



U.S. Department
of Transportation
**Federal Highway
Administration**

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

December 23, 2011

In Reply Refer To:
HSST/ CC-123F

Mr. Barry D. Stephens, P.E.
Sr. Vice President Engineering
Energy Absorption Systems
3617 Cincinnati Avenue
Rocklin, CA 95678

Dear Mr. Stephens:

This letter is in response to your request for the Federal Highway Administration (FHWA) to review a roadside safety system for eligibility for reimbursement under the Federal-aid highway program.

Name of device: Trinity End Terminal (TREND™ 350), Flared
Type of device: Redirective, Gating End Terminals (W-Beam)
Test Level: NCHRP Report 350 Test Level 3 (TL-3)
Testing conducted by: E-Tech Testing Services, Inc.
Date of request: December 17, 2010
Date of completed package: October 26, 2011
Task Force 13 Designator: SEW25; TREND End Terminal Flared

Decision

The following device was found acceptable, with details provided below:

- The TREND™ 350 End Terminal, Flared

Based on a review of crash test results submitted by the manufacturer certifying the device described herein meets the crashworthiness criteria of the National Cooperative Highway Research Program (NCHRP) Report 350, the device is eligible for reimbursement under the Federal-aid highway program. Eligibility for reimbursement under the Federal-aid highway program does not establish approval or endorsement by the FHWA for any particular purpose or use.

The FHWA, the Department of Transportation, and the United States Government do not endorse products or services and the issuance of a reimbursement eligibility letter is not an endorsement of any product or service.

FHWA: HSST: WLongstreet: ms:x60087:12/8/11

Revised: sf:x62288:12/21/11

File: h://directory folder/HSST/ CC-123F_Trinity End Terminal TREND

Requirements

Roadside safety devices should meet the guidelines contained in the National Cooperative Highway Research Program Report 350 (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

The TREND™ 350 End Terminal family of products includes the TREND™ 350 End Terminal, Flared. This new product is designed to shield the end of w-beam guardrail in roadside tangent and flared installations. The flared system is constructed from the same components with the only difference being the product’s installation with a flare relative to the edge of road. The beginning of length of need (BLON BLON = the point where 20 degree redirection occurs under 350 guidelines) for the TREND™ 350 End Terminal, Flared is cited as the third post.

The TREND™ 350 End Terminal, Flared is based on AASHTO w-beam rail that has been modified to include slots. These slots extend the length of the rail from the guardrail bolts that hold the rail together. When an errant vehicle strikes the impact head of the terminal in an end on impact, the vehicle’s energy is safely absorbed by the terminal’s rail sections as each of the adjacent pairs of rail sections slide past each other. The vehicle’s kinetic energy is dissipated by tearing of the panel slots, re-shaping of the panels by a calibrated fin at the back of each panel, and by friction. A lightweight impact head is attached to the front of the unit to engage the front of vehicles impacting the nose.

The TREND™ 350 End Terminal, Flared uses end terminal posts and anchorage components that were previously tested to NCHRP 350. These posts designs, known as the Hinged Breakaway Assembly (HBA) and Steel Yielding Terminal Post (SYTP), have seen extensive use in the ET family of end terminals and also have previously been accepted by the FHWA. The TREND™ 350 End Terminal, Tangent and Flared designs use an HBA post in the first post position and an SYTP post in the second post position. These first two posts are joined together by another standard end terminal component, the Angle Strut. The TREND™ 350 End Terminal, Flared also uses four standard line posts resulting in total system length of 39 feet 2 inches. The FHWA letters for the above cited components are HSA-10/CC-12F (HBA & Angle Strut), HSA-10/CC-12L (W6X8.5 SYTP), and HAS-10/CC-12Q (ET with line posts).

Details of this system are included as an enclosure to this correspondence.

Crash Testing

A. TREND™ 350 End Terminal; Flared Configuration:

1. Test 3-30 (820C/ 100kph/ 0°/ w/4 Offset):
Impact speed = 97.0 km/h, Long. ΔV = 9.8 m/s, Long. Ridedown = -17.3 g[▲]
2. Test 3-35 (2000P/ 100kph/ 20°/ BLON):
Impact speed = 98.3 km/h, Long. ΔV = 6.2 m/s, Long. Ridedown = -11.2 g



▲ Manufacturer noted that the primary accelerometers recorded a value of -21.2 g for the longitudinal acceleration during Test 3-30 of the TREND™ 350 End Terminal in the flared configuration. Analysis of the data and the test vehicle revealed that this was due to a wrinkle in the floorboard, close to the mounting of the primary accelerometer package. Therefore, backup accelerometer data (i.e. ; -17.3 g) was used to measure occupant



risk for this test, as it more closely matches the rigid body motion of the test vehicle, as defined in NCHRP Report 350.



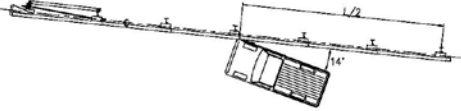
Test summaries of the above tests are included as an enclosure to this correspondence.

Tests 3-31 through 3-34 and Test 3-39 for the flared system were not run. The manufacturer requested these tests be waived from the test matrix for the as-stated reasons in Table 1. In addition, the manufacturer indicated the TREND™ 350 End Terminal family of end terminals uses a common set of hardware, and this hardware was successfully crash tested as per NCHRP Report 350 during the original tangent TREND™ 350 End Terminal testing.

Table 1. TREND™ 350 End Terminal Test Matrix, Flared Configuration

Test #	Illustration	Completed	Notes
3-30		Yes	Passed all Occupant Risk Values ¹
3-31		NO	The worst case condition for this test is a zero degree impact, as was run during the testing of the TREND™ End Terminal in the <u>tangent</u> configuration. It should be noted that an angled nose test with the 2000 kg. test vehicle (Test 3-33) was run during the certification of the TREND™ End Terminal in the <u>tangent</u> configuration and the results from this test passed all of the requirements of NCHRP 350.

Test #	Illustration	Completed	Notes
3-32		NO	<p>An angled nose test with the 820C vehicle was run during the certification of the TREND™ End Terminal in the <u>tangent</u> configuration and this test need not be rerun. Test 3-32 for a <u>flared</u> system is less severe, as the angle is greater, increasing the likelihood that the vehicle will gate through the system.</p>
3-33		NO	<p>An angled nose test with the 2000P vehicle was run during the certification of the TREND™ End Terminal in the <u>tangent</u> configuration and this test need not be rerun. Test 3-33 for a <u>flared</u> system is less severe, as the angle is greater, increasing the likelihood that the vehicle will gate through the system.</p>

Test #	Illustration	Completed	Notes
3-34		NO	<p>Test 3-34 (820c) was successfully run into TREND™ End Terminal in the <u>tangent</u> configuration, with smooth vehicle redirection and low occupant risk values. Test 3-35 (2000p) into the <u>flared</u> configuration also yielded smooth vehicle redirection (see next test). Due to these two successful redirect tests, smooth redirection and low occupant risk values are expected for the 820c, Test 3-34, into the Flared configuration.</p>
3-35		YES	<p>Passed all Occupant Risk Values</p>
3-39		NO	<p>Test 3-39 was run on the TREND™ End Terminal in the <u>tangent</u> configuration, which is a worst case condition, as the angle is greater. The <u>flared</u> test condition has a lower angle and this test need not be re-run.</p>

¹ The x accelerometer at the vehicle's c.g. recorded a value of -21.2g's during this test due to a ripple in the floorboard near the accelerometer mounting. The backup x accelerometer recorded a maximum value of -17.3 g's.

Findings

Based on the successful completion of the described NCHRP Report 350 testing, FHWA concurs that the TREND™ 350 End Terminal, Flared meets the evaluation criteria for NCHRP Report 350 redirective, gating end terminals at TL-3 impact conditions. FHWA also concurs with the request for a testing waiver and the reasons for waiver as stated within this correspondence.

Since the TREND™ 350 End Terminal, Flared was tested with flare rates ranging from 0 (tangent) to 4 feet of offset, the amount of offset for flared applications can range between the tangent position and fully flared. In addition, FHWA also concurs that the testing of the TREND™ 350 End Terminal, Flared was conducted at the worst-case guardrail height of 27-3/4 inches and it is acceptable to use the TREND End Terminal when attached to guardrail with heights between 27-3/4 inches and 31 inches. (SGR04a from 27 ¾ inches to 30 inches, MGS from 27 ¾ inches to 31 inches, and the various proprietary 31-inch designs.)

Therefore, the system described and detailed in the attached form is eligible for reimbursement and should be installed under the range of conditions tested, when such use is acceptable to a highway agency.

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

- This letter includes an AASHTO/ARTBA/AGC Task Force 13 designator that should be used to identify any new or updated Task Force 13 drawings.
- This finding of eligibility is limited to the crashworthiness characteristics of the devices and does not cover their structural features, or conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the device will require a new 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 this letter.
- 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 review, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of is designated as number CC-123F 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 TREND End Terminal, Flared is a patented product and is considered proprietary. If proprietary devices are specified by highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they 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 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 finding of eligibility 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



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Testing conducted by:	E-Tech Testing Services, Inc.
Date of request:	December 17, 2010
Date of completed package:	October 26, 2011
Task Force 13 Designator:	SEW25; TREND End Terminal Flared

Decision

The following device was found acceptable, with details provided below:

- The TREND™ 350 End Terminal, Flared

Based on a review of crash test results submitted by the manufacturer certifying the device described herein meets the crashworthiness criteria of the National Cooperative Highway Research Program (NCHRP) Report 350, the device is eligible for reimbursement under the Federal-aid highway program. Eligibility for reimbursement under the Federal-aid highway program does not establish approval or endorsement by the FHWA for any particular purpose or use.

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Requirements

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Description

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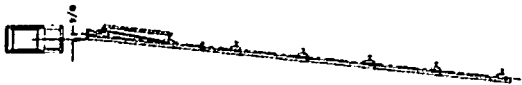
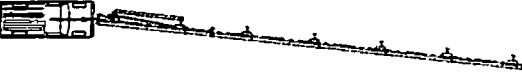
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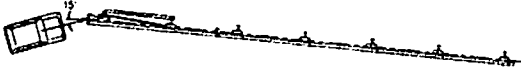

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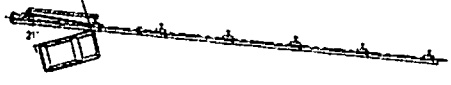
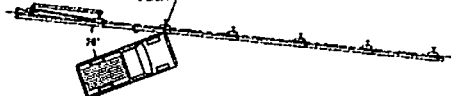
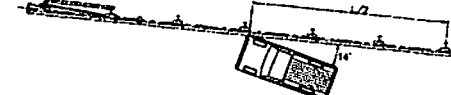
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- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of is designated as number CC-123F 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 TREND End Terminal, Flared is a patented product and is considered proprietary. If proprietary devices are specified by highway agency for use on Federal-aid projects, except exempt, non-NHS projects, (a) they 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.

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Sincerely yours,

A handwritten signature in blue ink that reads "Michael S. Griffith". The signature is written in a cursive style with a large, stylized initial "M".

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