December 22, 2010

Dean L. Sicking, Ph.D., P.E.
Director
Midwest Roadside Safety Facility
130 Whittier Bldg.
220 Vine Street
Lincoln, NE  68583-0583

Dear Dr. Sicking:

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

Name of device:   Low Tension Cable Guardrail End Terminal
Type of device:   End Terminal
Test Level:   NCHRP Report 350 Test Level 3 (TL-3)
Testing conducted by:  Midwest Roadside Safety Facility (MwRSF)
System Designator:  SEC10
Date of request:  August 1, 2010

You requested that we find this device acceptable for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350 testing guidelines.

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 24, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description
Per the submitted crash test report, the Low Tension Cable Guardrail End Terminal system is designed for low tension cable guardrail systems. The total length of the installation was 254 feet and consisted of four major structural components: (1) Wire ropes; (2) posts; (3) cable compensator assemblies, and (4) anchor assemblies. The design details of this system are included as an enclosure to this correspondence. Three 3/4-inch diameter cables comprised of 3 x 7 wire rope used for the rail elements. The cable rails were supported by nineteen posts with an upper cable mounting height of 30 inches, a middle mounting height of 27 inches, and a lower mounting height of 24 inches. The cables were tightened through the use of cable compensators. The ends of the cables were threaded rods that terminated in the cable anchor. The threaded rods were attached to the cable anchor by three 2-inch diameter galvanized washers and two 3/4-inch...
diameter galvanized Grade 5 heavy hex nuts. The anchor bracket posts, post number 1 and 19, were 96-inch long W6 x 25 sections with a 24-inch x 24-inch soil plate welded along the downstream flange of the post. The anchor post was embedded to a depth of 96-inches. A 141/2-inch x 9-inch x 1/2-inch plate was welded to the top of the anchor post to which the cable anchor bracket was bolted with four 2/4-in x 2-1/2-inch Grade 5 hex head bolts. Post Numbers 2 and 18 were configured with S3 x 5.7 sections measuring 30 inches long for the slip post and W6 x 9 sections measuring 72 inches long for the foundation posts. The foundation post was embedded to a depth of 70 inches. A slip base plate was welded to the bottom of the skip post and the top of the foundation post. Four 1/2-inch x 2-inch ASTM A307 bolts with nuts and washers were used to form the slip base configuration. Post Numbers 3 through 7 were configured with S3 x 5.7 sections measuring 30 inches long for the slip post and W6 x 9 sections measuring 72 inches long for the foundation posts. The foundation post was embedded to a depth of 70 inches. A slip base plate was welded to the bottom of the slip post and the top of the foundation post. Four 1/2-inches x 2-inch ASTM A307 bolts with nuts and washers were used to form the slip base configuration. The line posts, post numbers 8 through 17, consisted of 63-inch long S3 x 5.7 sections, with 30-inch embedment depth and an 8-inch x 24-inch x 1/4-inch soil plate welded along the back flange of the post. These line posts were spaced 16-ft. on center with a soil plate embedment depth of 30 inches. The top cable hook was located 3-1/2 inches down from the top of the post with the middle and lower cable hooks 6 ½-inches and 9-1/2-inches for the top of the post, respectively.

A steel cable anchor bracket was bolted to the top base plate of the steel anchor post. The steel cable anchor bracket was modified from existing designs in order to accept a new, fabricated steel cable release lever device. The cable release lever consisted of a pair of 17-inch long 1-1/4-inch x 1-1/4-inch x 3/16-inch vertical tubes mounted 2 inches apart on a 9-inch x 3-inch x 1/2-inch steel plate. The cable release lever was implemented in order to dislodge and release the wire rope cables during end-on vehicular impacts with the end terminal system. The steel cable anchor bracket was designed to accept the ends of the three 3/4-in. diameter by 3 x 7 wire rope cables. A 0.375-inch diameter, 32-inch long 7 x 19 galvanized aircraft cable was added to retain the cable release lever to the anchor bracket upon impact.

**Crash Testing**
Per the submitted crash test report, the following physical crash testing was conducted:

A. **Test 3-30 (820C/ 100km/hr. / 0 degrees with 1/4-point offset).**

B. **Test 3-35 (2000P/ 100 km/hr. / 20 degrees).**
In addition, the following tests are requested to be waived per the following comparisons:

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<th>Test Number</th>
<th>Test Level</th>
<th>Requested Comparison</th>
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</thead>
<tbody>
<tr>
<td>3-31</td>
<td>TL-3</td>
<td>Not necessary since Test 3-30 is considered worst case.</td>
</tr>
<tr>
<td>3-32</td>
<td>TL-3</td>
<td>Not necessary since Test 3-30 is considered worst case; and similar to prior successful Crash Test No. 104 on New York Department of Transportation (NYDOT) terminal design.</td>
</tr>
<tr>
<td>3-33</td>
<td>TL-3</td>
<td>Not necessary since Test 3-30 is considered worst case.</td>
</tr>
<tr>
<td>3-34</td>
<td>TL-3</td>
<td>Not necessary due to equivalence to a prior successful crash testing of similar NYDOT terminal design tested at 20 degrees.</td>
</tr>
<tr>
<td>3-39</td>
<td>TL-3</td>
<td>Not necessary due to equivalence to prior successful crash testing of two small car tests (Tests No. 98 and 404211-6) performed on the reverse direction of similar NYDOT design.</td>
</tr>
</tbody>
</table>

**Findings**

The FHWA concurs to the submitted physical crash testing and to requested comparisons relating to the proposed TL-3 Low Tension Cable Guardrail End Terminal. Therefore, the TL-3 Low Tension Cable Guardrail End Terminal System meets the TL-3 impact conditions and evaluation criteria for a NCHRP 350 Terminals, and is acceptable for use on the NHS when requested by a highway agency.

Please note the following standard provisions that apply to the 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 Manual for Assessing Safety Hardware.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-111 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 TL-3 Low Tension Cable Guardrail End Terminal system is non-proprietary. Therefore FHWA regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411 are non-applicable.

• 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,

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

2 Enclosures
Figure B-1. Summary of Test Results and Sequential Photographs (English), Test No. CT-1
Test Agency: MwRSF
Test Number: CT-2
Date: 7/16/2002
NCHRP 350 Test Designation: 3-30
Appurtenance: Cable Guardrail End Terminal
Total Length: 254 ft
Key Elements - Wire Rope:
- Diameter: 0.75 in.
- Size: 7x19
- Top Mounting Height: 30 in.
- Spacing: 3 in.
Key Elements - Cable Anchor Post:
- Post Nos. 1 and 19: W6x25 by 96 in. long
- Post Nos. 2 and 18: S3x5.7 by 30 in. long with W6x9 by 72 in. long
Key Elements - Line Post:
- Post Nos. 3-17: S3x5.7 by 63 in. long
- Post Spacing: 16 ft
Test Vehicle:
- Type/Designation: 820C
- Make and Model: 1995 Geo Metro
- Curb: 1,553 lb
- Test Inertial: 1,799 lb
- Gross Static: 1,965 lb
Impact Conditions:
- Speed: 62.1 mph
- Angle: 1.5 degrees
- Impact Location: Centerline of Post No. 1

Exit Conditions:
- Speed: N/A
- Angle: N/A
- Exit Box Criterion: N/A

Post-Impact Trajectory:
- Vehicle Stability: Unsatisfactory
- Stopping Distance: 210 ft - 9 in. downstream
  5 ft - 8 in. traffic-side face
- Occupant Impact Velocity:
  - Longitudinal: 9.81 ft/s < 39.37 ft/s
  - Lateral: -0.39 ft/s < 39.37 ft/s
- Occupant Ridedown Deceleration:
  - Longitudinal: 5.37 Gs < 20 Gs
  - Lateral: 3.99 Gs < 20 Gs
- Test Article Damage: Moderate
- Test Article Deflections:
  - Permanent Set: N/A
  - Dynamic: N/A
  - Working Width: N/A
- Vehicle Damage: Extensive
  - VDS: 12-L&D-6
  - CDC: 12-TDD08
  - Maximum Deformation: N/A

Figure B-2. Summary of Test Results and Sequential Photographs (English), Test No. CT-2
Test Agency: MwRSF
Test Number: CT-4
Date: 6/8/2005
NCHRP 350 Test Designation: 3-30
Appurtenance: Cable Guardrail End Terminal
Total Length: 254 ft
Key Elements - Wire Rope:
- Diameter: 0.75 in.
- Size: 7x19
- Top Mounting Height: 30 in.
- Spacing: 3 in.
Key Elements - Cable Anchor Post:
- Post Nos. 1 and 19: W6x25 by 96 in. long
- Post Nos. 2 and 18: S3x5.7 by 30 in. long with W6x9 by 96 in. long
Key Elements - Line Post:
- Post Nos. 11-17: S3x5.7 by 63 in. long
- Post Spacing: 16 ft
Test Vehicle:
- Type/Designation: 820C
- Make and Model: 1998 Geo Metro
- Curb: 1,720 lb
- Test Inertial: 1,795 lb
- Gross Static: 1,961 lb
Impact Conditions:
- Speed: 61.1 mph
- Angle: 0.1 degrees
- Impact Location: Centerline of Post No. 1
Exit Conditions:
- Speed: 46.4 mph
- Angle: 13 degrees
Post-Impact Trajectory:
- Vehicle Stability: Satisfactory
- Stopping Distance: 141 ft - 10 in. downstream
- 27 ft traffic-side face
Occupant Impact Velocity:
- Longitudinal: 11.41 ft/s < 39.37 ft/s
- Lateral: -2.54 ft/s < 39.37 ft/s
Occupant Ridedown Deceleration:
- Longitudinal: 7.85 Gs < 20 Gs
- Lateral: -3.48 Gs < 20 Gs
Test Article Damage:
- Permanent Set: N/A
- Dynamic: N/A
Working Width: 254.8 in.
Vehicle Damage:
- VDS: 12-12-FD-1
- CDC: 12-FDEN-9
Maximum Deformation: 0.25 in.

Figure B-4. Summary of Test Results and Sequential Photographs (English), Test No. CT-4
Cable Anchor Bracket

Long loops and 1" long clip.
Circled cable 36" long with 3" galvanized X 19 galvanized.
Note: The lever retaining cable used.

(Part A)
Cable Anchor Bracket

**Material**

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<td>ITEM</td>
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<td>a1</td>
<td>2</td>
<td>Anchor Plate</td>
<td>A36 13mm Plate</td>
</tr>
<tr>
<td>a2</td>
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<td>Cable Plate</td>
<td>A36 9.5mm Plate</td>
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<tr>
<td>a3</td>
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<td>Release Lever Plate</td>
<td>A36 13mm Plate</td>
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<td>a4</td>
<td>4</td>
<td>Ext. Cable Plt Gusset</td>
<td>A36 13mm Plate</td>
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<td>a5</td>
<td>6</td>
<td>Int. Cable Plt Gusset</td>
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<td>a6</td>
<td>2</td>
<td>Release Lever Plt Gusset</td>
<td>A36 13mm Plate</td>
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</table>

**Anchor Bracket Plate (Part a1)**

**Cable Plate (Part a2)**

**Release Lever Plate (Part a3)**

**Interior Cable Plate Gusset (Part a5)**

**Exterior Cable Plate Gusset (Part a4)**

**Release Lever Plate Gusset (Part a6)**
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</tr>
<tr>
<td>b3</td>
<td>2</td>
<td>Anchor Base Plate</td>
<td>XXX</td>
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<tr>
<td>b4</td>
<td>8</td>
<td>19mm Dia. Rod</td>
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</table>

**W6x25 Post (Part b1)**

**Soil Plate (Part b2)**

**Anchor Base Plate (Part b3)**

**φ³/₈” Rod (Part b4)**

Scale: 1"=4”
Base and Bearing Strut Assembly with Cable Support Post Post 2

\[\frac{\phi}{2} A307 \text{ grade bolt, 2'' long w/ nut and 3 washers, 1 washer between plates. (torque to 26 ft-lb)}\]

\[\frac{\phi}{2} A307 \text{ grade bolt, 8'' long w/ nut & 2 washers}\]
Base and Bearing Strut Assembly with Cable Support Post Posts 3-7

\( \phi \frac{1}{2} \) A307 Grade bolt, 2" long w/ nut and 3 washers, 1 washer between plates. (torque to 26 ft-lb)
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<td>Bearing Strut</td>
<td>XXX</td>
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<tr>
<td>c1</td>
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<td>Bearing Plate</td>
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<tr>
<td>c2</td>
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<td>Bearing Plate Brace</td>
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</tr>
<tr>
<td>c3</td>
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Bearing Strut
(Part C - Post 2 only)

Bearing Plate
(Part c1)

Bearing Plate Brace
(Part c2)

Bearing Plate Brace
(Part c3)
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<tr>
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<td>S76x8.5 Post</td>
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(Part d3—Page 10)

Cable Support Post (Part 1)

S3x5.7 Post (Part i1)
Cable Release Lever
(complete details, weld all interfaces as required $\frac{1}{4}"$)
(Part F)

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<td>Cable Release Lever</td>
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<td>f1</td>
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<tr>
<td>f3</td>
<td>4</td>
<td>Kicker Plate Gusset</td>
<td>A36 13mm Plate</td>
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<tr>
<td>f4</td>
<td>2</td>
<td>Kicker Plate</td>
<td>A36 13mm Plate</td>
</tr>
</tbody>
</table>

Connecting Tube
(Part f2)

Kicker Lever
(Part f1)

Kicker Plate Gusset
(Part f3)

Kicker Plate
(Part f4)

Midwest Roadside Safety Facility
Drawing Name: CT-4 R6.dwg
Scale: 1=8
Rev: KAP/JCH
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<tr>
<td>g2</td>
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<td>Cable Hook Bolts</td>
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<td>g3</td>
<td>10</td>
<td>Soil Plate</td>
<td>A36 6mm Plate</td>
</tr>
<tr>
<td>h1</td>
<td>4</td>
<td>Cable— 77.42m</td>
<td>Ø19mm 3x7 Wire rope</td>
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</table>

Shouldered Cable Hook Bolt, FBH04 (Part g2)

S3x5.7 Post (Part g1)

Soil Plate, PLS01 (Part g3)