

**TRINITY HIGHWAY PRODUCTS  
WORK PLAN  
FOR  
CRASH TEST OF THE ET-PLUS WITH 4-INCH GUIDE CHANNELS**

November 6, 2014

**Introduction**

This work plan is in response to the October 21, 2014 letter from Mr. Gregory Nadeau, Acting Administrator of the Federal Highway Administration (FHWA), to Mr. Gregory Mitchell, President of Trinity Highway Products, LLC (THP).<sup>1</sup> Mr. Nadeau requested that THP perform additional NCHRP Report 350 Test Level 3 crash tests of the ET-PLUS guardrail end terminal system. THP presents the following work plan pursuant to that request.

We will complete the FHWA-requested test series in conformity with the test criteria established under the governing NCHRP Report 350. The safety of the American driving public is very important to Trinity, and we take very seriously the safety of the products that we manufacture for installation on the nation's roadways. We believe that this process will confirm going forward that our products meet the NCHRP Report 350 standard.

**Crash Test Facility**

THP is working with Southwest Research Institute (SwRI) in San Antonio, Texas to perform the eight crash tests. SwRI has a long record of performing crash tests dating back more than 40 years. SwRI is one of the crash test laboratories listed on FHWA's list of laboratories suitable for performing Report 350 and MASH crash tests and is accredited according to ISO/IEC 17025:2005 (A2LA Certificate Number 1110.02, valid until March 2016).<sup>2 3</sup> SwRI has not previously tested the ET-PLUS guardrail end terminal system.

Over 20 years ago SwRI developed the CAT and VAT guardrail end terminal systems which were licensed to Syro Steel Company. Syro Steel Company merged with Trinity companies in 1992. The patents expired on both of these designs in April 2007 and the royalty arrangement between THP and SwRI also ceased. All the SwRI inventors of those products retired from SwRI several decades ago. SwRI has done contract testing for THP in recent years (e.g., the MDS bridge railing was tested at SwRI in 2009) but these more recent tests did not involve product development or royalty arrangements; SwRI was simply hired to perform the tests and report the results.

Prior to the commencement of crash testing, SwRI will provide certification to THP that:

1. It has not previously conducted crash tests of the ET-Plus end terminal system.
2. It has no financial interest in any of the roadside safety hardware being tested.

---

<sup>1</sup> Mr. Gregory Nadeau, Acting Administrator, Federal Highway Administration, Letter to Mr. Gregory Mitchell, President, Trinity Highway Products, October 21, 2014.

<sup>2</sup>[http://safety.fhwa.dot.gov/roadway\\_dept/policy\\_guide/road\\_hardware/forms/request\\_for\\_fhwa\\_acceptance\\_form\\_AUG14.pdf](http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/forms/request_for_fhwa_acceptance_form_AUG14.pdf)

<sup>3</sup> [http://safety.fhwa.dot.gov/roadway\\_dept/policy\\_guide/road\\_hardware/laboratories/](http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/laboratories/)

3. It has no financial interest in any guardrail terminal products competing with the ET-PLUS system.

These certifications will be provided to the FHWA prior to the commencement of testing and will also be included in the summary reports documenting the results of the crash tests performed.

Given the above qualification and experience, SwRI meets the requirements of Attachment A of Mr. Nadeau's letter since they are (1) nationally accredited, (2) have not previously tested the ET-PLUS and (3) have no competing proprietary interests in the ET-PLUS system or similar products.

### **Crash Tests**

Mr. Nadeau's letter specifies eight crash tests: Report 350 tests 3-33, 3-31, 3-32 and 3-30 for both the 27-3/4" and 31" tall configurations. Two series of crash tests will be performed. The first series will involve test 3-33, 3-31, 3-32, and 3-30 for the 27-3/4" tall configuration (herein after referred to as the ET27 test series). The second test series will repeat the same tests but with the 31" configuration (herein after referred to as the ET31 test series). All tests will be performed according to the requirements in NCHRP Report 350. The order in which the tests will be performed are as follows, where the numbers at the left indicating the anticipated test number. This logical sequence represents the most efficient method for expediting the entire program.

FHWA has requested that we explore the possibility of concluding both test series before the end of the year. We have again explored the options for an accelerated timeline with Southwest Research Institute (SwRI). We feel strongly that the schedule should remain as presented. As set forth in this Test Plan, the first weeks of this process will necessarily involve ensuring the calibration and accuracy of the equipment and processes to be undertaken at SwRI. SwRI is nevertheless committed to compressing the test schedule whenever possible while confirming the necessary quality control.

#### **Test Series #1: ET-PLUS with guardrail height of 27-3/4"**

- |         |  |
|---------|--|
| ET27-33 | NCHRP 350 Test 3-33: 2000-kg pickup traveling at 100 km/hr impacting the head of the ET-Plus at an angle of 15 degrees. The centerline of vehicle path and centerline of the impact head will intersect at the center of the impact head as shown in Figure 1.                       |
| ET27-31 | NCHRP 350 Test 3-31: 2000-kg pickup traveling at 100 km/hr impacting head-on into the center of the ET-Plus head with the pickup aligned with the center of the impact face of the terminal as shown in Figure 1.  |
| ET27-32 | NCHRP 350 Test 3-32: 820-kg passenger car traveling at 100 km/hr impacting the head of the ET-Plus at an angle of 15 degrees. The centerline of vehicle path and centerline of the impact face of the terminal will intersect at the center of the impact head as shown in Figure 1. |

ET27-30 NCHRP 350 Test 3-30: 820-kg passenger car traveling at 100 km/hr impacting head-on into the center of the ET-Plus head with the car offset  $\frac{1}{4}$  of the car width to the traffic side from the centerline of the impact face of the terminal as shown in Figure 1.

**Test Series #2: ET-PLUS with guardrail height of 31”**

ET31-33 NCHRP 350 Test 3-33: 2000-kg pickup traveling at 100 km/hr impacting the head of the ET-PLUS at an angle of 15 degrees. The centerline of vehicle path and centerline of the impact head will intersect at the center of the impact head as shown in Figure 1.

ET31-31 NCHRP 350 Test 3-31: 2000-kg pickup traveling at 100 km/hr impacting head-on into the center of the ET- PLUS head with the pickup aligned with the center of the impact face of the terminal as shown in Figure 1.

ET31-32 NCHRP 350 Test 3-32: 820-kg passenger car traveling at 100 km/hr impacting the head of the ET-PLUS at an angle of 15 degrees. The centerline of vehicle path and centerline of the impact head will intersect at the center of the impact head as shown in Figure 1.

ET31-30 NCHRP 350 Test 3-30: 820-kg passenger car traveling at 100 km/hr impacting head-on into the center of the ET-PLUS head with the car offset  $\frac{1}{4}$  of the car width to the traffic side from the centerline of the guardrail as shown in Figure 1.



Figure 1. Impact Conditions for Report 350 End-On Guardrail Terminal Crash Tests.

In accordance with Report 350, Chapter 2, Test parameters, Section 2.4.1.1., the requisite tests will be performed using older vehicles that demonstrate key properties that are essentially the same as those of a vehicle meeting all of the Report 350 recommended requirements. According to 2.4.1.1, *“Exceptions to the age limitation are acceptable if it can be demonstrated that key properties of the test vehicle are essentially the same as those of a vehicle meeting all above recommended requirements.”*

The FHWA has confirmed its agreement that SwRI can use vehicle models that conform to NCHRP Report 350 test vehicle specifications. With regard to the test vehicles to be used for both NCHRP Report 350 test series, the experts in NCHRP Report 350 testing with whom we have consulted all feel that it is important to find and use vehicles that were commonly used for NCHRP Report 350 testing. We understand that FHWA does not want to modify or strip down newer model vehicles to get them to the test weight set forth in NCHRP Report 350 criteria and have confirmed that SwRI can use older vehicle models that conform to NCHRP Report 350 specifications. Trinity will locate vehicles that comply with NCHRP Report 350, and we believe such vehicles are available. Trinity will provide for FHWA review specific information on the test vehicles proposed.

## Test Articles

The test articles to be used will be standard production ET-PLUS guardrail terminal systems using the current production 4-inch guide channel impact head. All tests will use the standard installation option as defined in the THP ET-PLUS assembly manual (i.e., 50-ft long installation with breakaway wood posts in foundation tubes at post 1 and 2 and CRT posts for posts 3 through 7).<sup>4</sup>

The FHWA has agreed that Trinity will provide the devices to be tested subject to the FHWA's approval of such devices. Trinity understands that it is the FHWA's preference that heads be identified and selected from inventories of State Departments of Transportation, to the extent acceptable heads can be located. To the extent heads are identified from existing inventories, Trinity will inspect the devices at the selected State DOT maintenance yards prior to shipment to SwRI to confirm that the heads (i) were manufactured by Trinity and have not been altered or compromised, (ii) have not been previously removed from the inventory of the State DOT for installation or any other purpose and have not actually been installed or impacted, and (iii) have been properly stored and maintained.

Prior to the tests, each installation will be thoroughly documented. Characteristic dimensions of the impact heads as shown in Exhibit A (which has been designated and marked Business Confidential) will be recorded for each impact head tested. The measurements documenting the pre-crash dimensions will be included in the test report.

Exhibit B (which has been designated and marked Business Confidential) contains the installation drawing for the ET-PLUS guardrail terminal system for the 27-3/4" guardrail height that will be used in the first test series (i.e. – ET27). Exhibit B is a nominal 50' long ET-PLUS guardrail terminal system using 12' 6" guardrail panels mounted to 27-3/4" above the ground, two wood breakaway posts in foundation sleeves without soil plates at posts 1 and 2 and CRT posts at posts 3 through 8. The guardrail line posts will be 6"x8" wood posts with 6"x8" wood blockouts. The total system length will be nominally 156'-3" including the 50' ET-PLUS terminal, 100' of guardrail and a 6'-3" long straight cable anchor. Report 350 suggests 100' of guardrail downstream of the terminal, so this arrangement conforms to the Report 350 guidelines.

Exhibit C (which has been designated and marked Business Confidential) contains the installation drawing for the ET-PLUS guardrail terminal system for the 31" guardrail height that will be used in the second test series (i.e. – ET31). Exhibit C is a nominal 53'-1 1/2" long ET-PLUS guardrail terminal system using 12' 6" guardrail panels mounted to 31" above the ground, two wood breakaway posts in foundation sleeves without soil plates at posts 1 and 2 and CRT posts at posts 3 through 8. The guardrail line posts will be 6"x8" wood posts with 6"x8" wood blockouts. The total system length will be nominally 162'-6" including the 53'-1 1/2" ET-PLUS terminal, 100' of guardrail and a 9'-4 1/2" long straight cable anchor (i.e – the TXDOT Downstream Cable Anchor)<sup>5</sup>. Report 350 suggests 100' of guardrail downstream of the terminal, so this arrangement conforms to the Report 350 guidelines.

---

<sup>4</sup> <http://www.highwayguardrail.com/products/pdfs/65101%20Trinity%20ET%20Plus%20299%20Acr4.pdf>

<sup>5</sup> <ftp://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/roadway/gf31dat14.pdf>

All the dimensions shown on the drawing in Exhibits B and C will be checked, verified and documented prior to the test and the as-built/as-tested dimensions will appear in the test report. An installation checklist is shown in Exhibit D (which has been designated and marked as Business Confidential) and a completed copy of the installation checklist will be included for each test installation in the test report.

Report 350 implies in Section 2.2.1 that for guardrail and guardrail terminal testing a trench should be excavated that is approximately 5 ft deep and 5 ft wide for the entire length of the installation (i.e., 150 ft in these cases). THP proposes to mount the terminal and line posts of the guardrail by using a 2-ft soil auger, setting the posts and then back-filling the soil and compacting it in lifts. This has been the common procedure used by most crash test facilities for many years but it is pointed out here since it is not specifically called out that way in Report 350.

By separate correspondence, Trinity will provide the current ET-Plus weldment assembly details (designated and marked Business Confidential) for your review. These details depict the current assembly instructions for the ET-Plus extruder head.

## **Observers**

We appreciate your confirmation that we will receive a list for our review of FHWA personnel and consultants who will be attending the testing. We support FHWA's suggestion to include, along with FHWA personnel, members of AASHTO, FHWA's independent experts, and State DOT representatives. SwRI has informed us that their testing policies and procedures include, among others, the following: (i) SwRI will not allow anyone except SwRI test personnel to record the testing performed on their campus, (ii) with the exception of those used by SwRI staff to document the testing, no cameras will be allowed at the test site, (iii) anyone observing the testing activities will be restricted to an area within view of but located a safe distance from the testing activities, and (iv) only personnel materially involved in the testing will be allowed in the immediate crash testing area.

FHWA's attendance list will be provided prior to the start of the testing program in order to facilitate communications with attendees regarding test dates and travel arrangements and to assure that the on-site observers are then the same as those listed. THP will notify the observers regarding the final test schedule. Prior to each of the eight tests, notification shall be issued early enough to allow observers to travel to the test site in order to inspect the installation and witness the crash event.

## **Reporting**

The crash test reports will be assembled in accordance with Report 350 Chapter 6 and will contain the complete Report 350 evaluation criteria as well as documentation of the pre- and post-crash test installation. Shortly after each crash test, an initial assessment shall be completed as to whether the test met NCHRP 350 evaluation criteria.

All the individual test reports will be assembled into one of two summary reports; one containing the test reports for the ET27 test series and the other containing the test reports for the ET31 test series as described above. The summary test report, including all the individual crash reports

and results from the first series (i.e., ET27), will be developed immediately following the final test in the series. The summary test report, including all the individual crash reports and results from the second series (i.e., ET31), will be developed immediately after the completion of the final test in this series. SwRI will be responsible for preparing the test reports and performing the evaluations. The summary reports will be transmitted from SwRI to THP, which will then forward them to the FHWA.

Although SwRI will use best efforts in conducting the crash tests to comply with all Report 350 requirements, test outcomes can be affected by the random nature of crash events which are difficult to predict. Examples include poor tracking of crash test vehicles, failure of test equipment, etc. Thus, test outcomes need to be assessed by SwRI before conclusions can be reached.

## **Schedule**

It is the intention of THP and SwRI to perform these crash tests as expeditiously as possible while ensuring a high-level of quality control. Set-up takes time; including test article installation, test vehicle preparation, etc. A minimum of a day is generally required between crash tests to re-set the vehicle towing equipment, reposition cameras, etc. The following is an approximate schedule to offer guidance for this entire 8-test process;

Week 1-2      Ship test materials to SwRI for 27-3/4” ET-PLUS test series  
                  Install test installations for 27-3/4” ET-PLUS test series  
                  Acquire and prepare test vehicles for 27-3/4” ET-PLUS test series  
                  Calibrate the accuracy of the equipment and processes to be undertaken

### **Test Series ET27 -**

Week 3 –      Perform ET27-33  
                  Perform ET27-31  
Week 4      Perform ET27-32  
                  Perform ET27-30  
Week 5      Evaluate test results and prepare test reports for the ET27 test series  
                  Ship test materials to SwRI for 31” ET-PLUS test series  
                  Install test installations for 31” ET-PLUS test series  
Week 6-7     Holidays  
                  Acquire and prepare test vehicles for 31” ET-PLUS test series  
                  Calibrate the accuracy of the equipment and processes to be undertaken

### **Test Series ET31 -**

Week 8      Perform ET31-33  
                  Perform ET31-31  
Week 9      Perform ET31-32  
                  Perform ET31-30  
Week 10     Evaluate test results and prepare test reports for ET31 test series  
Week 11     Deliver the two test report summaries and all photographs and videos to THP to forward to the FHWA.

THP and SwRI will attempt to start the project (i.e., beginning of Week 1 above) during the week of November 17, 2014. Please note, the holiday season will occur in the middle of this project. The first series of tests, however, should be completed and the test reports available by approximately December 19, 2014. The second series of tests will begin as soon as practical after the holidays and the entire project should be completed by the end of January, 2015. This test schedule is ambitious, but THP and SwRI will make every effort to compress the schedule if possible.

***\*\*PROPRIETARY AND CONFIDENTIAL BUSINESS INFORMATION\*\****

**EXHIBIT A: Characteristic Dimensions of the ET-PLUS Impact Head**

***\*\*PROPRIETARY AND CONFIDENTIAL BUSINESS INFORMATION\*\****

**EXHIBIT B: Installation Drawing for the ET-PLUS (ET27 Test Series)**

***\*\*PROPRIETARY AND CONFIDENTIAL BUSINESS INFORMATION\*\****

**EXHIBIT C: Installation Drawing for the ET-PLUS (ET31 Test Series)**

***\*\*PROPRIETARY AND CONFIDENTIAL BUSINESS INFORMATION\*\****

**EXHIBIT D: Installation Checklist**