Mr. Ron Faulkenberry  
Gibraltar Global LLC  
1208 Houston Clinton Drive, Burnet, TX 78611  
Burnet, TX 78611  
United States

Dear Mr. Faulkenberry:

This letter is in response to your November 02, 2018 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number B-316 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- Gibraltar Global TL-4 Cable Barrier System

Scope of this Letter

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials’ (AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
Eligibility for Reimbursement

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the AASHTO's MASH. Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system: Gibraltar Global TL-4 Cable Barrier System
Type of system: Longitudinal Barrier
Test Level: MASH Test Level 4 (TL4)
Testing conducted by: KARCO Engineering
Date of request: November 02, 2018

FHWA concurs with the recommendation of the accredited crash testing laboratory on the attached form.

Full Description of the Eligible Device

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

Notice

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO's MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.
Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-316 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 upon request.

- This 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.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

Sincerely,

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

Enclosures
# Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

<table>
<thead>
<tr>
<th>Date of Request:</th>
<th>November 02, 2018</th>
<th>☑ New  ☐ Resubmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
<td>Robert Ramirez</td>
<td></td>
</tr>
<tr>
<td>Company:</td>
<td>KARCO Engineering</td>
<td></td>
</tr>
<tr>
<td>Address:</td>
<td>9270 Holly Rd. Adelanto, CA 92301</td>
<td></td>
</tr>
<tr>
<td>Country:</td>
<td>United States</td>
<td></td>
</tr>
<tr>
<td>To:</td>
<td>Michael S. Griffith, Director</td>
<td>FHWA, Office of Safety Technologies</td>
</tr>
</tbody>
</table>

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

**Device & Testing Criterion - Enter from right to left starting with Test Level**

<table>
<thead>
<tr>
<th>System Type</th>
<th>Submission Type</th>
<th>Device Name / Variant</th>
<th>Testing Criterion</th>
<th>Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>'B': Rigid/Semi-Rigid Barriers (Roadside, Median, Bridge Railings)</td>
<td>☑ Physical Crash Testing  ☐ Engineering Analysis</td>
<td>Gibraltar Global TL-4 Cable Barrier System</td>
<td>AASHTO MASH</td>
<td>TL4</td>
</tr>
</tbody>
</table>

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

**Individual or Organization responsible for the product:**

<table>
<thead>
<tr>
<th>Contact Name:</th>
<th>Ron Faulkenberry</th>
<th>Same as Submitter ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Name:</td>
<td>Gibraltar Global LLC</td>
<td>Same as Submitter ☐</td>
</tr>
<tr>
<td>Address:</td>
<td>1208 Houston Clinton Drive, Burnet, TX 78611</td>
<td>Same as Submitter ☐</td>
</tr>
<tr>
<td>Country:</td>
<td>United States</td>
<td>Same as Submitter ☐</td>
</tr>
</tbody>
</table>

Enter below all disclosures of financial interests as required by the FHWA 'Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.

All MASH testing was conducted at Karco Engineering in Adelanto, CA. Karco Engineering was compensated for conducting the tests but has no financial nor patent interests in any of Gibraltar's products.
PRODUCT DESCRIPTION

The Gibraltar Global TL-4 Cable Barrier System is a high tension 4-cable longitudinal barrier. The barrier consists of four (4) 0.75 in. (19 mm) steel cables, C-section steel posts, steel sockets, aluminum hair pins and steel lock plates. The C-section posts were placed on alternate sides of the 4 cables and are held in place by the aluminum hair pins. The top two (2) cables of the system were stitched together making the cables alternate in the top hairpin location. The hair pins held the cables at 20.0 in (508 mm), 30.0 in (762 mm) and 39.0 in. (991 mm) above grade. The system can be installed with post spacing ranging from 7 ft. to 21 ft.

Gibraltar also offers various post and socket options such as concrete socket foundations with steel or plastic sockets, driven steel sockets, and direct driven posts. Other options include swaged and wedge-type fittings which were installed and crash tested. Pre-stretched and non pre-stretched cable are permissible.

CRASH TESTING

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash tests are necessary to determine the device meets the MASH criteria.

Engineer Name: Robert Ramirez

Engineer Signature: Robert Ramirez

Address: 9270 Holly Rd. Adelanto, CA 92301

Country: United States

A brief description of each crash test and its result:

<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-10 (1100C)</td>
<td>KARCO Engineering Project number P37379-01 was conducted with an 1100C test vehicle impacting the system midspan between posts at a nominal velocity and angle of 62 mph and 25 degrees, respectively. As recommend by MASH 2016 the narrowest allowable post spacing of 7.0 ft. (2.1 m) was used. The test vehicle, a 2011 Kia Rio weighing 2,427.2 lbs (1,101.0 kg) impacted the system at a speed and angle of 62.38 mph (100.39 km/h) and 25.1 degrees, respectively. The system redirected the vehicle and had a maximum working width of 7.6 ft. (2.3 m). The test vehicle sustained moderate damage. There was no potential for the article to penetrate the vehicle and the occupant compartment deformation limits were not exceeded. The Occupant Impact Velocities (OIV) and ridedown accelerations are within the recommended limits.</td>
<td>PASS</td>
</tr>
<tr>
<td>Required Test Number</td>
<td>Narrative Description</td>
<td>Evaluation Results</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>4-11 (2270P)</td>
<td>As recommend by MASH 2016 the narrowest allowable post spacing of 7.0 ft. (2.1 m) and the widest allowable post spacing of 21.0 ft. (6.4 m) was tested with the 2270P test vehicle. KARCO Engineering Project number P37358-01 was conducted with a 2270P test vehicle impacting the system 1.0 ft. (0.3 m) upstream of a post with the narrowest allowable post spacing of 7.0 ft. (2.1 m) at a nominal velocity and angle of 62 mph and 25 degrees, respectively. The test vehicle, a 2013 Chevrolet Silverado weighing 5,011.0 lbs (2,273.0 kg) impacted the system at a speed and angle of 60.93 mph (98.06 km/h) and 25.3 degrees, respectively. The system redirected the vehicle and had a maximum working width of 7.9 ft. (2.4 m). The test vehicle sustained moderate damage. There was no potential for the article to penetrate the vehicle and the occupant compartment deformation limits were not exceeded. The Occupant Impact Velocities (OIV) and ridedown accelerations are within the recommended limits.</td>
<td>PASS</td>
</tr>
<tr>
<td></td>
<td>KARCO Engineering Project number P37359-01 was conducted with a 2270P test vehicle impacting the system 1.0 ft. (0.3 m) upstream of a post with the widest allowable post spacing of 21.0 ft. (6.4 m) at a nominal velocity and angle of 62 mph and 25 degrees, respectively. The test vehicle, a 2013 Chevrolet Silverado weighing 5,028.7 lbs (2,281.0 kg) impacted the system at a speed and angle of 61.78 mph (99.43 km/h) and 25.1 degrees, respectively. The system redirected the vehicle and had a maximum working width of 13.8 ft. (4.2 m). The test vehicle sustained moderate damage. There was no potential for the article to penetrate the vehicle and the occupant compartment deformation limits were not exceeded. The Occupant Impact Velocities (OIV) and ridedown accelerations are within the recommended limits.</td>
<td></td>
</tr>
</tbody>
</table>
KARCO Engineering Project number P37320-01 was conducted with an 10000S test vehicle impacting the system 1.0 ft. (0.3 m) upstream of a post at a nominal velocity and angle of 56 mph and 15 degrees, respectively. The largest allowable post spacing of 21.0 ft. (6.4 m) was tested to increase the loading on the splices. The test vehicle, a 2007 Ford F650 weighing 22,641.1 lbs (10,270.0 kg) impacted the system at a speed and angle of 54.39 mph (87.54 km/h) and 14.9 degrees, respectively. The system redirected the vehicle and had a maximum working width of 17.4 ft. (5.3 m). The maximum test debris was approximately 25 ft. laterally to the non-traffic side of the barrier. The test vehicle sustained moderate damage. There was no potential for the article to penetrate the vehicle and the occupant compartment deformation limits were not exceeded.

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-12 (10000S)</td>
<td>Test 4-12 is not applicable for this type of system.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
<tr>
<td>4-20 (11000C)</td>
<td>Test 4-20 is not applicable for this type of system.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
<tr>
<td>4-21 (2270P)</td>
<td>Test 4-21 is not applicable for this type of system.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
<tr>
<td>4-22 (10000S)</td>
<td>Test 4-22 is not applicable for this type of system.</td>
<td>Non-Relevant Test, not conducted</td>
</tr>
</tbody>
</table>

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory’s accreditation status as noted in the crash test reports):

**Laboratory Name:** Applus IDIADA KARCO Engineering

**Laboratory Signature:**

<table>
<thead>
<tr>
<th>Address</th>
<th>9270 Holly Rd. Adelanto CA. 92301</th>
<th>Same as Submitter</th>
</tr>
</thead>
</table>

**Country:** United States

**Accreditation Certificate Number and Dates of current Accreditation period:** TL-371 valid up to July 1, 2019
Attach to this form:
1) Additional disclosures of related financial interest as indicated above.
2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

FHWA Official Business Only:

<table>
<thead>
<tr>
<th>Eligibility Letter</th>
<th>Number</th>
<th>Date</th>
<th>Key Words</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MASH Test 4-10 Summary

Figure 3 Summary of Test 4-10

<table>
<thead>
<tr>
<th>GENERAL INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Agency .......... KARCO Engineering, LLC.</td>
</tr>
<tr>
<td>KARCO Test No ....... P3791-01</td>
</tr>
<tr>
<td>Test Designation ...... 4-10</td>
</tr>
<tr>
<td>Test Date ............ 12/06/17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEST ARTICLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name / Model .......... TL-4 Cable Barrier System</td>
</tr>
<tr>
<td>Type .......... Longitudinal Barrier</td>
</tr>
<tr>
<td>Installation Length ...... 597.7 ft. (182.2 m)</td>
</tr>
<tr>
<td>Post Spacing .......... 7.0 ft. (2.1 m)</td>
</tr>
<tr>
<td>Key Elements .......... Cable, Hair Pins, Lock Plates</td>
</tr>
<tr>
<td>Road Surface .......... Concrete and Soil</td>
</tr>
<tr>
<td>Type / Designation ....... 1100C</td>
</tr>
<tr>
<td>Year, Make, and Model ... 2011 Kia Rio</td>
</tr>
<tr>
<td>Curb Mass ............. 2,489.0 lbs (1,289.0 kg)</td>
</tr>
<tr>
<td>Test Inertial Mass ...... 2,427.2 lbs (1,010.0 kg)</td>
</tr>
<tr>
<td>Gross Static Mass ...... 2,621.3 lbs (1,189.0 kg)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Velocity .......... 62.38 mph (100.39 km/h)</td>
</tr>
<tr>
<td>Impact Angle .......... 25.1°</td>
</tr>
<tr>
<td>Location / Orientation ...... 3.5 ft. (1.1 m) upstream of Post 42</td>
</tr>
<tr>
<td>Impact Severity .......... 66.8 kip-ft (77.0 kJ)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exit Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit Velocity .......... 50.2 mph (80.8 km/h)</td>
</tr>
<tr>
<td>Exit Angle .......... 7.1°</td>
</tr>
<tr>
<td>Final Vehicle Position ...... 236.8 ft. (72.2 m) Downstream</td>
</tr>
<tr>
<td>Exit Box Criterion .......... Exited within exit box</td>
</tr>
<tr>
<td>Vehicle Snagging .......... Satisfactory</td>
</tr>
<tr>
<td>Vehicle Pocketing .......... Satisfactory</td>
</tr>
<tr>
<td>Maximum Roll Angle .......... 23.4°</td>
</tr>
<tr>
<td>Maximum Pitch Angle .......... 8.3°</td>
</tr>
<tr>
<td>Maximum Yaw Angle .......... -30.0°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupant Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal OIV .......... 15.7 ft/s (4.8 m/s)</td>
</tr>
<tr>
<td>Lateral OIV .......... 13.5 ft/s (4.1 m/s)</td>
</tr>
<tr>
<td>Longitudinal RA .......... -3.8 g</td>
</tr>
<tr>
<td>Lateral RA .......... 5.2 g</td>
</tr>
<tr>
<td>THIV .......... 23.3 ft/s (7.1 m/s)</td>
</tr>
<tr>
<td>PHD .......... 5.5 g</td>
</tr>
<tr>
<td>ASI .......... 0.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Article Deflections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static .......... N/A</td>
</tr>
<tr>
<td>Dynamic .......... 78.5 in. (2.0 m)</td>
</tr>
<tr>
<td>Working Width .......... 90.9 in. (2.3 m)</td>
</tr>
<tr>
<td>Debris Field .......... 13.0 ft. (4.0 m)</td>
</tr>
<tr>
<td>Field Side ..........</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vehicle Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Damage Scale ...... 11LFQ6</td>
</tr>
<tr>
<td>CDC .......... 11LYAK8</td>
</tr>
<tr>
<td>Maximum Intrusion .......... 1.0 in. (25 mm)</td>
</tr>
</tbody>
</table>
MASH Test 4-11 Summary

**Figure 4 Summary of Test 4-11**

### GENERAL INFORMATION
- **Test Agency:** Applus IDIADA KARCO
- **KARCO Test No.:** P37359-01
- **Test Designation:** 4-11
- **Test Date:** 12/07/18

### TEST ARTICLE
- **Name / Model:** TL-4 Cable Barrier System
- **Type:** Longitudinal Barrier
- **Installation Length:** 597.7 ft. (182.2 m)
- **Post Spacing:** 21.0 ft. (6.4 m)
- **Key Elements:** Cable, Hair Pins, Lock Plates
- **Road Surface:** Concrete and Soil

### TEST VEHICLE
- **Type / Designation:** 2270P
- **Year, Make, and Model:** 2013 Chevrolet Silverado 1500
- **Curb Mass:** 5,067.2 lbs (2,298.5 kg)
- **Test Inertial Mass:** 5,028.7 lbs (2,281.0 kg)
- **Gross Static Mass:** 5,028.7 lbs (2,281.0 kg)

### Impact Conditions
- **Impact Velocity:** 61.78 mph (99.43 km/h)
- **Impact Angle:** 25.1°
- **Location / Orientation:** 11.5 in. (292 mm) upstream from post 17
- **Impact Severity:** 115.5 kip-ft (156.5 kJ)

### Exit Conditions
- **Exit Velocity:** 47.40 mph (76.28 km/h)
- **Exit Angle:** 2.4°
- **Final Vehicle Position:** 315.3 ft. (96.1 m) Downstream
- **Exit Box Criteria Met:** Yes
- **Vehicle Snagging:** Satisfactory
- **Vehicle Pocketing:** Satisfactory
- **Maximum Roll Angle:** -3.1°
- **Maximum Pitch Angle:** -2.9°
- **Maximum Yaw Angle:** -25.7°

### Occupant Risk
- **Longitudinal OIV:** 8.5 ft/s (2.6 m/s)
- **Lateral OIV:** 9.5 ft/s (2.9 m/s)
- **Longitudinal RA:** -2.6 g
- **Lateral RA:** 3.4 g
- **THIV:** 13.1 ft/s (4.0 m/s)
- **PHD:** 3.7 g
- **ASI:** 0.31

### Test Article Deflections
- **Static:** N/A
- **Dynamic:** 13.8 ft. (4.2 m)
- **Working Width:** 13.8 ft. (4.2 m)
- **Debris (lateral):** 14.5 ft. (4.4 m)

### Vehicle Damage*
- **Vehicle Damage Scale:** 11-LFQ-3
- **CDC:** 11LFEN2
- **Maximum Intrusion:** none

*Vehicle damaged assessed before secondary impact.
MASH Test 4-11 Summary

0.000 s 0.200 s 0.300 s 0.500 s 0.700 s

Figure 3 Summary of Test 4-11

GENERAL INFORMATION
Test Agency .................. Applus IDIADA KARCO
KARCO Test No .............. P37358-01
Test Designation ......... 4-11
Test Date ........ ......... . 12/07/18

TEST ARTICLE
Name / Model ............. TL-4 Cable Barrier System
Type ....................... Longitudinal Barrier
Installation Length .... 597.7 ft. (182.2 m)
Post Spacing .......... 7.0 ft (2.1 m)
Key Elements ............. Cable, Hair Pins, Lock Plates
Road Surface .......... Concrete and soil

TEST VEHICLE
Type / Designation ...... 2270P
Year, Make, and Model 2013 Chevrolet Silverado 1500
Curb Mass ................. 5,261.2 lbs (2,386.5 kg)
Test Inertial Mass ...... 5,011.0 lbs (2,273.0 kg)
Gross Static Mass ...... 5,011.0 lbs (2,273.0 kg)

Impact Conditions
Impact Velocity .......... 60.93 mph (98.06 km/h)
Impact Angle ............ 25.3°
Location / Orientation 1.5 in. upstream from Post 42
Impact Severity ......... 113.6 kip-ft (154.0 kJ)

Exit Conditions
Exit Velocity .......... 36.7 mph (59.1 km/h)
Exit Angle .......... 6.2°
Final Vehicle Position 256.6 ft. (78.2 m) Downstream
Exit Box Criterion .... Exited within exit box
Vehicle Snagging ...... None
Vehicle Pocketing ...... None
Maximum Roll Angle ...... 5.4°
Maximum Pitch Angle ...... 3.6°
Maximum Yaw Angle ...... -26.3°

Occupant Risk
Longitudinal OIV ......... 9.2 ft/s (2.8 m/s)
Lateral OIV ........ 12.1 ft/s (3.7 m/s)
Longitudinal RA .......... 4.0 g
Lateral RA ........ 5.6 g
THIV .................. 15.7 ft/s (4.8 m/s)
PHD ................. 5.3 g
ASI ................. 0.41

Test Article Deflections
Static .................. 0.5 ft (0.2 m)
Dynamic .................. 7.9 ft (2.4 m)
Working Width ........ 7.9 ft (2.4 m)
Debris Field .......... 10.0 ft (3.0 m) Field side

Vehicle Damage
Vehicle Damage Scale ...... 11-LFQ-3
CDC .................. 11LYEW2
Maximum Intrusion ...... 0.5 in. (13 mm)
MASH Test 4-12 Summary

GENERAL INFORMATION
Test Agency: Applus IDIADA KARCO
KARCO Test No.: P37320-01
Test Designation: 4-12
Test Date: 12/5/17

TEST ARTICLE
Name / Model: TL-4 Cable Barrier
Type: Longitudinal Barrier
Installation Length: 625.7 ft. (190.7 m)
Key Elements: Cable, Hair Pins, Lock Plates
Road Surface: Concrete and Soil

TEST VEHICLE
Type / Designation: 1000S
Year, Make, and Model: 2007 Ford F-750
Curb Mass: 16,210.5 lbs (7,353.1 kg)
Test Inertial Mass: 22,641.1 lbs (10,270.0 kg)
Gross Static Mass: 22,641.1 lbs (10,270.0 kg)

Impact Conditions
Impact Velocity: 54.39 mph (87.53 km/h)
Impact Angle: 14.9°
Location / Orientation: 1.0 ft. Upstream of Post
Impact Severity: 148.0 kip-ft (200.7 kJ)

Exit Conditions
Exit Velocity: N/A
Exit Angle: 3.2°
Final Vehicle Position: 326.0 ft. (99.4 m) downstream

Exit Box Criteria Met: N/A
Vehicle Snagging: None
Vehicle Pocketing: None
Maximum Roll Angle: N/A
Maximum Pitch Angle: N/A
Maximum Yaw Angle: N/A

Occupant Risk
Longitudinal OIV: N/A
Lateral OIV: N/A
Longitudinal RA: N/A
Lateral RA: N/A
THIV: N/A
PHD: N/A
ASI: N/A

Test Article Deflections
Static: 5.0 ft. (1.5 m)
Dynamic: N/A *
Working Width: 17.4 ft. (5.3 m)

Vehicle Damage
Vehicle Damage Scale: 12-FL-2
CDC: 12FLDW1
Maximum Intrusion: No measurable deformation

* Cable wrapped around vehicle. Measurement unable to be taken.

Figure 3 Summary of Test 4-12
Start interchanging top two cables. See Cable Interchange Drawing.

Begin Required Post Spacing (See MASH Test and Post Spacing Chart)

Swage Cable Connections at CIP (approximately 20' downstream from impact point, not on a post)

(4) 3/4" Wire Ropes

UPSTREAM TERMINAL SECTION

End of Terminal Section (no post present)

Alternate posts for barrier installation

1" Anchor Terminal Fitting

1" Swaged Cable Connection

C Section Post

1" RH Swaged Terminal Fitting

(4) Anchor Terminal Fitting Ends

REINFORCED FOUNDATION

2'-0" x 10'-0" Foundation
(no rebar shown)

13'-9" x 12" 7'-6" x 12"

27'-6" 11'-9" x 12" 6'-2" x 12"

Cable Release & Anchor Post

Terminal Post (Welded Rebar Socket)

Terminal Post (Welded Rebar Socket)

Line Post (Welded Rebar Socket)

Cable Tension Chart*

<table>
<thead>
<tr>
<th>Cable Tension</th>
<th>lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>10°F - 5°F</td>
<td>8600</td>
</tr>
<tr>
<td>0°F</td>
<td>8200</td>
</tr>
<tr>
<td>10°F</td>
<td>7800</td>
</tr>
<tr>
<td>20°F</td>
<td>7400</td>
</tr>
<tr>
<td>30°F</td>
<td>7000</td>
</tr>
<tr>
<td>40°F</td>
<td>6600</td>
</tr>
<tr>
<td>50°F</td>
<td>6200</td>
</tr>
<tr>
<td>60°F</td>
<td>5800</td>
</tr>
<tr>
<td>70°F</td>
<td>5400</td>
</tr>
<tr>
<td>80°F</td>
<td>5000</td>
</tr>
<tr>
<td>90°F</td>
<td>4600</td>
</tr>
<tr>
<td>100°F</td>
<td>4200</td>
</tr>
<tr>
<td>110°F</td>
<td>3800</td>
</tr>
</tbody>
</table>

*Allowable Deviation From Chart +/- 10%

MASH 4 Cable Tests

PROPRIETARY TO GIBRALTAR

TL-4 4 Cable System Layout

Gibraltar Cable Barrier Systems

MASH 4 Cable Tests

TL-4 4 Cable MASH Test and Post Spacing Chart

<table>
<thead>
<tr>
<th>MASH TEST</th>
<th>Line Post Spacing*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-10</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>3-11</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>3-12**</td>
<td>21'-0&quot;</td>
</tr>
<tr>
<td>4-12**</td>
<td>21'-0&quot;</td>
</tr>
</tbody>
</table>

*4'-6" post spacing tolerance

**All tests are impacted near the midpoint of the installation at a 25° angle, except the 4-12 test, which is impacted at 15°.
Note:
First five posts after anchor must alternate side of cable, typical each end.

Cable Installation Note:
1. Interchanging top two cables run semi-parallel to each other, never twisting.
2. The top cables alternate passing through the top hairpin loop and resting on the top hairpin loop at each post starting after TP4-4.
**RH STUD ATF ASSY**
- Anchor Terminal Fitting RH Stud

**ATF**
- Anchor Terminal Fitting

**ATF-END**
- Anchor Terminal Fitting End

**Tube Socket** (Steel or Plastic)

**SOCK-S**
- Short Rebar Socket

**TUBE-D**
- Driven Socket

**4-LNP-S**
- Line Post/Socketed

**4-LNP-D**
- Line Post/Driven

**4-HPIN ALUM**

**4-LOCK**
- TL4 Lockplate

**CST8**
- Cable Splice Turnbuckle

**WEDGE**
- W-1 Wedge

**ACORN**
- Acorn w/ Wedge

**TORP**
- Longitudinal Section ONLY
  - Torpedo Cable Splice

**J-BLT**
- J-Bolt

**U-Bolt Lock-Plate Assembly**
GENERAL NOTES:
1. For additional information contact Gibraltar, Inc. at 1-833-715-0810 or see the manufacturer’s product manual.
2. All concrete shall be per specification; minimum 2500 PSI.
3. 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. (Max. Post Spacing 1'8" on 4:1)
4. The Cable Barrier System is accepted by the FHWA Test Level - 4. See the specification for delineation.
5. Post Spacing Chart (Drive in)
6. Rock Clause: Where solid rock is encountered:
   a. For socketed post, continue digging 12" diameter with two #4 rebar vertical bars 30" long or 30" welded rebar socket.
   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.
7. The Gibraltar cable barrier system shall be installed in standard compacted soil. Soil must be well drained.
8. All non-welded rebar by others.
9. Minimum recommended line post foundation:
   a. Without mowstrip, 36" Deep x 12" diameter foundations with #3 rebar ring x 8" diameter with two #4 rebar vertical bars 30" long or 30" welded rebar socket.
   b. With 4" minimum depth hot mix asphalt, 30" deep x 12" diameter foundations with #3 rebar ring x 8" diameter with two #4 rebar vertical bars 30" long or 30" welded rebar socket.
   c. With 3" minimum depth concrete mowstrip, 24" deep x 12" diameter foundations. (No rebar required.)
   d. Direct drive driven post and driven socket 42" deep.

Cable Tension Chart*

-30°F 8600
-0°F 8200
10°F 7800
20°F 7400
30°F 7000
40°F 6600
50°F 6200
60°F 5800
70°F 5400
80°F 5000
90°F 4600
100°F 4200
110°F 3800

TL-4 Cable MASH Test and Post Spacing Chart

MASH TEST Line Post Spacing
3-10 7'-0"
3-11 7'-0"
3-11 21'-0"
4-12 21'-0"

*6" post spacing tolerance
*Allowable Deviation from Chart +/- 10%

MASH 4 Cable Tests PROPRIETARY TO GIBRALTA