed at our office upon request.
- The four-cable Gibraltar Cable Barrier System is a patented product and considered proprietary. If proprietary devices are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, they: (a) 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



REV: 7 DATE: 10/23/07 APPROVER: RF

GENERAL NOTES

1. For additional information contact Gibraltar, Inc. at 1-800-495-8957. or see the manufacture's product manual.
2. All concrete shall be minimum 2500 PSI.
3. Alternate Post for bi-directional traffic flow. If installed for traffic in one direction install cables on traffic side of posts.
4. The Cable Barrier System shall be installed on shoulders or on medians with slopes of 6:1 or flatter. If installed on slopes steeper than 6:1 up to 4:1 the TL-4 system performs as a TL-3 and Gibraltar must be contacted for various guidelines related to placement.
5. The Cable Barrier System is accepted by the FHWA Test Level - 4
6. See the MUTCD for proper "Barrier" delineation
7. Rock Clause: Where solid rock is encountered
   a.) For socketed post, continue digging 12" diameter, 15" deep into rock or the required plan depth, whichever comes first.
   b.) For driven post, core drill a 4" diameter hole 18" deep into rock or the required plan depth, whichever comes first.
   c.) For Anchor post, continue digging 24" diameter, 30" deep into rock or the required plan depth, whichever comes first
8. The Gibraltar cable barrier system shall be installed in NCHRP Report 350 standard compacted soil. Soil must be well drained.
9. Every component to be galvanized.

Cable Tension	
-10F	8000
0	7600
10	7200
20	6800
30	6400
40	6000
50	5600
60	5200
70	4800
80	4400
90	4000
100	3600
110	3200

Allowable Deviation from Chart +/- 10%

Deflection	Post Spacing
9'3"	30.FT
9'	28.FT
8'	20.FT
7'	12.FT
6'8"	10.FT

GIBRALTAR
320 Southland Road
Burnet, Texas 78611
1-800-495-8957

Cable Barrier System
Patent Pending

SYSTEM: TL-4-4 SCALE: NTS DRAFTERS: EJ&TJ DATE: 10/23/07

400 Seventh St., S.W.
Washington, D.C. 20590

September 9, 2005

Mr. Bill Neusch, President
Gibraltar
320 Southland Road
Burnet, Texas 78611

In Reply Refer To: HSA-10/B-137A

Dear Mr. Neusch:

TL 4

In your August 11 letter to Mr. Richard Powers of my staff, you requested the Federal Highway Administration's (FHWA) acceptance of a modified version of your TL-3 Gibraltar cable barrier system that was tested to the NCHRP Report 350 test level 4 (TL-4). Copies of the August 5 report prepared by Exponent Failure Analysis Associates in Phoenix, Arizona entitled "NCHRP Report 350 Test 4-12 of the Gibraltar Longitudinal Cable Barrier System" and digital videos of the test were also submitted.

Your modified cable barrier system consists of three, 3/4-inch diameter 3 X 7 post-tensioned galvanized steel cables supported by steel C-posts 3.25 x 2.5 x 0.15-inches thick and 7-ft long, The posts, set on 14-foot centers, were driven to a depth of 3.5 feet and installed on alternate sides of the cables. The 3 cables are locked in place by a 7/16-inch diameter x 24-inch long galvanized steel hairpin and lock plate that fits inside each post. For your TL-4 design, the bottom, middle, and top cable heights are set at 20 inches, 30 inches and 39 inches, respectively. These details are shown in Enclosure 1, which also includes drawings of the terminal. This terminal is essentially identical to the TL-3 design developed for use with the original TL-3 Gibraltar Cable Barrier. The only modification needed in the terminal to match the higher cables in the TL-4 barrier design was the increased height of the center and top cables at terminal post 4. The barrier test installation was 350 feet long and each cable was tensioned to 4800 lbs. prior to the tests.

The NCHRP Report 350 test 4-12 was successfully conducted and the summary results are shown in Enclosure 2. Dynamic deflection was reported to be 7 feet in the 350-foot long test installation. Since the bottom cable remained at the same height as the TL-3 design, we agreed beforehand that tests with the small car and the pickup truck could be waived. Based on the test results, the Gibraltar Cable Barrier as described herein may be considered an NCHRP Report 350 TL-4 median barrier when the posts are set on alternate sides of the cables or as a TL-4 roadside barrier when the cables are all on the traffic side of the C-posts. Shorter, socketed line posts, as shown in the enclosed drawing may be used in lieu of driven posts.

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

- Our acceptance is limited to the crashworthiness characteristics of the tested device and does not cover its structural features, durability, or maintenance characteristics.

- Any design or material changes that may adversely affect the crashworthiness of the barrier 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 barrier being marketed is significantly different from the version that was crash tested, it reserves the right to modify or revoke its 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 they will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance, designated as number B-137A shall not be reproduced except in full. This letter, and the test documentation upon which this letter is based, is public information. All such letters and documentation may be reviewed at our office upon request.
- The Gibraltar Cable Barrier includes patented components and is considered proprietary. When proprietary devices are *specified by a highway agency* for use on Federal-aid projects, except exempt, non-NHS projects, they: (a) must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with 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.

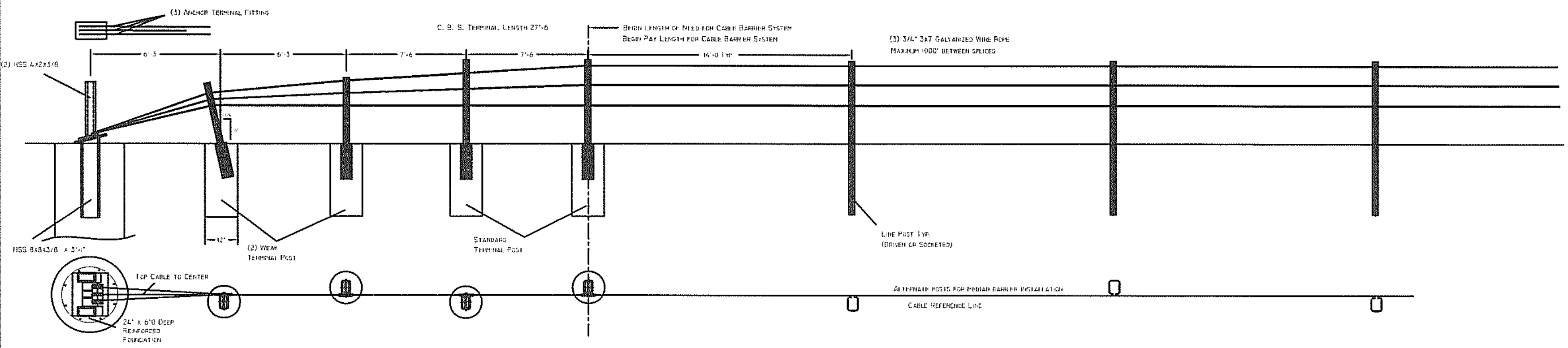
Sincerely yours,

/original signed by George E. Rice, Jr./

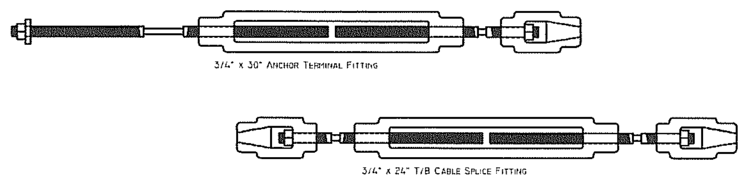
~for~

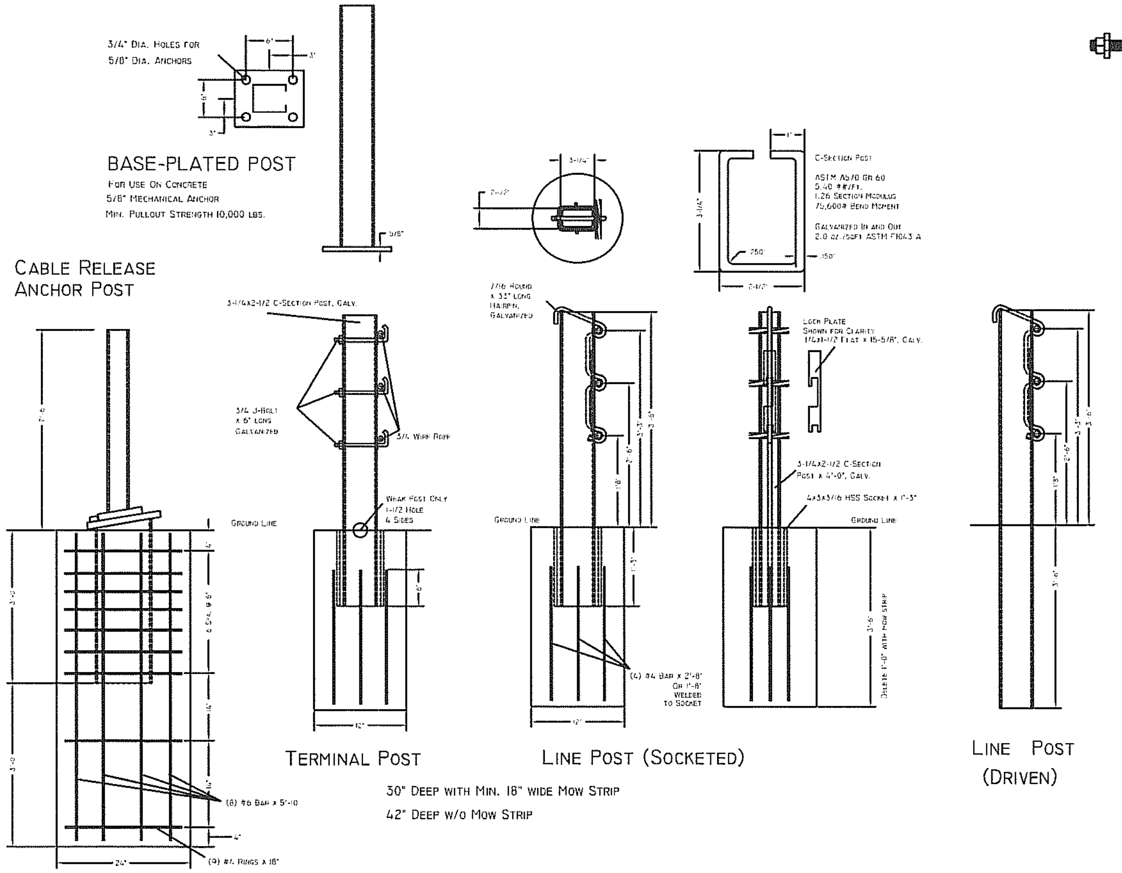
John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

2 Enclosures



Cable Tension	
-10F	8210
0	7819
10	7447
20	7069
30	6677
40	6301
50	5928
60	5536
70	5155
80	4773
90	4390
100	4009
110	3627





30" Deep with Min. 18" wide Mow Strip

42" Deep w/o Mow Strip

General Notes

1. For additional information contact Gibraltar at 1-800-495-8957.
2. All concrete shall be 2500 psi.
3. For Additional Information see Manufacturer's Product Manual.
4. The Cable Barrier System is designed for bi-directional traffic flows. If installed for traffic in one direction install cables on traffic side of posts.
5. The Cable Barrier System shall be installed on median shoulders or on depressed medians with slopes of 6:1 or flatter without obstructions, depressions, etc. that may influence trajectory of an errant vehicle.

Date 8/10/05			Gibraltar — 320 Southland Road, Burnet, Texas 78611
Drawn by DM			
Issued For Construction			Cable Barrier System
Approver	Date		1 May 2005 Patent Pending

TEST FINDINGS SUMMARY

GENERAL INFORMATION	
TEST AGENCY	EXPONENT
TEST NO.	4-12
DATE	8/5/05
TEST ARTICLE	GIBRALTAR CABLE BARRIER SYSTEM
TYPE	LONGITUDINAL BARRIER
INSTALLATION LENGTH	106.7 m (350 ft)
SOIL CLASSIFICATION (AASHTO M145) & MOISTURE CONDITION	A-4 7.3% MOISTURE CONTENT
TEST VEHICLE	8000S
TYPE	PRODUCTION
DESIGNATION	SINGLE-UNIT TRUCK
MAKE/ MODEL	INTERNATIONAL/ 4700
MASS (TEST INERTIAL)	8,000 kg (17,600 lb)
ATD	OPTIONAL - NOT USED
IMPACT SPEED	80 km/hr (49.7 mph)
IMPACT ANGLE (Deg.)	15
EXIT SPEED	55.9 km/hr (34.7 mph) at 5 seconds after initial impact
EXIT ANGLE	LESS THAN 4-degrees

(1) Not a requirement for a 4-12 test, but the data was recorded to obtain these values upon request of the test sponsor, Gibraltar.
(2) The test article yielded as designed, which controlled lateral displacement of the test vehicle to approximately 2.13 m (7 ft) measured at the vehicle left rear outboard tire

OCCUPANT RISK VALUES	
IMPACT VELOCITY	
X-DIRECTION	(1)
Y-DIRECTION	(1)
THIV	(1)
RIDEDOWN ACCELERATIONS	
X-DIRECTION	(1)
Y-DIRECTION	(1)
PHD	(1)
ASI	(1)
TEST ARTICLE DEFLECTION	
DYNAMIC	(2)
PERMANENT	(2)
VEHICLE DAMAGE	
ENGAGEMENT WITH THE BARRIER CAUSED MINIMAL FRONT-END BODY DAMAGE AT THE BUMPER AND THE LEFT FRONT WHEEL WELL AND HOOD. DUE TO A COLLISION WITH A CONCRETE BARRIER AFTER DISENGAGEMENT FROM THE TEST ARTICLE, IT WAS NOT POSSIBLE TO ASCERTAIN THE EXTERNAL DAMAGE CAUSED BY THE TEST ARTICLE. NO INTRUSION OR PENETRATION INTO THE OCCUPANT COMPARTMENT OCCURRED.	
POST IMPACT VEHICULAR BEHAVIOR	
MAXIMUM ROLL ANGLE	4.4° LEFT DOWN, 5.6° RIGHT DOWN
MAXIMUM PITCH ANGLE	7.6° NOSE UP
MAXIMUM YAW ANGLE	15.9° TO RIGHT

Figure 3: TEST FINDINGS SUMMARY

U.S. Department of Transportation
Federal Highway Administration

April 3, 2006

400 Seventh St., S.W.
Washington, D.C. 20590

In Reply Refer To: HSA-10/B-137B

Mr. Bill Neusch
President
Gibraltar
320 Southland Road
Burnet, Texas 78611

VARIABLE POST SPACING

Dear Mr. Neusch:

In your March 2, 2006, letter to Mr. Richard Powers of my staff, you provided summary information on two additional tests you ran on your test level 4 (TL-4) Gibraltar cable barrier system and requested the Federal Highway Administration's (FHWA) acknowledgment and acceptance of the test results. On March 9, 2006, you sent him complete copies of the January 6, 2006, reports prepared by Karco Engineering, LLC (Test Report Nos. TR-P26021-01-A and TR-P26028-01-B) and digital videos that documented the results of these tests. Both tests were run on your TL-4 design in which the cables are 20, 30, and 39 inches above the ground. The support posts were C-posts 3.25 inches by 2.5 inches by 0.15 inches by 4.9-feet long. Each post was set in a 15-inch deep socket placed in a 42-inch deep by 12-inch diameter reinforced concrete footing. The shape and the dimensions of the steel "hairpin" and lock plate that hold the cables in place were slightly modified from your earlier design and are shown in Enclosure 1. For both tests, the total installation length was 305 feet and the cables were tensioned to 5700 pounds.

For the first test, the line posts were set on 10-foot centers and the reported dynamic deflection was 6.8 feet. For the second test, the posts were spaced on 30-foot centers, resulting in 9.3 feet of deflection. The summary sheets for both of these tests are shown as Enclosure 2. I concur with the test agency's assessment that both tests met the appropriate evaluation criteria for National Cooperative Highway Research Program Report 350 test 3-11, and either design may be used on the National Highway System when such use is acceptable to the contracting agency. In your March 29, 2006, follow-up letter, you requested confirmation that either 6.25-foot long posts (for TL-3) or 7-foot long C-posts (for TL-4), driven directly into the soil to a depth of 42-inches, could be used as an alternative to the tested socketed posts. Since the longer posts were successfully used in the June 20, 2005, TL-3 test referenced below and in your earlier TL-4 test, I agree that either the driven or the socketed post design may be used.

Based on a straight-line interpolation of the dynamic deflection distances noted above, you also requested FHWA concurrence in assumed deflections based on intermediate post spacings, i.e., post spacings *between* 10 feet and 30 feet. In reviewing our earlier acceptance letters for the

Gibraltar system, we noted that for your original TL-3 design with a 15-foot post spacing, the reported dynamic deflection was approximately 8.5 feet. A test conducted for you by Karco on June 20, 2005, on a slightly modified design resulted in a reduced dynamic deflection of 7.75 feet. Because both test installations were shorter in those tests (only 200 feet) and the tension in the cables was less (4800 lbs.), a direct comparison with your two recent tests cannot be made. However, the predicted deflections based on a straight-line interpolation between the 10- and 30-foot post spacing deflections appear reasonable. Thus, with your TL-4 design, the assumed deflections with a 12-foot post spacing would be approximately 7 feet, those with a 20-foot spacing would be approximately 8 feet, and those with a 30-foot spacing would be approximately 9 feet.

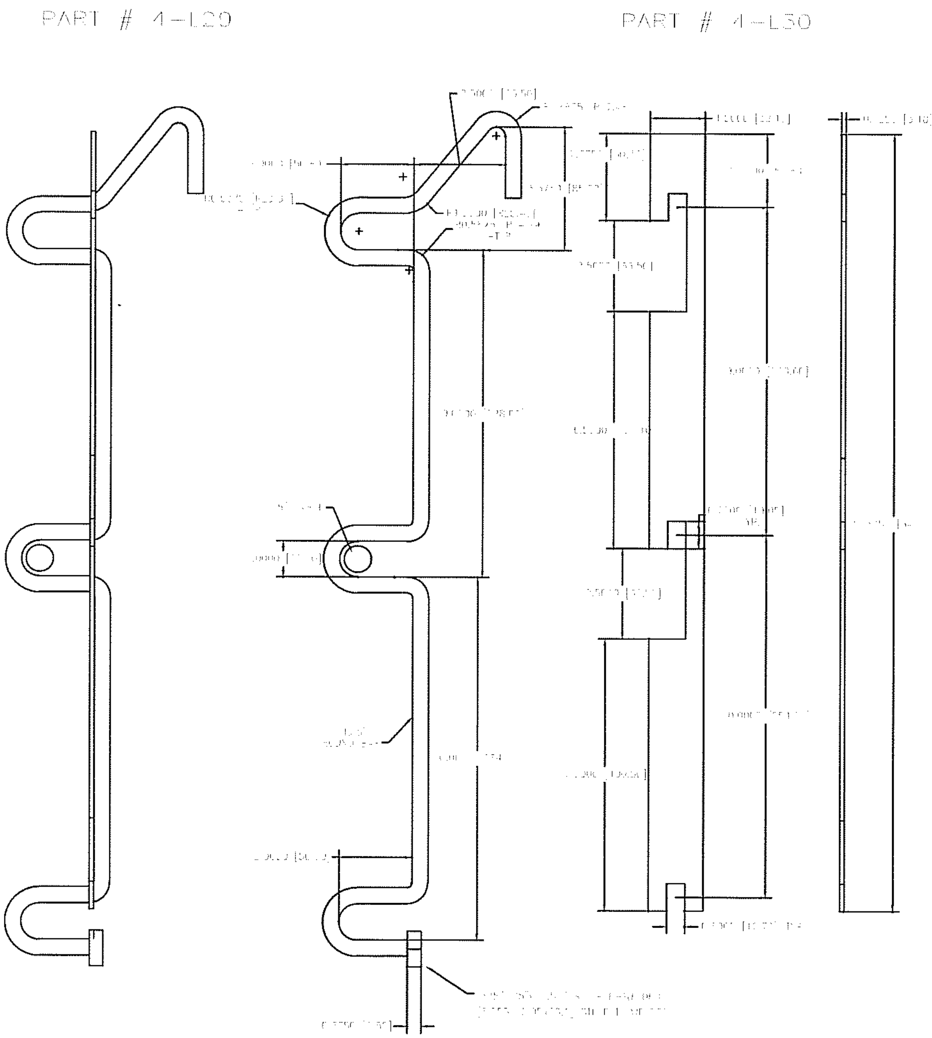
As noted in my original acceptance letter B-137, dated June 13, 2005, dynamic deflection distances based on a single standardized test are not precise and represent only an approximation of what is likely to be seen in the field. Many deflections will be less, but some will be significantly greater, depending on actual crash conditions. Assuming test deflections are accurate to the nearest inch and designing a barrier installation accordingly presumes a degree of precision that simply does not exist. To increase the factor of safety afforded the motoring public, the available deflection distance should exceed the design deflection distance for a flexible or semi-flexible barrier system whenever practicable.

Sincerely yours,

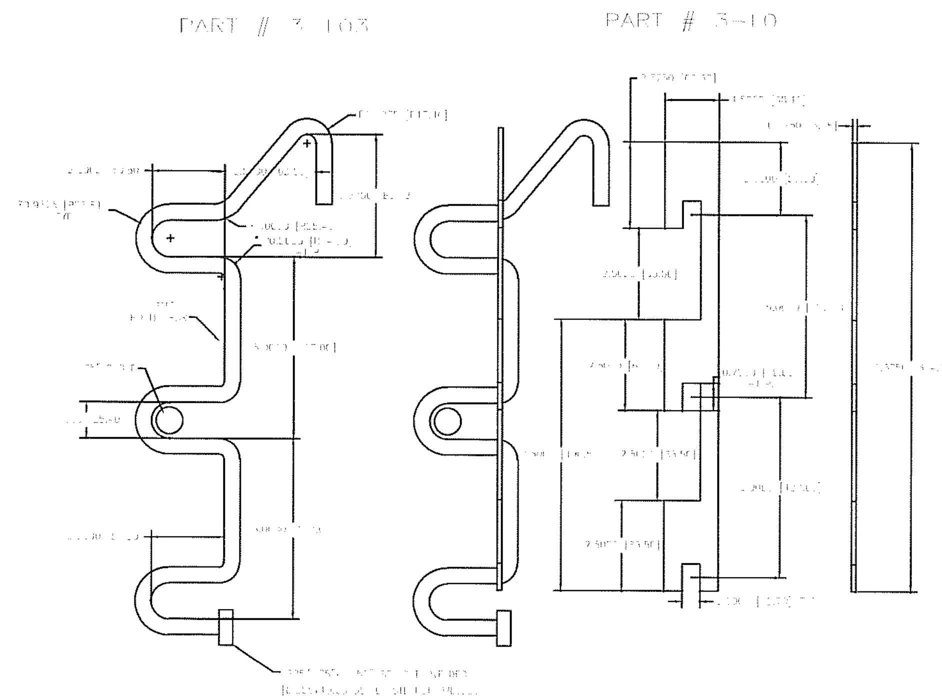
/original signed by/

John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

2 Enclosures



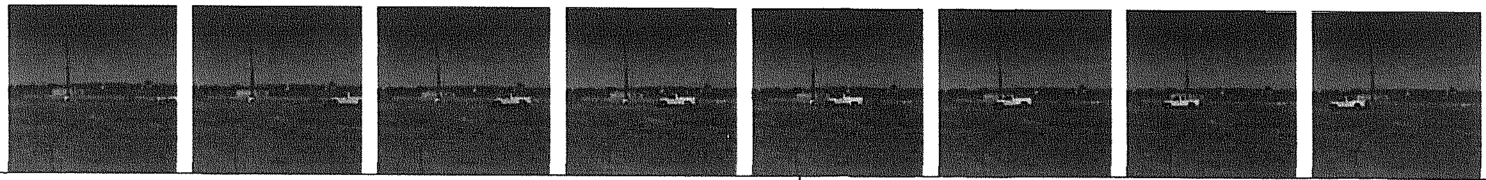
TL-4 HAIRPIN AND LOCKPLATE



TL-3HAIPPIN AND LOCKPLATE

DATA SHEET NO. 4

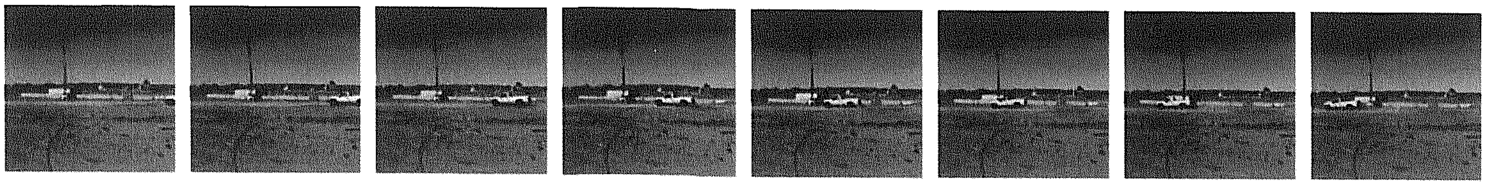
SUMMARY OF RESULTS FOR TEST NO. 3-11



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	IMPACT VELOCITY (m/sec)	
TEST NO.	3-11	X-DIRECTION	4.0
DATE	01/06/06	Y-DIRECTION	6.8
TEST ARTICLE		THIV (optional)	N/A
TYPE	Gibraltar TL-4 Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	93 m(305 ft)	X-DIRECTION	-2.3
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 10 ft post spacings	Y-DIRECTION	-5.3
SOIL TYPE AND CONDITION	CONCRETE	PHD (optional)	N/A
TEST VEHICLE	2000P	ASI (optional)	0.44
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	N/A
DESIGNATION	3-11	DYNAMIC	2 m (6.8 ft)
MODEL	Chevrolet 2500 Pick-Up Truck	PERMANENT	N/A
MASS (CURB)	2138 kg (4712 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2020 kg (4452 lbs)	EXTERIOR	
DUMMY(s) MASS	N/A	VDS	1FR1
GROSS STATIC WEIGHT	2020 kg (4452 lbs)	CDC	01RDEN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	99.85 km/h (62.06 mph)	OCDI	FS0000000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	140	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	-33.0
SPEED (km/h)	83.3 km/h @1000 ms	MAXIMUM YAW ANGLE (Deg.)	-12.7
ANGLE (Deg.)	<10	MAXIMUM PITCH ANGLE (Deg.)	2.8

DATA SHEET NO. 4

SUMMARY OF RESULTS FOR TEST NO. 3-11



GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	IMPACT VELOCITY (m/sec)	
TEST NO.	3-11	X-DIRECTION	4.0
DATE	01/06/06	Y-DIRECTION	6.8
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar TL-4 Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	93 m(305 ft)	X-DIRECTION	-2.3
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft post spacings	Y-DIRECTION	-5.3
SOIL TYPE AND CONDITION	CONCRETE	PHD (optional)	
TEST VEHICLE	2000P	ASI (optional)	0.44
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	N/A
DESIGNATION	3-11	DYNAMIC	2.8 m (9.3 ft)
MODEL	Chevrolet 2500 Pick-Up Truck	PERMANENT	N/A
MASS (CURB)	2138 kg (4712 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2020 kg (4452 lbs)	EXTERIOR	
DUMMY(s) MASS		VDS	1FR1
GROSS STATIC WEIGHT	2020 kg (4452 lbs)	CDC	01RDEN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	101.5 km/h (62.80 mph)	OCDI	FS0000000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	140	POST IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	-33.0
SPEED (km/h)	54.9 km/h @ 1500ms	MAXIMUM YAW ANGLE (Deg.)	-12.7
ANGLE (Deg.)	<10	MAXIMUM PITCH ANGLE (Deg.)	2.8

U.S. Department of Transportation
Federal Highway Administration

400 Seventh St., S.W.
Washington, D.C. 20590

In Reply Refer To:
HSA-10/B137C

July 12, 2006

Mr.Bill Neusch
President, Gibraltar
320 Southland Road
Burnet, Texas 78611

4:1 SLOPE

Dear Mr. Neusch:

In your June 22, 2006, letter, you requested the Federal Highway Administration's (FHWA's) concurrence that your TL-4 cable barrier system would be acceptable as a National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3) traffic barrier when placed as described below on a side slope as steep as 1V: 4H. At that time, you also provided staff members with preliminary test results. On July 11, Mr. Powers received a test report prepared by KARCO Engineering, LLC, entitled "Crash Test Report for Gibraltar TL-4 Cable Barrier System Installed on a 4:1 Sloped Median" and dated June 12, 2006.

In my letter dated September 9, 2005, the FHWA accepted a modified Gibraltar cable barrier system as a TL-4 design. This design consisted of three, 3/4-inch diameter 3 X 7 post-tensioned galvanized steel cables supported by steel C-posts 3.25 x 2.5 x 0.15-inches thick and 7-ft long. These posts were driven to a depth of 3.5 feet and installed on alternate sides of the cables. The 3 cables are locked in place by a 7/16-inch diameter x 24-inch long galvanized steel hairpin and lock plate that fits inside each post. For your TL-4 design, the bottom, middle, and top cable heights are set at 20 inches, 30 inches, and 39 inches, respectively.

A total of four tests were conducted with the TL-4 Gibraltar cable installed in a 7.3-m (24-feet) wide depressed median with 1V: 4H side slopes. For the first test, the barrier was located 2.7 m (9 feet) up the slope from the ditch bottom and the test vehicle crossed the ditch bottom and started up the backslope before impacting the barrier. For the remaining tests (NCHRP Report 350 tests 3-10 and 3-11), the barrier was located down the foreslope, 1.2 m (4 feet) from the edge of pavement. For the first two tests, all line posts were on 30-foot centers.

The first test was a modified 3-10 test in which a Geo Metro weighing 874 kg (1926 lb) was directed into the median at a 25° angle and 104.7 km/hr (65.1 mph), went down the slope, across the ditch bottom [located 3.7 m (12 ft) from edge of pavement] and 2.7 m (9 feet) up the far side of the ditch where it then impacted the backside of the cable [located 8.5 m (21 ft) from edge of pavement] at 97.5 km/hr (60.6 mph). The vehicle deflected the barrier 1.5 m (4.9 ft) laterally and was safely contained and redirected by the Gibraltar cable.

Enclosure 1 is the summary sheet for this test.

The second test was a standard NCHRP Report 350 3-11 test, with the Gibraltar cable, again with a 30-foot post spacing, located 1.2 m (4 ft) down the 1V: 4H slope from the edge of pavement. A Chevrolet C2500 3/4-ton pickup truck weighing 2,038 kg (4,494 lb) impacted the barrier at a 25-degree angle at 98.7 km/hr (61.3 mph). The maximum dynamic deflection of the barrier was not reported. Although the barrier contained the vehicle, cable deflection allowed the pickup truck to impact the backslope of the ditch and it subsequently overturned as it was being redirected by the cable. This test clearly demonstrated that adverse terrain behind a barrier can cause significant instability when barrier deflection allows an impacting vehicle to reach it, even when the barrier itself prevents penetration. Enclosure 2 is the test summary sheet for this test.

The third test was a repeat of the failed test, but the post spacing was reduced to 20 feet, and a heavier test vehicle was used, specifically a Dodge Ram 1500 weighing 2222 kg (4898 lbs). This is the new vehicle currently proposed for use in the draft Report 350 update. Impact conditions were 25 degrees and 97 km/h (60.3 mph). In this test, the pickup truck was contained and redirected upright with a maximum cable deflection of 2.6 m (8.6 ft). Test results are shown in Enclosure 3.

The final test was a standard NCHRP Report 350 3-10 test with the Gibraltar cable again located 1.2 m (4 ft) down the 1V: 4H slope from the edge of pavement. A Geo Metro weighing 919 kg (2,026 lb) impacted the barrier at a 20-degree angle at 101.6 km/hr (63.2 mph). The maximum dynamic deflection of the barrier was 1.4 m (4.7 ft), and the vehicle was safely contained and redirected by the cable. Enclosure 4 is the test summary sheet for this test.

Based on the test results summarized above, your TL-4 Gibraltar cable design is acceptable as a TL-3 traffic barrier when placed no farther than 1.2 m (4 feet) down a 1V: 4H slope (for adjacent traffic impacts) and no closer than 9 feet from the ditch bottom for opposite-side impacts. This offset may be decreased to 8 feet based on computer simulation done by the National Crash Analysis Center on the generic cable barrier and on our review of the vehicle position at that point in your test, provided the maximum down-slope offset remains at 4 feet. Although the tested design was your TL-4 system (successfully tested previously with the single unit truck on a flat slope), transportation agencies using this design on a 1V: 4H slope should understand that it has been tested only to TL-3 when installed on such a slope. Thus, it remains possible that the single-unit TL-4 truck may not be captured or contained by the barrier when installed on a 4:1 slope.

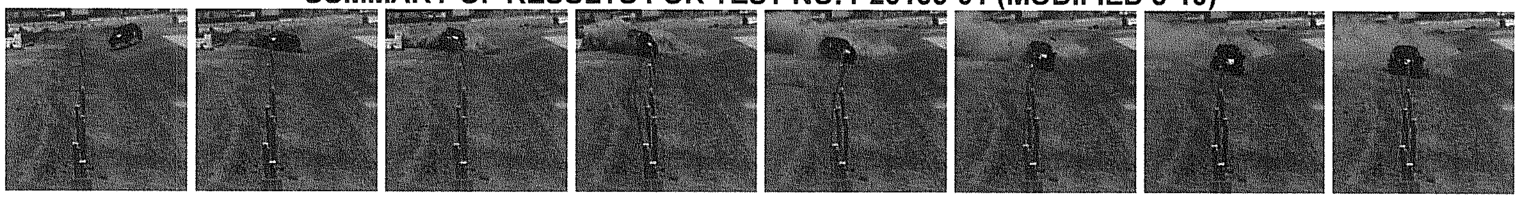
Sincerely yours,

/original signed by John R. Baxter/

John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

4 Enclosures

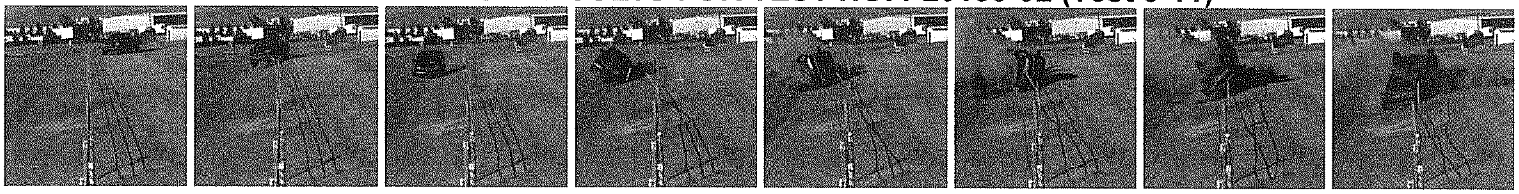
DATA SHEET NO. 2
SUMMARY OF RESULTS FOR TEST NO. P26133-01 (MODIFIED 3-10)

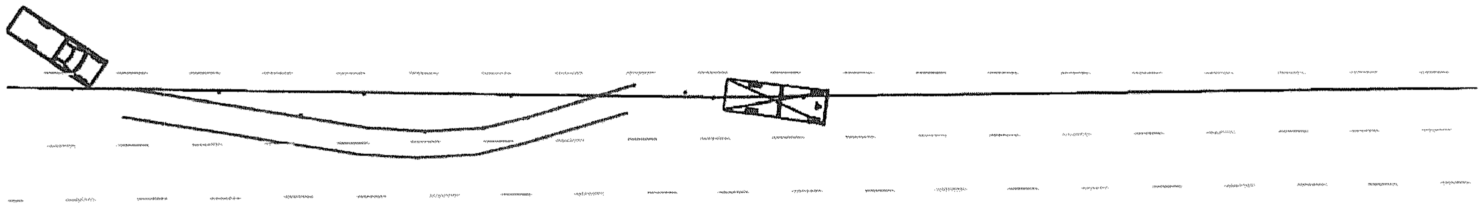


GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	Modified 3-10	X-DIRECTION	5.2
DATE	06/12/06	Y-DIRECTION	0.8
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	91.44 m (300 ft.)	X-DIRECTION	-7.4
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft. post spacings	Y-DIRECTION	-4.3
SOIL TYPE AND CONDITION	4:1 slope (upslope 25°)	PHD (optional)	
TEST VEHICLE	820C	ASI (optional)	0.84
TYPE	Production	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-10	DYNAMIC	1.50 m (4.92 FT.)
MODEL	Geo Metro	PERMANENT	N/A
MASS (CURB)	799 kg (1762 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	812 kg (1790 lbs)	EXTERIOR	
DUMMY(s) MASS	75 kg (165 lbs)	VDS	1-FR-4
GROSS STATIC WEIGHT	874 kg (1926 lbs)	CDC	01RDMN6
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	104.7 km/h (65.08 mph) 97.51 km/h (60.60 mph) at impact	OCDI	FR0000000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	34.8	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	22.7
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-41.0
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	6.7

* Vehicle remained in contact with the cable barrier for the duration of the event.

DATA SHEET NO. 6
SUMMARY OF RESULTS FOR TEST NO. P26133-02 (Test 3-11)

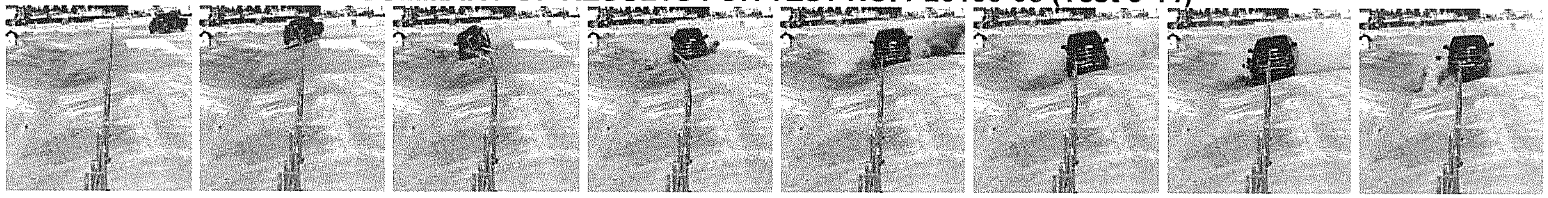




GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	3-11	X-DIRECTION	3.3
DATE	06/12/06	Y-DIRECTION	5.4
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	91.44 m(300 ft.)	X-DIRECTION	-15.1
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft. post spacings	Y-DIRECTION	10.4
SOIL TYPE AND CONDITION	4:1 slope	PHD (optional)	
TEST VEHICLE	2000P	ASI (optional)	0.49
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-11	DYNAMIC	
MODEL	2500	PERMANENT	N/A
MASS (CURB)	2210 kg (4872 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2038 kg (4494 lbs)	EXTERIOR	
DUMMY(s) MASS	N/A	VDS	1-L&T-6
GROSS STATIC WEIGHT	N/A	CDC	01RDGN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	98.65 km/h (61.31 mph)	OCDI	FS0100000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	89.5	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	258.7
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-49.3
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	35.5

* Vehicle rolled over on the cable barrier.

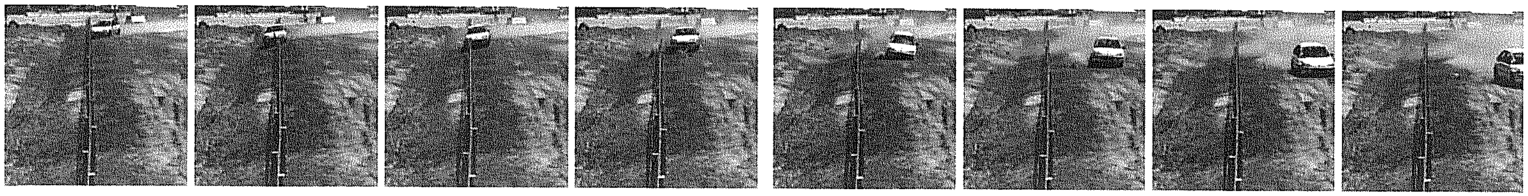
DATA SHEET NO. 10
SUMMARY OF RESULTS FOR TEST NO. P26133-03 (Test 3-11)

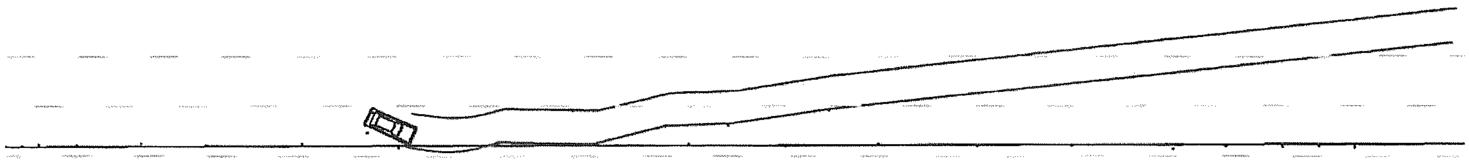


GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	3-11	X-DIRECTION	2.7
DATE	06/14/06	Y-DIRECTION	8.3
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	92.9 m(305 ft.)	X-DIRECTION	-3.6
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 20 ft. post spacings	Y-DIRECTION	-3.9
SOIL TYPE AND CONDITION	4:1 slope(down slope 25°)	PHD (optional)	
TEST VEHICLE	2270P	ASI (optional)	0.35
TYPE	Production	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-11	DYNAMIC	2.61 m (8.58 ft.)
MODEL	RAM 1500	PERMANENT	N/A
MASS (CURB)	2194 kg (4836 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	2222 kg (4898 lbs)	EXTERIOR	
DUMMY(s) MASS	N/A	VDS	1-FR-2
GROSS STATIC WEIGHT	N/A	CDC	01RDEN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	97.05 km/h (60.32 mph)	OCDI	FS0000000
ANGLE (Deg.)	25		
IMPACT SEVERITY (kJ)	144.7	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	23.8
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-44.3
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	-17.9

* Vehicle remained in contact with the cable barrier for the duration of the event.

DATA SHEET NO. 14
SUMMARY OF RESULTS FOR TEST NO. P26133-04 (Test 3-10)





GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	FLAIL SPACE VELOCITY (m/sec)	
TEST NO.	3-10	X-DIRECTION	2.8
DATE	06/16/06	Y-DIRECTION	4.9
TEST ARTICLE		THIV (optional)	
TYPE	Gibraltar Cable Barrier System	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	91.44 m (300 ft.)	X-DIRECTION	-4.8
SIZE AND/OR DIMENSION OF KEY ELEMENTS	¾ in 3 X 7 cable on 30 ft. post	Y-DIRECTION	-5.6
SOIL TYPE AND CONDITION	4:1 slope (upslope 25°)	PHD (optional)	
TEST VEHICLE	820C	ASI (optional)	0.63
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-10	DYNAMIC	1.43 m (4.70 FT.)
MODEL	Geo Metro	PERMANENT	N/A
MASS (CURB)	858 kg (1892 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	845 kg (1862 lbs)	EXTERIOR	
DUMMY(s) MASS	75 kg (165 lbs)	VDS	1-FR-2
GROSS STATIC WEIGHT	919 kg (2026 lbs)	CDC	01RRGN8
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	101.63 km/h (63.16 mph)	OCDI	FS0000000
ANGLE (Deg.)	20		
IMPACT SEVERITY (kJ)	39.3	POST-IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	37.6
SPEED (km/h)	N/A*	MAXIMUM YAW ANGLE (Deg.)	-34.3
ANGLE (Deg.)	N/A*	MAXIMUM PITCH ANGLE (Deg.)	4.4

*Test vehicle exit conditions occurred beyond the view of the overhead cameras.

U.S. Department
of Transportation
Federal Highway Administration

August 9, 2006

400 Seventh St., S.W.
Washington, D.C. 20590

In Reply Refer To: HSA-10

SOCKETS

Mr. Bill Neusch
Gibraltar
320 Southland Road
Burnet, Texas 786112

Dear Mr. Neusch:

In response to your e-mail request, please be advised it is the Federal Highway Administration's current position to consider driven posts and socketed posts set in concrete footings or driven steel sockets to be equivalent and, thus interchangeable when used in any configuration (i.e., post spacing) that was physically tested or at a spacing that lies between two spacings that were physically tested. In short, any post embedment type (i.e., driven posts, concrete-socketed posts, and driven steel tube socketed posts) for any post spacing that you have physically tested may be considered acceptable. The assumed design deflection for any alternative embedment design used would be the maximum deflection noted in any test with the same post spacing, even though a different embedment detail was used in the actual crash test. Based on tests run to date, there is some difference in deflection that can be attributed to embedment type, but it seems not to be significant, particularly since design deflections based on a single test are only a rough approximation of what will be seen in the field, given the potential disparity in actual crash conditions.

Since you have tested your Gibraltar cable system with posts set 15 inches into 42 deep concrete footings and also with posts driven directly into the ground to a 42-inch depth, I can agree that posts set 15 inches into a 3/16-inch thick 3"x 4" steel socket driven 42-inches deep would be expected to perform satisfactorily as well.

Sincerely yours,

/original signed by M.McDonough/

~for~

John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

U.S. Department
of Transportation
Federal Highway Administration

400 Seventh St., S.W.
Washington, D.C. 20590

June 23, 2005

In Reply Refer To: HSA-10/CC-92

Mr. Bill Neusch, President
Gibraltar
320 Southland Road
Burnet, Texas 78611

END TERMINALS

Dear Mr. Neusch:

In your June 7 letter to Mr. Richard Powers of my staff, you requested the Federal Highway Administration's acceptance of a cable barrier terminal designed for use with the Gibraltar Cable Barrier that was acknowledged to be a test level 3 (TL-3) barrier in my June 10 acceptance letter, B-137. With your letter, you submitted copies of crash test reports prepared by Karco Engineering and digital videos that documented the results of the crash tests that were conducted on the new terminal.

Your cable barrier terminal consists of a cable release anchor post and four terminal posts, the first of which is set 6'-3" beyond the anchor post, the second 6'-3" beyond the first, and the third and fourth on 7'-6" centers. These posts are then followed by standard line posts on 15-foot centers. The cable release anchor post is comprised of two HSS 2 x 4 x 3/8 steel posts welded to a ¾-inch thick steel base plate. This anchor post rests on a 1/2-inch thick base plate that is welded to an HSS 8 x 8 x 3/8 tube, 30-inches long, set in a 6-foot deep x 24-inch diameter reinforced concrete foundation. This anchor post is designed to pry the cable ends out of slots in the base plate when it is struck, thus releasing all cable tension and allowing a vehicle to pass over the terminal with a relatively stable trajectory. All terminal posts are 3.25 x 2.5 C-posts, like the line posts, but the cables are held in place by 3/4-in x 5.5-in long J-bolts rather than the steel hairpins and lock plates used on the line posts. The first terminal post is angled towards the cable release post as show in Enclosure 1 and the first two terminal posts have 1.5-in diameter holes on all four sides at the ground line. All posts beyond the anchor post are set in 42-in deep reinforced concrete footings. We noted that the anchor post design was modified during the testing sequence. Specifically, the original HSS 8 x 8 x 3/8 steel anchor post was replaced with the anchor post described above for tests 3-30 and 3-34 because the larger post lodged under the impacting vehicle in earlier tests, causing the small car to overturn. The original post remained intact in the length-of-need test 3-35 and its release mechanism remained unchanged. Likewise, the larger post yielded satisfactorily in the reverse-direction test 3-39. Thus, I agreed that neither test needed to be conducted again with the smaller anchor post.

The National Cooperative Highway Research Program (NCHRP) Report 350 tests 3-30, 3-32, 3-35, and 3-39 were successfully conducted and the summary results of each are shown in Enclosure 2. We agreed that, upon successful results of tests 3-30 and 3-32, tests 3-31 and 3-33 could be waived for your specific terminal design. Therefore, based on the test results, the Gibraltar Cable Barrier Terminal, as described herein, may be considered an NCHRP Report 350 terminal at TL-3. In test 3-35, the pickup truck impacted the terminal at post 4 and was contained and redirected. Thus, the beginning length of need for the Gibraltar terminal is at the last terminal post, 27.5 feet downstream from the anchor post.

We noted that in test 3-30, the impacting vehicle rolled after exiting the test installation. After reviewing the film, we concluded that the vehicle had regained stability as it rode along the cable and that the rollover was the result of its wheels tripping in the loose soil at the test site rather than instability caused directly by impact into the terminal. However, this result and the post-impact trajectory seen in test 3-32 emphasize the fact that your terminal, like all cable terminals tested to date, has virtually no attenuating capability. Thus, vehicles impacting the end will normally continue a significant distance behind and beyond the barrier and are then likely to encounter non-traversable terrain or other roadside hazards or encroach into opposing traffic lanes when the barrier is used in a median. Designers must take this fact into account when selecting an optimum location for terminals in the field.

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

- Our acceptance is limited to the crashworthiness characteristics of the tested device and does not cover its structural features, durability, or maintenance characteristics.
- Any design or material changes that may adversely affect the crashworthiness of the barrier 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 barrier being marketed is significantly different from the version that was crash tested, it reserves the right to modify or revoke its 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 they will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance, designated as number CC-92 shall not be reproduced except in full. This letter, and the test documentation upon which this letter is based, is public information. All such letters and documentation may be reviewed at our office upon request.
- The Gibraltar Cable Barrier Terminal includes patented components and is considered proprietary. When proprietary devices are *specified by a highway agency* for use on

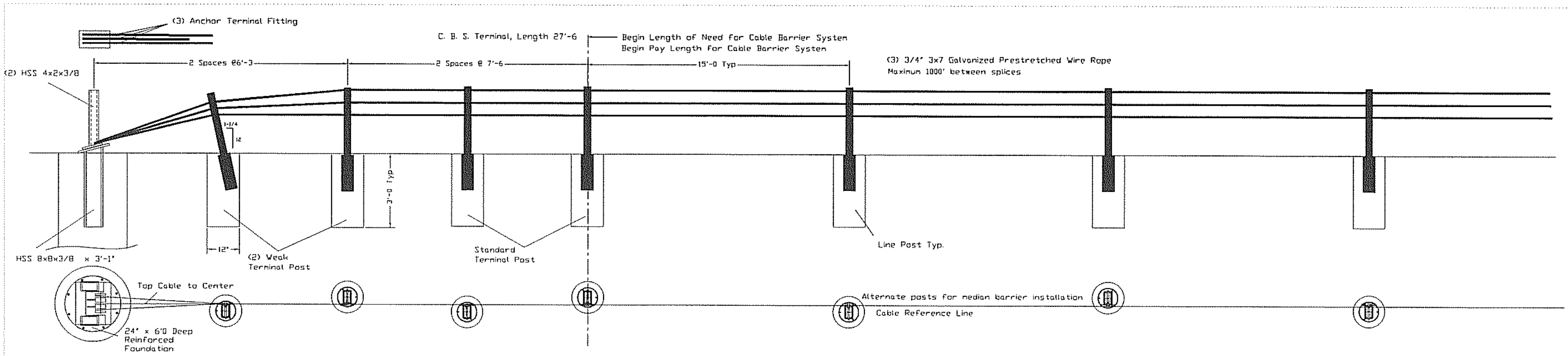
Federal-aid projects, except exempt, non-NHS projects, they: (a) must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with existing highway facilities or that no equally suitable alternative 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.

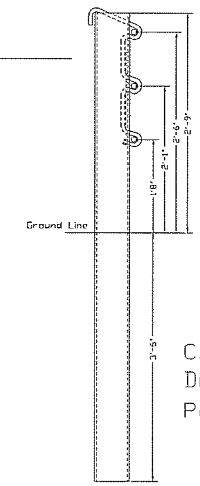
Sincerely yours,

/original signed by/

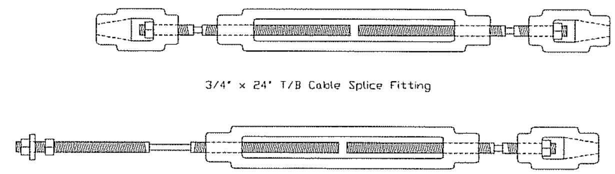
John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

2 Enclosures



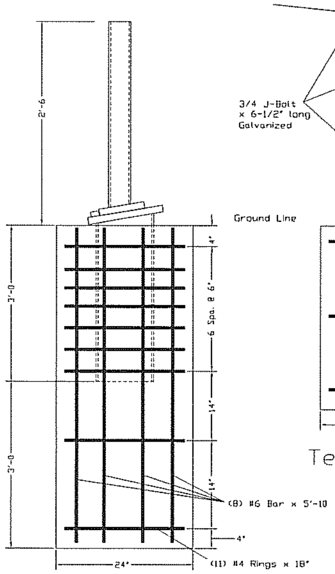


C. B. S. Driven Post

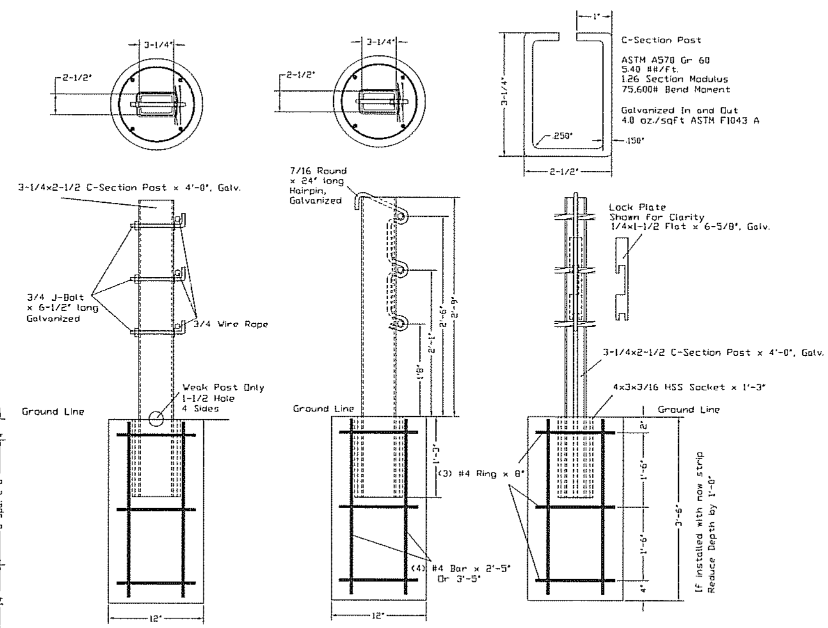


3/4" x 24" T/B Cable Splice Fitting

3/4" x 30" Anchor Terminal Fitting



Cable Release Anchor Post



Terminal Post

Line Post

GENERAL NOTES

1. For additional information contact Gibraltar at 1-800-495-8957.
2. All concrete shall be Class C. All posts shall be socketed design unless otherwise specified.
3. The Cable Barrier System is designed for bi-directional traffic flow. If installed for traffic in one direction install cables on traffic side of posts.
4. The Cable Barrier System shall be installed on median shoulders or on depressed medians with slopes of 6:1 or flatter without obstructions, depressions, etc. that may influence trajectory of an errant vehicle.
5. See the Texas MUTCD for proper delineation.

Cable	Tension
-10F	9122
0	8688
10	8274
20	7954
30	7419
40	7001
50	6586
60	6151
70	5728
80	5303
90	4878
100	4455
110	4030

Date 6/10/05	
Drawn by DM	
Issued For Construction	
Approver	Date

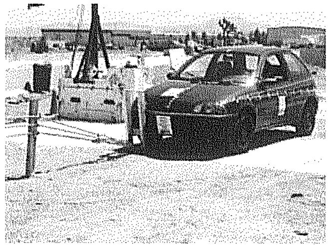
Gibraltar 320 Southland Road Burnet, Texas 78611

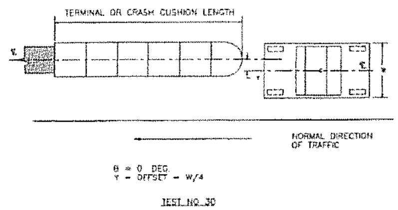
Cable Barrier System

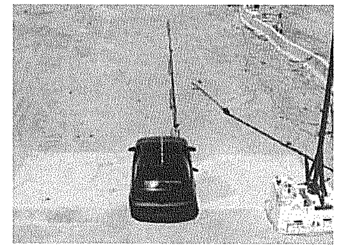
1 May 2005

DATA SHEET NO. 3

SUMMARY OF RESULTS FOR TEST NO. 3-30



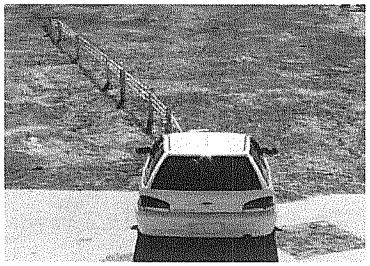


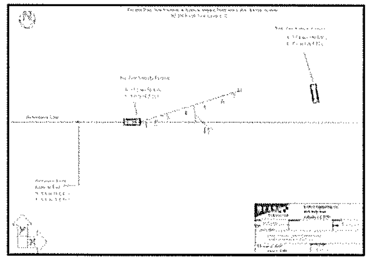


GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING, LLC	IMPACT VELOCITY (m/sec)	
TEST NO.	3-30	X-DIRECTION	4.4
DATE	06/01/05	Y-DIRECTION	0.1
TEST ARTICLE		THIV (optional)	
TYPE	CABLE BARRIER SYSTEM	RIDEDOWN ACCELERATION (g's)	
INSTALLATAION LENGTH (m)		X-DIRECTION	-1.9
SIZE AND/OR DIMENSION OF KEY ELEMENTS		Y-DIRECTION	1.5
SOIL TYPE AND CONDITION	CONCRETE	PHD (optional)	
TEST VEHICLE	820C	ASI (optional)	0.35
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-30	DYNAMIC LATERAL	
MODEL	1998 Chevrolet Metro	LONGITUDINAL	
MASS (CURB)	807 kg (1780 lbs)	PERMANENT	
MASS (TEST INERTIAL)	804 kg (1772 lbs)	VEHICLE DAMAGE	
DUMMY(s) MASS	75 Kg.	EXTERIOR	
GROSS STATIC WEIGHT	878 kg (1936 lb)	VDS	1FR1
IMPACT CONDITIONS		CDC	12RDEN2
SPEED (km/h)	100.2 (62.3 mph)	INTERIOR	
ANGLE (Deg.)	0.0	OCDI	FS0000000
IMPACT SEVERITY (kJ)	311.8	POST IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	21.9
SPEED (km/h)	79.2 (49.2 mph)	MAXIMUM PITCH ANGLE (Deg.)	-12.8
ANGLE (Deg.)		MAXIMUM YAW ANGLE (Deg.)	8.9

DATA SHEET NO. 3

SUMMARY OF RESULTS FOR TEST NO. 3-32

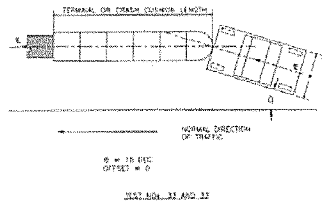


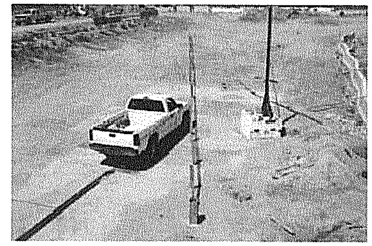


GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING, LLC	IMPACT VELOCITY (m/sec)	
TEST NO.	3-32	X-DIRECTION	3.5
DATE	5/31/05	Y-DIRECTION	0.2
TEST ARTICLE		THIV (optional)	
TYPE	LONGITUDINAL FENCE BARRIER UNIT	RIDEDOWN ACCELERATION (g's)	
INSTALLATAION LENGTH (m)		X-DIRECTION	-1.2
SIZE AND/OR DIMENSION OF KEY ELEMENTS		Y-DIRECTION	-1.6
SOIL TYPE AND CONDITION	CONCRETE	PHD (optional)	
TEST VEHICLE	820C	ASI (optional)	0.5
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-32	DYNAMIC LATERAL	
MODEL	2000 Chevrolet Metro	LONGITUDINAL	
MASS (CURB)	848 kg (1870 lb)	PERMANENT	
MASS (TEST INERTIAL)	844 kg (1860 lb.)	VEHICLE DAMAGE	
DUMMY(s) MASS	75 Kg.	EXTERIOR	
GROSS STATIC WEIGHT	919 kg (2026 lb.)	VDS	1FR1
IMPACT CONDITIONS		CDC	01RDEN2
SPEED (km/h)	103.2 (64.1 mph)	INTERIOR	
ANGLE (Deg.)	15.0	OCDI	FS0000000
IMPACT SEVERITY (kJ)	375.8	POST IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	-27.1
SPEED (km/h)	88.9 (55.2 mph)	MAXIMUM PITCH ANGLE (Deg.)	-7.4
ANGLE (Deg.)		MAXIMUM YAW ANGLE (Deg.)	-19.2

DATA SHEET NO. 3

SUMMARY OF RESULTS FOR TEST NO. 3-35

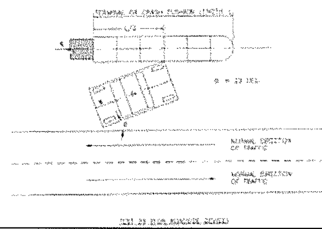


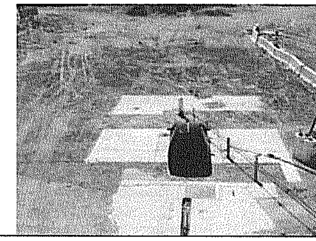


GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING, LLC	IMPACT VELOCITY (m/sec)	
TEST NO.	3-35	X-DIRECTION	2.5
DATE	5/27/05	Y-DIRECTION	3.0
TEST ARTICLE		THIV (optional)	N/A
TYPE	CABLE BARRIER SYSTEM	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	N/A	X-DIRECTION	-5.5
SIZE AND/OR DIMENSION OF KEY ELEMENTS		Y-DIRECTION	-5.3
SOIL TYPE AND CONDITION	CONCRETE	PHD (optional)	N/A
TEST VEHICLE	2000P	ASI (optional)	N/A
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	
DESIGNATION	3-35	DYNAMIC	2 (6.5 ft)
MODEL	CHEVROLET 2-DOOR PICKUP	PERMANENT	N/A
MASS (CURB)	2033 Kg (4482 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	1987 Kg (4380 lbs)	EXTERIOR	
DUMMY(s) MASS	N/A	VDS	1FR1
GROSS STATIC WEIGHT	1987 Kg (4380 lbs)	CDC	01RDEN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	99.95 (62.12 mph)	OCDI	FS0000000
ANGLE (Deg.)	20		
IMPACT SEVERITY (kJ)	89.6	POST IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	44.2
SPEED (km/h)	38 (23.7 mph)	MAXIMUM PITCH ANGLE (Deg.)	7.7
ANGLE (Deg.)	N/A	MAXIMUM YAW ANGLE (Deg.)	51.0

DATA SHEET NO. 3

SUMMARY OF RESULTS FOR TEST NO. 3-39 (Modified)





GENERAL INFORMATION		OCCUPANT RISK VALUES	
TEST AGENCY	KARCO ENGINEERING	IMPACT VELOCITY (m/sec)	
TEST NO.	3-39 (Modified)	X-DIRECTION	11.0
DATE	5/27/05	Y-DIRECTION	4.4
TEST ARTICLE		THIV (optional)	N/A
TYPE	CABLE BARRIER SYSTEM	RIDEDOWN ACCELERATION (g's)	
INSTALLATION LENGTH (m)	N/A	X-DIRECTION	-17.5
SIZE AND/OR DIMENSION OF KEY ELEMENTS		Y-DIRECTION	N/A
SOIL TYPE AND CONDITION	CONCRETE	PHD (optional)	N/A
TEST VEHICLE	820C	ASI (optional)	N/A
TYPE	PRODUCTION	TEST ARTICLE DEFLECTIONS (m)	N/A
DESIGNATION	3-39 (Modified)	DYNAMIC	N/A
MODEL	CHEVROLET METRO 2-DOOR	PERMANENT	N/A
MASS (CURB)	808 Kg (1780 lbs)	VEHICLE DAMAGE	
MASS (TEST INERTIAL)	803 Kg (1769 lbs)	EXTERIOR	
DUMMY(s) MASS	75 kg (165 lbs.)	VDS	1FR1
GROSS STATIC WEIGHT	873 Kg (1924 lbs)	CDC	01RDEN2
IMPACT CONDITIONS		INTERIOR	
SPEED (km/h)	98.9 (61.47 mph)	OCDI	FS0000000
ANGLE (Deg.)	20		
IMPACT SEVERITY (Kj)	38.6	POST IMPACT VEHICULAR BEHAVIOR	
EXIT CONDITIONS		MAXIMUM ROLL ANGLE (Deg.)	-53.9
SPEED (km/h)	0	MAXIMUM PITCH ANGLE (Deg.)	-60.5
ANGLE (Deg.)	0	MAXIMUM YAW ANGLE (Deg.)	-15.5