July 17, 2008

In Reply Refer To: HSSD/B-146

Mr. Gerald M. McCarthy, Coordinator
New England Transportation Consortium
c/o Advanced Technology & Manufacturing Center
University of Massachusetts Dartmouth
151 Martine Street
Fall River, MA 02723

Dear Mr. McCarthy:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of the New England Transportation Consortium (NETC) roadside safety system for use on the National Highway System (NHS).

Name of systems:
1) NETC New Hampshire T2 Bridge Rail Transition
2) NETC New Hampshire T4 Bridge Rail Transition
3) NETC Massachusetts End Wall Transition to S3-TL4 Bridge Rail with Sidewalk
4) NETC Massachusetts End Wall Transition to S3-TL4 Bridge Rail Curb-Mounted

Type of systems:
1&2) W- to Thrie-Beam Transition direct to beam-and-post bridgerail
3&4) W- to Thrie-Beam Transition to concrete end wall

Test Level:
1&2) National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3 (TL-3)
3&4) NCHRP Report 350 TL-4

Testing conducted by: Texas Transportation Institute (TTI)
Date of request: February 1, 2006
Date of completed package: August 29, 2007 (NETC), June 26, 2008 (TTI)

You requested that we find these systems acceptable for use on the NHS under the provisions of the NCHRP Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features.” We appreciate your patience and cooperation while finalizing this acceptance package.
Requirements

Description
In the current project, the NETC developed bridge rail transitions for two bridge rail systems and for a concrete end wall, and desired to crash test them to TL-3 requirements of the NCHRP Report 350. Four transitions were developed:

1. Transition to the 2-Bar steel bridge rail with approach curb.
2. Transition to the 4-Bar steel bridge rail mounted on a sidewalk.
3. Transition to the concrete end wall with approach curb.
4. Transition to the concrete end wall mounted behind a sidewalk.

Transitions #1 and #2 were developed by New Hampshire Department of Transportation (NHDOT) and transitions #3 and #4 by Massachusetts Highway Department (MHD). The MHD transitions were designed for use with various bridge rail systems beyond the end wall.

Our office reviewed the four transitions and determined that two crash tests were required.

1. Test 3-21 on transition #1 to the 2-bar steel bridge rail with approach curb for TL-3.
2. Test 3-21 on transition #4 to the concrete end wall behind a sidewalk for TL-4.

The FHWA accepted transition #3 to the concrete end wall with approach curb for TL-3 based on crash tests of similar systems already performed by others, and will accept transition #2 to the 4-bar steel bridge rail mounted on a sidewalk pending successful testing of transition #1 to the 2-bar steel bridge rail system with approach curb.

The NETC decided that if the first test (using the 2000P vehicle) on transition #4 to a concrete end wall mounted behind a sidewalk was successful a TL-4 test with a single-unit truck (8000 kg vehicle) would be performed. If transition #4 was successful for TL-4, the FHWA indicated that they would accept transition #3 with an approach curb for TL-4 without testing.

Brief descriptions of the transitions follow:

New Hampshire Transitions
The NETC New Hampshire transition consisted of standard W-beam guardrail attached to a symmetric 10-gage W-beam to Thrie-beam transition section, attached to nested 12-gage Thrie beam, connected to the two tube transition rail by means of a Thrie-beam terminal connector. The two tube transition rails are the same tubular elements used in the bridge rail. A TS 8 x 4 x 5/16 rail element was attached to the top of the W6 x 25 steel posts at a height of 34 inches above the pavement surface (to the top of the rail) with two 6-inch long, 3/4-inch diameter round headed bolts. The TS 4 x 4 x 1/4 bottom rail was attached to the posts at a height of 20 inches with similar bolts. Wood posts throughout the transition were 6 inches x 8 inches x
7 feet long. The seven wood posts adjacent to the tubular transition rail were installed 18-3/4 inches on center, and the remainder of the posts in the transition were installed 37-1/2 inches on center. Posts in the w-beam section were installed at 6 foot 3-inch centers. The upstream end of the guardrail was anchored with an ET terminal. A 7-inch tall simulated granite curb was installed throughout the transition and extended in front of the rail tubes by 6 inches, and in front of the Thrie-beam by 1-1/4 inches.

**Massachusetts Transitions**

The Massachusetts S3-TL4 Steel Bridge Railing system is a beam and post system consisting of three tubular steel rail elements mounted on steel wide flange posts bolted to the concrete deck/sidewalk. It was mounted on a sidewalk a distance of 61 inches from the face of an 8-inch high curb. The bridge railing was attached to a concrete end wall that is part of the bridge abutment. The end wall flares away from the face by 8.8 inches over a distance of 2-feet, 10 inches. A collapsing tube assembly is located in this flared area. The Thrie-beam transition was attached to the straight portion of the concrete end wall with a Thrie-beam end shoe. Two sections of 12 gage Thrie-beam were nested and attached to the end shoe and wood support posts. Posts 1 through 4 were 6 x 8-inch x 7-foot long with 18-inch long blockouts of the same section, spaced 1-1/2 feet on center. Posts 5 and 6 were 6x8-inch x 6.5-foot long, with 18-inch blockouts (6 x 8) and spaced 3 feet on center. Post 7 was 6x8-inch, 6.5-foot long with a 14-inch blockout (6 x 8). A 10-gage symmetric Thrie-beam to W-beam transition was mounted on posts 5, 6, and 7. The sidewalk transitioned from 8 inches tall to 6 inches tall at post 8.

**Testing**

Full-scale truck testing was conducted on these transitions, as summarized in the tables below and detailed in the enclosed Crash Test Data Sheets for reference. The New Hampshire transition was tested to TL-3, whereas the Massachusetts transition was tested to TL-4.

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Test 3-21 401181-1</th>
<th>Test 4-21 401181-2</th>
<th>Test 4-22 401181-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transition</td>
<td>New Hampshire</td>
<td>Massachusetts</td>
<td>Massachusetts</td>
</tr>
<tr>
<td>Critical Impact Point Location</td>
<td>1635 mm from 1st bridgerail post</td>
<td>1570 mm from start of wall slope</td>
<td>1570 mm from start of wall slope</td>
</tr>
<tr>
<td>Mass of Test Vehicle</td>
<td>2135 kg (2000P)</td>
<td>2108 kg (2000P)</td>
<td>8106 kg (8000S)</td>
</tr>
<tr>
<td>Impact Speed</td>
<td>102.3 km/hr</td>
<td>101.2</td>
<td>82.2</td>
</tr>
<tr>
<td>Impact Angle</td>
<td>24.9 degrees</td>
<td>25.2 degrees</td>
<td>13.6 degrees</td>
</tr>
<tr>
<td>Occupant Impact Velocity</td>
<td>5.2 mps long. 7.5 mps lat.</td>
<td>5.1 mps long. 6.6 mps lat.</td>
<td>2.5 mps long. 3.0 mps lat.</td>
</tr>
<tr>
<td>Maximum Ridedown*</td>
<td>-8.3 g’s long. 13.5 g’s lat.</td>
<td>-19.3g’s long. 17.4g’s lat.</td>
<td>-4.5 g’s long. 7.4 g’s lat.</td>
</tr>
<tr>
<td>Working Width</td>
<td>580 mm</td>
<td>450 mm</td>
<td>539 mm</td>
</tr>
<tr>
<td>Max. Occup. Deform.**</td>
<td>44 mm</td>
<td>104 mm</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Maximum Ridedown: maximum longitudinal and lateral ridedown accelerations
**Max. Occup. Deform.: maximum occupant compartment deformation
**Findings**

In all three impacts, the test vehicles were smoothly redirected by the barrier, with maximum roll angles quite low or negligible. The results of the testing met the FHWA requirements and, therefore, the transitions described above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when proposed by a highway agency.

**Findings**

The systems described in the various requests above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency. Specifically, the following scenarios are acceptable:

1. New Hampshire Transition to the 2-Bar steel bridge rail with approach curb.
2. New Hampshire Transition to the 4-Bar steel bridge rail mounted on a sidewalk.
3. Massachusetts Transition to the concrete end wall with approach curb.
4. Massachusetts Transition to the concrete end wall mounted behind a sidewalk.

Please note that system #4 requires that either there be an existing sidewalk on the approach to the bridge, or that a gradual transition from the shoulder grade to the sidewalk is provided in conjunction with the transition.

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

- This acceptance is limited to the crashworthiness characteristics of the systems 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 system 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 system 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.
- Users should ensure that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-146 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.
- This acceptance 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. The acceptance letter is limited to the crashworthiness characteristics of the
candidate system, 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

cc: Mr. James Sime
    Manager of Research
    Research & Materials
    ConnDOT
    280 West Street
    Rocky Hill, CT 06067-0207
THREADED INSERTS EACH
WITH 5/8" X 11-1/2" BOLT
SEE NOTE 1

THREADED INSERTS EACH
WITH 5/8" X 11-1/2" BOLT
SEE NOTE 2

THREADED INSERTS WITH
5/8" X 11-1/2" BOLT
SEE NOTE 1 (TOP)

THREADED INSERTS WITH
5/8" X 11-1/2" BOLT
SEE NOTE 2 (TOP)

THREADED INSERTS
SEE NOTE 1 (TOP)

THREADED INSERTS
SEE NOTE 2 (TOP)

NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION - S3-TL4 RAILING AT SAFETY CURB

PARTIAL PLAN AT SAFETY CURB
SCALE: 1" = 1'-0"

PARTIAL ELEVATION AT SAFETY CURB
SCALE: 1" = 1'-0"

SECTION 3
SCALE: 1" = 1'-0"

SECTION 4
SCALE: 1/4" = 1'-0"

SECTION 5
SCALE: 1/4" = 1'-0"

SECTION 6
SCALE: 1/4" = 1'-0"

SECTION 7
SCALE: 1" = 1'-0"

RAIL ATTACHMENT
SCALE: 1/4" = 1'-0"

ELEVATION
SCALE: 1/4" = 1'-0"

PLAN

NOTES:

1. THREADED INSERTS SHALL BE PREQUALIFIED BY THE MANUFACTURER AS BEING CAPABLE OF DEVELOPING AN ULTIMATE SHEAR CAPACITY OF 26 KIPS PER 5/8" X 11-1/2" BOLT. 5/8" BOLTS SHALL BE 1-1/2" LONG FULLY THREADED AND MADE FROM STAINLESS STEEL. INSERTS FOR 5/8" BOLTS SHALL BE CAST-IN-PLACE AND GALVANIZED.

2. TOP OF GUARDRAIL TRANSITION AND RAIL POCKETS SHALL BE SLOPED TO MATCH THE PROFILE GRADE.
THREADED INSERTS SHALL BE PREOASSEMBLED BY THE MANUFACTURER AS BEING CAPABLE OF DEVELOPING AN ULTIMATE SHEAR CAPACITY OF 20 KIPS PER 3" x 3" S.S. BOLT. S.S. BOLTS SHALL BE 3" LONG FULLY THREADED AND TYPE 304 STAINLESS STEEL. INSERTS FOR 3" x 3" BOLTS SHALL BE CAST-IN-PLACE AND GALVANIZED.

TOP OF GUARDRAIL TRANSITION AND RAIL POCKETS SHALL BE SLOPE TO MATCH THE PROFILE GRADING.

NOTES:
1. THREADED INSERTS SHALL BE PREOASSEMBLED BY THE MANUFACTURER AS BEING CAPABLE OF DEVELOPING AN ULTIMATE SHEAR CAPACITY OF 20 KIPS PER 3" x 3" S.S. BOLT. S.S. BOLTS SHALL BE 3" LONG FULLY THREADED AND TYPE 304 STAINLESS STEEL. INSERTS FOR 3" x 3" BOLTS SHALL BE CAST-IN-PLACE AND GALVANIZED.

2. TOP OF GUARDRAIL TRANSITION AND RAIL POCKETS SHALL BE SLOPE TO MATCH THE PROFILE GRADING.
NOTES:
1. Threaded inserts shall be supplied by the manufacturer as being capable of developing an ultimate shear capacity of 20 kips per 2" S.S. bolt. S.S. bolts shall be 8" long fully threaded and type 316 stainless steel. Inserts for S.S. bolts shall be cast-in-place and backfilled.
2. Top of guardrail transition shall be sloped to match the roadway grade.
3. All concrete above the construction joint of the highway guardrail transition shall be 5000 psi, 1" free 6B5 HP cement concrete.

SCALE: 1" = 1'-0"
General Information
Test Agency: Texas Transportation Institute
Test No.: 401181-1
Date: 04-14-2005

Test Article
Type: Transition
Name: NETC New Hampshire T2 Transition
Installation Length (m): 21.5
Material or Key Elements: W-beam to symmetric 10 gauge W-beam to thrie-beam transition section, to nested 12 gauge thrie-beam sections, to two tube transition by thrie-beam terminal connector

Soil Type and Condition: Standard Soil, Dry

Test Vehicle
Type: Production
Designation: 2000P
Model: 2000 Chevrolet 2500 Pickup
Mass (kg):
  - Curb: 2156
  - Test Inertia: 2135
  - Dummy: No dummy
  - Gross Static: 2135

Impact Conditions
- Speed (km/h): 102.3
- Angle (deg): 24.9

Exit Conditions
- Speed (km/h): 85.1
- Angle (deg): 11.7

Occupant Risk Values
- Impact Velocity (m/s):
  - Longitudinal: 5.2
  - Lateral: 7.5
- THIV (km/h): 32.9
- Ridedown Accelerations (g's):
  - Longitudinal: -8.3
  - Lateral: -10.0
  - PHD (g's): 11.9
  - ASI: 1.74
- Max. 0.050-s Average (g's):
  - Longitudinal: -8.1
  - Lateral: 13.5
  - Vertical: -7.6

Test Article Deflections (m)
- Dynamic: 0.20
- Permanent: 0.15
- Working Width: 0.58

Vehicle Damage
- Exterior: 11LFQ3, 11FYEW2
- Max. Exterior Vehicle Crush (mm): 530
- Interior: LF0114000
- Max. Occupant Compartment Deformation (mm): 44

Post-Impact Behavior
- (during 1.0 sec after impact)
  - Max. Yaw Angle (deg): 56
  - Max. Pitch Angle (deg): -14
  - Max. Roll Angle (deg): -19

Summary of results for NCHRP Report 350 test 4-21 on the Massachusetts transition.
Summary of results for NCHRP Report 350 test 4-22 on the Massachusetts transition.