U.S. Department of Transportation
Federal Highway Administration

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

November 10, 2010

In Reply Refer To:
HSSI/B-209

Mr. Paul Fossier, P.E.
Assistant Bridge Design Administrator
Louisiana Department of Transportation and Development, Rm. 608J
P.O. Box 94254
Baton Rouge, LA 70804-9245

Dear Mr. Fossier:

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

Name of system: Test Level 2 (TL-2) T-Intersection (Short Radius) Guardrail System
Type of system: W-Beam Guardrail
Test Level: NCHRP Report 350 (Report 350) TL-2
Testing Research conducted by: Texas Transportation Institute (TTI)
Date of Request: August 24, 2010
Drawing Designator: SGR40

You requested that we find this system acceptable for use on the NHS under the provisions of Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features."

Requirements
Roadside safety systems should meet the guidelines contained in Report 350. The FHWA memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description
The test and evaluation of T-Intersection system is a similar design as originally tested in January 1989 by the Southwest Research Institute for the Yuma County Highway Department, Arizona. The test conditions were based on Performance Level 1 (PL-1) of the 1989 AASHTO Guide Specifications for Bridge Railings.

Your request is for a R*eport 350* TL-2 T-intersection system details as described below and the layout of this test system is shown in the attached details. The T-intersection system is a 690 mm (27 inches) high rail system. The nose section of this T-intersection system consists of a 3.82 m (12-1/2 ft) curved W-beam segment which has a 2.44 m (8 ft) radius. The curved section is attached to a straight W-beam section on the secondary road via common W-beam splicing details. The secondary road W-Beam should have a 7.62 m (25 ft) minimum length and should be terminated with a positive anchor. Five Controlled Released Terminal (CRT) posts, spaced at 1.91 m (6.25 ft), are placed along the curved section and secondary road section. Details of the system are presented in Appendix A. On the primary road direction, the curved section is spliced to a short W-beam segment (6.25 ft) at CRT post 7. The short W-beam section has also two 200 × 200 × 1980 mm (7-7/8 × 7-7/8 × 72 inches) posts embedded 1117.6 mm (44 inches) in soil.

Starting at post 8, a stiffer rail section is used to act as a transition to the bridge rail. The transition section consists of the 1905 mm (6.25 ft) short W-beam segment which is spliced to a 3810 mm (12.5 ft) W-beams guardrail. The W-beam guardrail is backed by an MC 200 x 33.9 (MC 8 × 22.8) structural steel channel which runs from post 9 to the bridge barrier. The transition has three timber posts which are 250 × 250 × 1980 mm (9-7/8 × 9-7/8 × 78 inches). They are embedded 1270 mm (50 inches) in soil (Post Detail A). The five timber posts (post 8 to post 12) have 200 × 200 × 360 mm (7-7/8 × 7-7/8 × 14 inches) wood blockouts.

In addition, the following design changes to the aforementioned system as recommended by the testing researcher will not affect the impact performance of the T-Intersection system. The testing researcher therefore concludes the following modifications to be acceptable.

1. The T-Intersection guardrail system can be terminated on the secondary roadway using any NCHRP Report 350 TL-2 or higher compliant terminal if the secondary roadway design requires such end termination. However, a minimum span of 7.62 m (25 ft) with a positive anchor is still required even if a crashworthy terminal is not needed.
2. The transition section on the primary road can be replaced with any NCHRP Report 350 TL-2 or higher compliant transition.
3. The bridge barrier section can be any NCHRP Report 350 TL-2 or higher compliant bridge rail.
4. Additional W-beam guardrail sections with standard post spacing 1.91 m (6.25 ft) may be added between the tangent point of the curved section and the beginning of the transition section as needed to provide the length of need for a given site as shown in Figure 6.2.
5. Blockout Details “E” and “G” can be replaced with other blockouts of similar size but made of different materials provided that they have been used in a successful crash test or have received FHWA acceptance under *NCHRP Report 350*.
6. A 178 mm (7 inches) diameter round wood post can be used instead of a 152 × 200 mm (6 × 8 inches) rectangular wood post. The round breakaway posts (posts 3 through 7 inches Figure 6.1) should have 89 mm (3.5 inches) diameter weakening holes similar to the CRT post.
7. A standard 200 × 152 × 360 mm (7-7/8 × 5-7/8 × 14 inches) blockout can be used in the curved section. This is not expected to cause any significant change to the performance of the system since the weakened (CRT) posts are expected to break prior to any significant change of height to the system.

Crash Testing
The original test conditions were based on Performance Level 1 (PL-1) of the 1989 *AASHTO Guide Specifications for Bridge Railings,* summarized below. The test matrix used consisted of a 50 mph impact with a 1800 lb. small car and a 45 mph impact with a 5400 lb. pickup truck with various impact angles and locations.

Test Level	Vehicle (Test No.)	Vehicle Weight	Nominal speed (mph)	Nominal angle (degree)
PL-1	small automobile (YC5&6)	1800 lb (817 kg)	50 mph (81 km/h)	20
	pickup truck (YC4&7)	5400 lb (2450 kg)	45 mph (72 km/h)	20

TTI developed a comparison of Report 350 TL-2 impact conditions for terminals and crash cushions to the Yuma County test conditions (YC).

I. Tests YC-5, YC-4, YC-6, and YC-7 are compared to Report 350 test designation 2-32, 2-33, 2-36, and 2-37, respectively. In addition to having similar impact locations when compared to the as recommended, it was also determined tests YC-5, YC-4, YC-6, and YC-7 have more severe impact conditions (due to increased vehicle mass and/or velocity) than required in Report 350 test conditions. Additional crash test comparison and recommendations are as follows:

   A. Under Report 350 Test 2-30, the 820C test vehicle impacts the curved section (terminal) head-on with one-quarter point offset at a speed of 43.5 mph. Under Report 350 Test 2-31, the 2000P test vehicle impacts the curved section (terminal) head-on at a speed of 43.5 mph. These two tests are considered less severe than Report 350 Tests 2-32 and 2-33 which impact the curved section at an angle of 15 degrees relative to the tangent section of rail along the primary roadway.

   B. Report 350 Test 2-30 falls within the impact envelope of YC-2 and YC-5. Similarly, Report 350 Test 2-31 falls within the impact envelope of YC-1 and YC-4. Therefore, TTI concludes that Report 350 Tests 2-30 and 2-31 conditions are satisfied using the aforementioned YC tests.

   C. Report 350 Test 2-38 specifies a 43.5 mph impact with a 2000P vehicle at an angle of 20 degrees at the Critical Impact Point (CIP). While Test 2-37 is intended primarily to evaluate structural adequacy and vehicle trajectory criteria, Test 2-38 differs in purpose from Test 2-37 in that it is intended to evaluate the potential for pocketing or snagging at the bridge rail end. Since Report 350 Test 2-38 falls within the impact envelope of YC-4 and YC-7, TTI concludes that Report 350 Test 2-38 conditions are satisfied.

   D. Report 350 Test 2-39 specifies a 43.5 mph reverse direction impact with a 2000P vehicle at an angle of 20 degrees at the midpoint of the tangent section of rail along the primary roadway. Reverse direction evaluates potential for snagging on a terminal anchor assembly or crash cushion. The short radius guardrail does not have an anchorage assembly along the primary roadway. This condition is no different than impacting a standard guardrail in the opposite direction. Therefore, Test 2-39 is considered unnecessary based on engineering review.

II. Yuma County short radius guardrail original design also incorporated two free standing CRT posts behind the curved rail to dissipate energy if the impacting vehicle and reduce the stopping distance. In 1995 and 2001, TTI conducted two separate dynamic pendulum impact tests on CRT posts to evaluate their performance. Based on these impact studies, the average energy absorbed by a single CRT post energy impacted about its strong axis is 9.45 kip-ft. This is 8.3 percent and 3.4 percent of the initial kinetic energy of the 820C and 2000P vehicles, respectively. Since impact conditions do not guarantee both posts breaking about their strong axes, these percentages represent an upper bound on the effectiveness of the free-standing CRT posts. In addition and under many impact scenarios, one or both posts may be missed. In addition, the maximum deflection of the barrier is controlled by the 2000P vehicle. If dynamic deflection is assumed to be proportional to the kinetic energy of the impacting vehicle, removal of the two CRT posts would result in an increase in deflection from 20 ft. to 21.4 ft. Therefore, TTI recommends these two free standing CRT posts can be removed with no significant change in the performance of this system.

Findings

We concur with your recommendations and accept the as described T-Intersection system for use on the NHS system. The FHWA also concurs with the following:

1. As requested waiver of Report 350 Test 2-39 for this installation in that the critical impact point (CIP) is located where the system transitions from 'stiff' portion (i.e., the transition or the Length of Need) to a 'less-stiff' portion (i.e., radius with CRT posts.).
2. Specification of additional design changes to the T-Intersection system as described herein and as recommended by testing researcher.

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

- This acceptance is limited to the crashworthiness characteristics of the system 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.
- 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 Report 350.

To prevent misunderstanding by others, this letter of acceptance is designated as number B-209 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,

George E. Rice, Jr.

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

Attachment

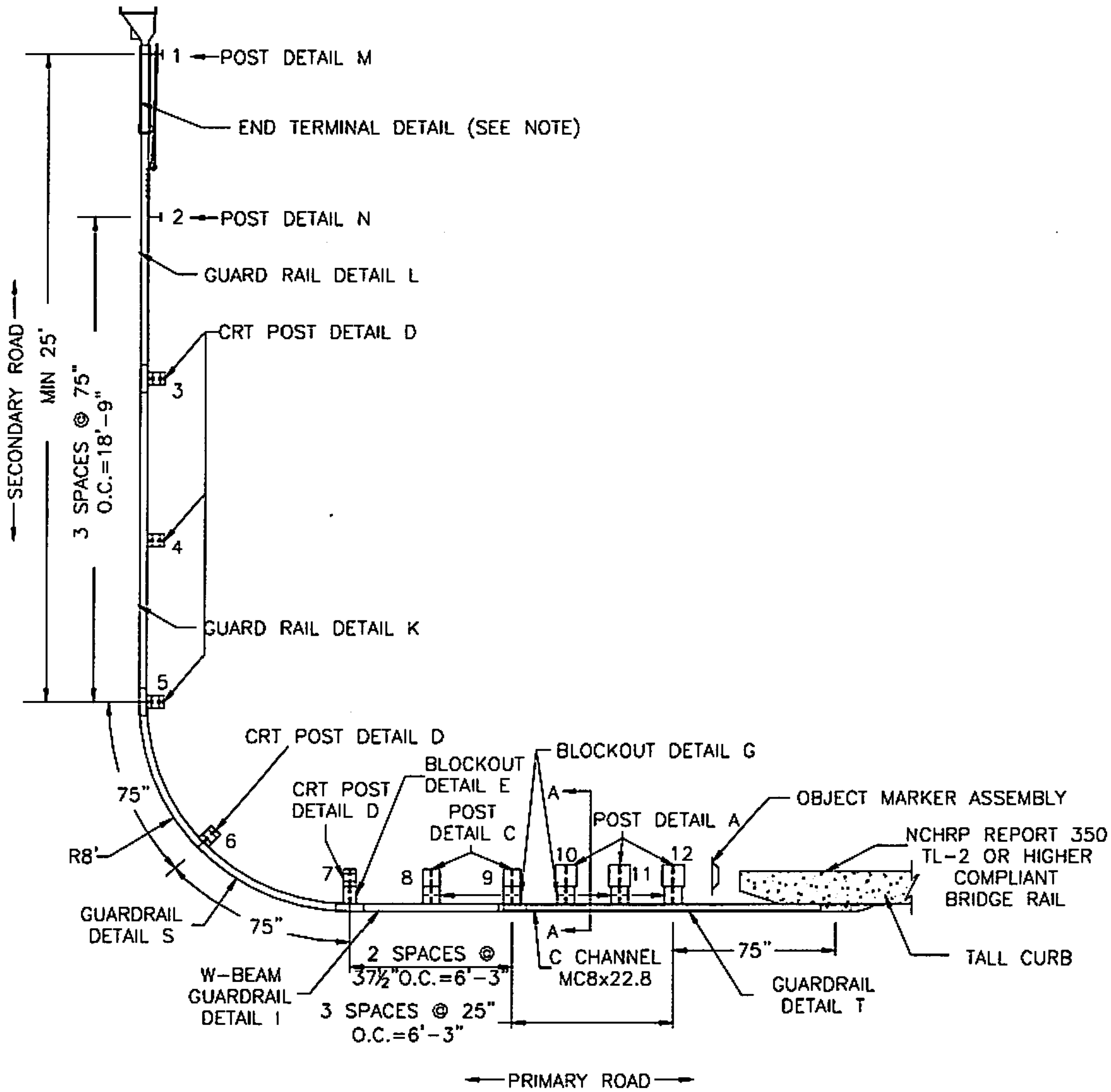

Figure 6.1 Recommended T-intersection system

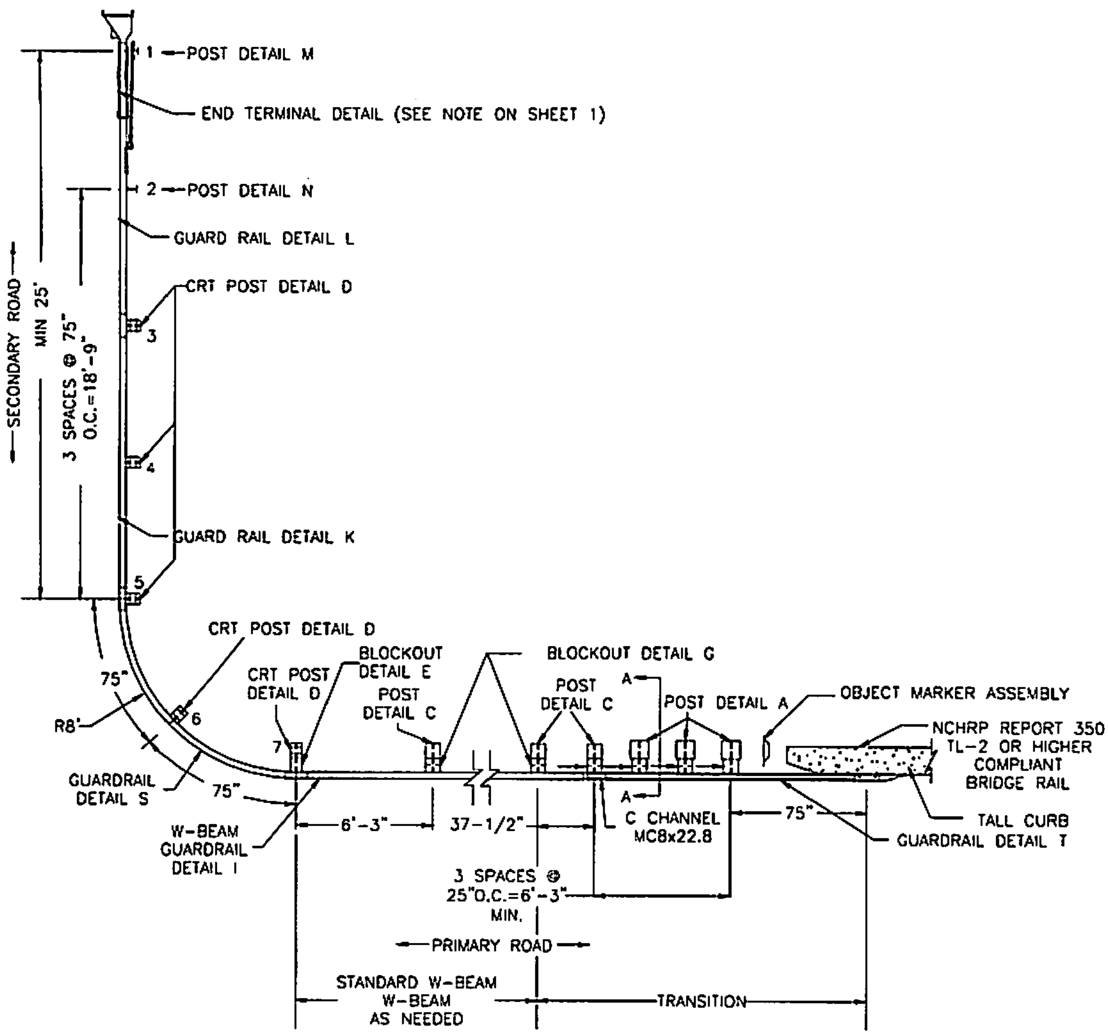

Figure 6.2 Acceptable variation of the recommended T-intersection system