



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

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

January 10, 2018

HSST-1/ CC-134

Mr. Gerrit A. Dyke  
Lindsay Transportation Solutions, Inc.  
180 River Road  
Rio Vista, CA 94571

Dear Mr. Dyke:

This letter is in response to your February 7, 2017 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number CC-134 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

### **Decision**

The following devices are eligible, with details provided in the form which is attached as an integral part of this letter:

- MAX-Tension™ Guardrail Terminal System (MAX™) TL2

### **Scope of this Letter**

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials' (AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

### **Eligibility for Reimbursement**

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH). Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system: MAX-Tension™ Guardrail Terminal System (MAX™)TL2

Type of system: Crash Cushion

Test Level: MASH Test Level 2

Testing conducted by: Safe Technologies, Inc.

Date of request: February 7, 2017

Date initially acknowledged: February 10, 2017

Date of Final Package: November 21, 2017

FHWA concurs with the recommendation of the accredited crash testing laboratory as stated within the attached form.

### **Full Description of the Eligible Device**

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

### **Notice**

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO's MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.

**Standard Provisions**

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number CC-134 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 upon request.
- This 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.
- If the subject device is a patented product it may be considered to be proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid 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.

Sincerely,



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

Enclosures

## Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

<b>Submitter</b>	Date of Request:	November 21, 2017	<input type="radio"/> New <input checked="" type="radio"/> Resubmission
	Name:	Gerrit A. Dyke, P.E.,	
	Company:	Lindsay Transportation Solutions, Inc.	
	Address:	180 River Road, Rio Vista, CA 94571	
	Country:	USA	
	To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

**Device & Testing Criterion** - Enter from right to left starting with Test Level

!-!-!

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'CC': Crash Cushions, Attenuators, & Terminals	<input checked="" type="radio"/> Physical Crash Testing <input type="radio"/> Engineering Analysis	MAX-Tension TL-2	AASHTO MASH	TL2

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

**Individual or Organization responsible for the product:**

Contact Name:	Gerrit A. Dyke, P.E.,	Same as Submitter <input checked="" type="checkbox"/>
Company Name:	Lindsay Transportation Solutions, Inc.	Same as Submitter <input checked="" type="checkbox"/>
Address:	180 River Road, Rio Vista, CA 94571	Same as Submitter <input checked="" type="checkbox"/>
Country:	USA	Same as Submitter <input checked="" type="checkbox"/>

Enter below all disclosures of financial interests as required by the FHWA 'Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.

Safe Technologies, Inc. (STI) performs testing and analysis services for Lindsay Transportation Solutions, Inc. (LTS). STI is a wholly owned subsidiary of LTS. STI is a fully accredited crash test facility to ISO 17025 by A2LA and is recognized by the US Federal Highway Administration (FHWA) to perform full scale crash tests per NCHRP Report 350 and MASH criteria.

The STI laboratory manager, technicians, and laborers are compensated by LTS for salaries and wages. STI and staff does not receive any incentives, compensation, commissions, or professional fees corresponding to the outcome of any testing or analysis.

STI or staff does not receive any research funding or other research support from LTS. STI and staff also do not have any financial interest in patents, copyrights, or other intellectual property associated with the products they test or analyze.

KARCO Engineering, LLC. was contracted by LTS to collaborate with STI for this testing program. KARCO provided guidance, recommendations, and suggestions for testing and reporting practices. KARCO reviewed test data and reports to ensure accuracy and correct representation of test parameters and results. KARCO nor any KARCO employee has any financial interest in LTS, STI, or the product being tested.



## PRODUCT DESCRIPTION

- New Hardware or Significant Modification
  Modification to Existing Hardware

The MAX-Tension™ Test Level 2 Guardrail Terminal System (MAX-TL2) is a non gating re-directive end terminal for corrugated W-beam barrier systems in tangent configurations. The MAX-TL2 system utilizes tensioned cables, a telescoping panel, and a cutting tooth to absorb the kinetic energy and safely contain or redirect impacting vehicles. The system is comprised of a friction based energy absorbing impact head, two tension cables, a releasable post 1, a ground anchor assembly, and an energy absorbing coupler with integrated cutting tooth used in conjunction with standard AASHTO 12 Ga guardrail panels, posts, blockouts, and hardware. The system length is approximately 14ft 6in [4.4m] and has an effective length of approximately 25.8 ft [7.9m], with the anchor assembly extending forward approximately 4.2 ft [1.3m]. The Length of Need is at Post 1.

The MAX-TL2 can be applied directly to W-Beam guardrail systems at, or transitioned to, 31" rail height with panels and post spacing configured at mid-span splice. Transitions to strong post W-beam guardrail systems or other barriers where the splice is not mid-span can be accomplished using 3ft 1 1/2in [0.95m], 9ft 4 1/2in [2.85m], or 15ft 7 1/2in [4.75m] panels after the MAX-TL2 system (minimum 25.8ft [7.9m] downstream of the first post) in accordance with Federal, State, and local standards. Transitions to other barrier systems such as thrie beam or rigid bridge or roadside barriers shall be in accordance with Federal, State, and local requirements and attached after the MAX-TL2 system (minimum 25.8ft [7.9m] downstream of the first post).

The MAX-TL2 can be applied with a 0 to 2 ft [610mm] offset in accordance with FHWA recommendations and memorandum titled "Guidelines for the Selection of W-Beam Barrier Terminals" dated October 26, 2004.

The MAX-TL2 may be configured using wood or composite blockouts with 8in [200mm] or 12in [305mm] depths. Reference Enclosure A, "MAX-Tension TL-2 System Configurations Justification".

The MAX-TL2 may utilize standard AASHTO 8.5lb/ft or 9lb/ft line posts after post number one. Reference Enclosure A.

The MAX-TL2 may utilize standard 25ft [7.6m] AASHTO M-180 12 Gauge panels after the slider assembly (panel 2 and beyond). Reference Enclosure A.

The MAX-TL2 may be painted, stained, or powder coated on surfaces that do not effect the function of the system in place of or in addition to galvanizing. Reference Enclosure A for details regarding surfaces that may be coated and the components or surfaces that should not.

Any delineation pattern, tape, or decal may be placed on the Delineation Bracket attached to the MAX-TL2 impact head. In addition, several variations of brackets may be utilized with the MAX-TL2. See Enclosure A.

The MAX-TL2 may display identification decals, tags, or stamps for product identification, component tracking and quality control. The identification method and location shall not effect the capacity, function, or performance of the MAX-TL2. Reference Enclosure A.

Two minor modifications to the system components are proposed in Enclosure A. The section titled "Stamped vs. Welded Traffic Side Slider Brackets" details an alternative manufacturing method for the coupler where it is stamped from a single sheet of steel instead of welding two components together. This component may be fabricated in either configuration with no effect on the capacity, function, or performance of the MAX-TL2.

Manufacturing drawings may be adjusted to ensure manufacturing capability and consistency with MASH tested and certified product.

## CRASH TESTING

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash tests are necessary to determine the device meets the MASH criteria.

Engineer Name:	Joseph Nagy	
Engineer Signature:	<b>Joseph Nagy</b>	Digitally signed by Joseph Nagy Date: 2017.11.21 16:14:02 -08'00'
Address:	170 River Road, Rio Vista, CA 94571	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input type="checkbox"/>

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
2-30 (1100C)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-30 for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article first captured and later redirected the 1100C vehicle in a controlled manner. The vehicle did not penetrate, underide, or override the installation. The test article exhibited controlled permanent and dynamic deflection in the test.</p> <p>All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were below the preferred limit of 30.0 ft/s (9.1 m/s). Ridedown accelerations in the longitudinal and lateral directions were well below the preferred limit of 15.0 G. There was no test article debris detached during the test.</p> <p>There was minimal deformation to the occupant compartment of the 1100C test vehicle shown in Table 4. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS

Required Test Number	Narrative Description	Evaluation Results
2-31 (2270P)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-31 for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article captured the 2270P vehicle in a controlled manner. The vehicle did not penetrate, underide, or override the installation. The test article exhibited controlled permanent and dynamic deflection in the test.</p> <p>All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were below the preferred limit of 30.0 ft/s (9.1 m/s). Ridedown accelerations in the longitudinal and lateral directions were below the preferred limit of 15.0 G. There was no test article debris detached during the test.</p> <p>There was no deformation to the occupant compartment of the 2270P test vehicle shown in Table 4. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS



2-32 (1100C)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-32 for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article captured the 1100C vehicle in a controlled manner. The vehicle did not penetrate, underide, or override the installation. The test article exhibited controlled permanent and dynamic deflection in the test. All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were below the maximum limit of 40.0 ft/s (12 m/s). Ridedown accelerations in the longitudinal and lateral directions were below the preferred limit of 15.0 G. There was no test article debris detached during the test.</p> <p>There was minimal deformation to the occupant compartment of the 1100C test vehicle shown in Table 4. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch. The vehicle did not intrude into adjacent lanes.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS
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2-33 (2270P)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-33 for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article captured the 2270P vehicle in a controlled manner. The vehicle did not penetrate, underride, or override the installation. The test article exhibited controlled permanent and dynamic deflection in the test. All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were below the preferred limit of 30.0 ft/s (9.1 m/s). Ridedown accelerations in the longitudinal and lateral directions were well below the preferred limit of 15 G. There was no test article debris detached during the test.</p> <p>There was minimal deformation to the occupant compartment of the 2270P test vehicle shown in Table 4. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS
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2-34 (1100C)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-34 for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article redirected the 1100C vehicle in a controlled manner. The vehicle did not penetrate, underide, or override the installation. The test article exhibited some permanent and dynamic deflection in the test.</p> <p>All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were well below the preferred limit of 30.0 ft/s (9.1 m/s). Ridedown accelerations in the longitudinal and lateral directions were well below the preferred limit of 15.0 G. There was no test article debris detached during the test.</p> <p>There was minimal deformation to the occupant compartment of the 1100C test vehicle shown in Table 4. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch. The vehicle did not intrude into adjacent lanes.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS
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2-35 (2270P)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-35 for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article captured and redirected the 2270P vehicle in a controlled manner. The vehicle did not penetrate, underide, or override the installation. The test article exhibited controlled permanent and dynamic deflection in the test.</p> <p>All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were well below the preferred limit of 30.0 ft/s (9.1 m/s). Ridedown accelerations in the longitudinal and lateral directions were well below the preferred limit of 15 G. There was no test article debris detached during the test.</p> <p>There was no deformation to the occupant compartment of the 2270P test vehicle. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch. The vehicle did not intrude into adjacent lanes.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS
2-36 (2270P)	<p>The MAX-Tension TL-2 is applied only to corrugated W-profile guardrail barrier systems of equal lateral stiffness. Therefore this test is not relevant and was not conducted.</p>	Non-Relevant Test, not conducted

2-37 (2270P)	<p>The MAX-Tension TL-2 was judged to have successfully met all of the evaluation criteria for MASH Test 2-37a for non-gating end terminals.</p> <p>The MAX-Tension TL-2 end terminal satisfied the MASH structural adequacy criteria for its intended function as a non-gating end terminal. The test article redirected the 2270P vehicle in a controlled manner. The vehicle did not gate to the backside of the system. It did not penetrate, underide, or override the installation. The test article exhibited controlled permanent and dynamic deflection in the test.</p> <p>All of the occupant risk criteria were satisfied in testing the MAX-Tension TL-2 end terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were well below the preferred limit of 30.0 ft/s (9.1 m/s). Ridedown accelerations in the longitudinal and lateral directions were well below the preferred limit of 15.0 G. There were some fragments of blockouts detached from the system that landed in the clear zone and did not pose a threat to the occupant compartment, other vehicles, pedestrians or personnel in a work zone.</p> <p>There was minimal deformation to the occupant compartment of the 2270P test vehicle as shown in Table 4. There was no intrusion into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch.</p> <p>The MAX-Tension TL-2 end terminal was judged as satisfying the applicable MASH vehicle trajectory criteria.</p>	PASS
2-38 (1500A)	Calculations performed to demonstrate acceptable occupant risk values per MASH evaluation criteria. Reference Enclosure A, "MAX-Tension TL-2 Configurations Justifications" section titled "1500A Vehicle (MASH Test 2-38)".	PASS
2-40 (1100C)	Not applicable.	Non-Relevant Test, not conducted
2-41 (2270P)	Not applicable.	Non-Relevant Test, not conducted
2-42 (1100C)	Not applicable.	Non-Relevant Test, not conducted
2-43 (2270P)	Not applicable.	Non-Relevant Test, not conducted
2-44 (2270P)	Not applicable.	Non-Relevant Test, not conducted
2-45 (1500A)	Not applicable.	Non-Relevant Test, not conducted

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

Laboratory Name:	Safe Technologies, Inc.	
Laboratory Signature:	<b>Joseph Nagy</b>	Digitally signed by Joseph Nagy Date: 2017.11.21 16:19:12 -08'00'
Address:	170 River Road, Rio Vista, CA 94571	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input type="checkbox"/>
Accreditation Certificate Number and Dates of current Accreditation period :	1851.01, Valid through March 31, 2018	

Submitter Signature\*: **Gerrit Dyke** Digitally signed by Gerrit Dyke  
Date: 2017.11.21 16:19:59 -08'00'

Submit Form

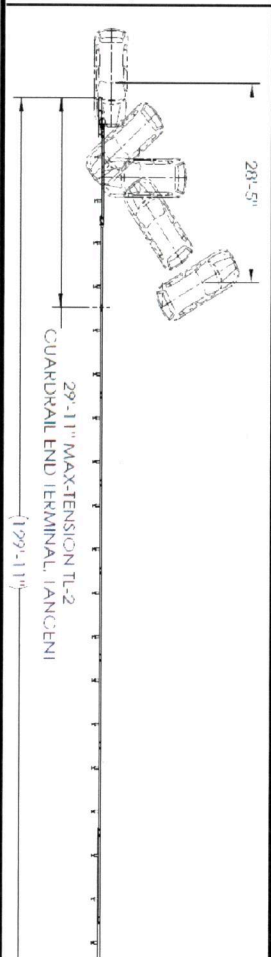
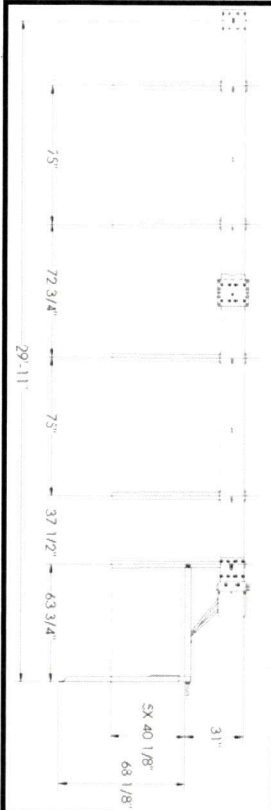
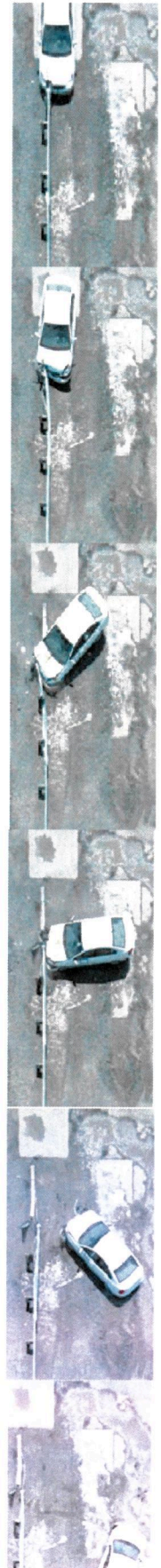
## ATTACHMENTS

Attach to this form:

- 1) Additional disclosures of related financial interest as indicated above.
- 2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
- 3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

**FHWA Official Business Only:**

Eligibility Letter		
Number	Date	Key Words

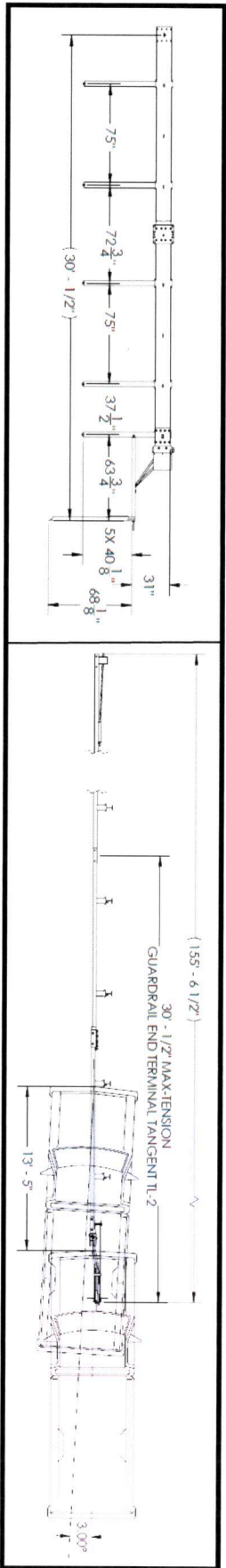
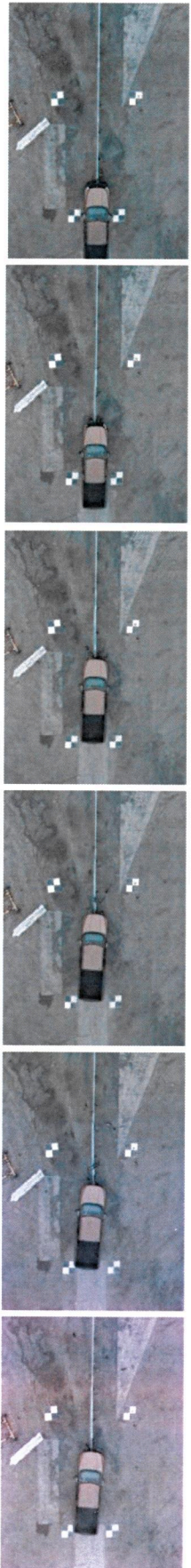


**General Information**

Test Agency: **SAFE TECHNOLOGIES, INC.**  
 Test Number: MET230-C1  
 Test Designation: MASH 2-30  
 Date: 8/22/2017  
 Test Article Name: Lindsay Transportation - Max-Tension TL-2  
 Type: Guardrail End Terminal  
 Installation Length: 129.9 ft (39.6 m)  
 Width: 17.5 in (444.5 mm)  
 Height: 31 in (787 mm)  
 Soil Conditions: AASHTO Grade A/B Soil-Aggregate  
 Type of soil: AASHTO Grade A/B Soil-Aggregate  
 Soil strength: 11,742 lb (52.2 kN)  
 Test Vehicle: 1100C  
 Type / Designation: 2011 Hyundai Accent  
 Make and Model: 2011 Hyundai Accent  
 Curb Weight: 2,462 lb (1,116.5 kg)  
 Test Inertial Weight: 2,448 lb (1,110.5 kg)  
 Gross Static Weight: 2,614 lb (1,185.5 kg)  
 Impact Conditions: Speed: 44.3 mph (71.3 kph)  
 Angle: 0 deg  
 Location / Orientation: 1/4 offset

**Exit Conditions**

Speed (mph): N/A  
 Angle (deg): N/A  
 Post Impact Trajectory: Satisfactory  
 Vehicle Stability: Satisfactory  
 Longitudinal Stopping Distance (CG): 28.4 ft (8.67 m)  
 Vehicle Snagging/Pocketing: N/A  
 Occupant Risk Values  
 Longitudinal OIV: 28.9 ft/s (8.8 m/s)  
 Lateral OIV: 1.31 ft/s (0.4 m/s)  
 Longitudinal ORA: 10 g's  
 Lateral ORA: 3.3 g's  
 THV: 29.2 ft/s (8.9 m/s)  
 PHD: 10.2 g's  
 ASI: 0.96  
 Test Article Damage: Moderate  
 Test Article Deflection  
 Longitudinal system stroke: 5.58 ft (1.70 m)  
 Permanent lateral deflection: 0.23 ft (0.07 m)  
 Dynamic lateral deflection: 1.38 ft (0.42 m)  
 Vehicle Damage  
 VDS: 12-FR-4  
 CDC: 12-FREN3  
 Maximum Interior Deformation: 0.25 in (6.35 mm) - dashboard



**General Information**

Test Agency: SAFE TECHNOLOGIES, INC.  
 Test Number: MET170201  
 Test Designation: MASH 2-31  
 Date: 2/1/2017

**Test Article**

Name: Lindsay Transportation - MAX-Tension, TL-2  
 Type: Guardrail End Terminal  
 Installation Length: 155.5 ft (39.8 m)  
 Width: 17.5 in (444.5mm)  
 Height: 31.0 in (787mm)

**Soil Conditions**

Type of Soil: AASHTO Grade A/B Soil-Aggregate  
 Soil Strength: 14,764.6 lb (65.7 kN)

**Test Vehicle**

Type / Designation: 2270P  
 Make and Model: 2012 Dodge Ram 1500 Quad Cab Pickup  
 Curb Weight: 5029.0 lb (2281.0 kg)  
 Test Inertial Weight: 5002.0 lb (2269.0 kg)  
 Gross Static Weight: 5002.0 lb (2269.0 kg)  
**Impact Conditions**  
 Speed: 41.8 mph (67.3 km/h)  
 Angle: 0 deg  
 Location / Orientation: Front/Center

**Exit Conditions**

Speed (mph): N/A  
 Angle (deg): N/A

**Post Impact Trajectory**

Vehicle Stability: Satisfactory  
 Stopping Distance: 13.4 ft (4.1 m)  
 Vehicle Snagging/Pocketing: N/A (see Figure 6)

**Occupant risk Values**

Longitudinal OIV: 23.3 ft/s (7.1 m/s)  
 Lateral OIV: 0.7 ft/s (0.2 m/s)  
 Longitudinal ORA: 7.4 g/s  
 Lateral ORA: 1.5 g/s  
 THIV: 23.3 ft/s (7.1 m/s)  
 PHD: 7.4 g/s

ASI: 0.55

**Test Article Damage:** Moderate

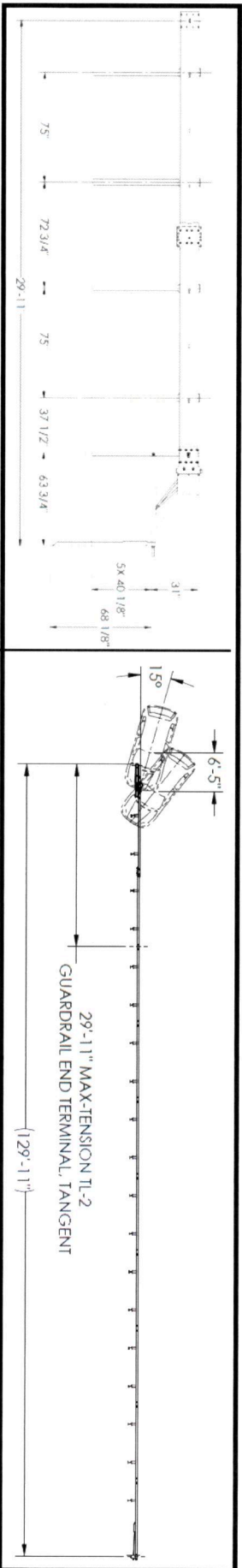
**Test Article Deflections**

Longitudinal system stroke: 10.5 ft (3.2 m)  
 Permanent lateral deflection: 0.43 ft (0.13 m)  
 Dynamic lateral deflection: 0.49 ft (0.15 m)

**Vehicle Damage**

VDS: 12-FC-5  
 CDC: 12FCEN2  
 Maximum Deformation: No interior damage



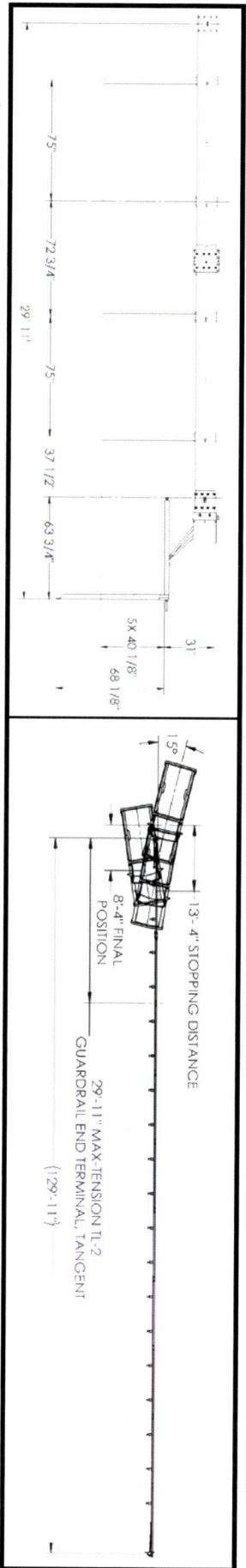
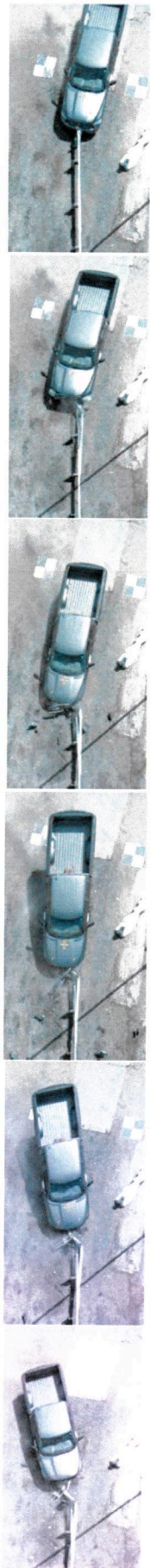


**General Information**

Test Agency..... **SAFE TECHNOLOGIES, INC.**  
 Test Number..... MET232-C1  
 Test Designation..... MASH 2-32  
 Date..... 8/15/2017  
 Test Article Name..... Lindsay Transportation - Max-Tension TL-2  
 Type..... Guardrail End Terminal  
 Installation Length..... 129.9 ft (39.6 m)  
 Width..... 17.5 in (444 mm)  
 Height..... 31.0 in (787 mm)  
**Soil Conditions**  
 Type of soil..... AASHTO Grade A/B Soil-Aggregate  
 Soil strength..... 13,465 lb (59.9 kN)  
**Test Vehicle**  
 Type / Designation..... 1100C  
 Make and Model..... 2011 Kia Rio  
 Curb Weight..... 2,434 lb (1,104 kg)  
 Test Inertial Weight..... 2,449 lb (1,111 kg)  
 Gross Static Weight..... 2,615 lb (1,186 kg)  
**Impact Conditions**  
 Speed..... 43.9 mph (70.6 kph)  
 Angle..... 15.0 deg  
 Location / Orientation..... Front/Center

**Exit Conditions**

Speed (mph)..... N/A  
 Angle (deg)..... N/A  
**Post Impact Trajectory**  
 Vehicle Stability..... Satisfactory  
 Longitudinal Stopping Distance (CG)..... 6.40 ft (1.95 m)  
 Vehicle Snagging/Pocketing..... N/A  
**Occupant Risk Values**  
 Longitudinal OIV..... 31.5 ft/s (9.6 m/s)  
 Lateral OIV..... 0.98 ft/s (0.3 m/s)  
 Longitudinal ORA..... 11.2 g's  
 Lateral ORA..... 2.5 g's  
 THIV..... 31.5 ft/s (9.6 m/s)  
 PHD..... 11.2 g's  
 ASI..... 1.01  
**Test Article Damage:**..... Moderate  
**Test Article Deflection**  
 Longitudinal system stroke..... 4.93 ft (1.50 m)  
 Permanent lateral deflection..... 1.51 ft (0.46 m)  
 Dynamic lateral deflection..... 2.59 ft (0.79 m)  
**Vehicle Damage**  
 VDS..... 12-FC-4  
 CDC..... 12FDEW2  
 Maximum Interior Deformation..... 1.13 in (28.6 mm) - ceiling



**General Information**

Test Agency.....SAFE TECHNOLOGIES, INC.  
 Test Number.....MET233-C1  
 Test Designation.....MASH 2-33  
 Date.....8/14/2017

**Test Article**  
 Name.....Lindsay Transportation - Max-Tension TL-2  
 Type.....Guardrail End Terminal  
 Installation Length.....129.9 ft (39.6 m)  
 Width.....17.5 in (444.5 mm)  
 Height.....31 in (787 mm)

**Soil Conditions**  
 Type of soil.....AASHTO Grade A/B Soil-Aggregate  
 Soil strength.....13,234 lb (58.9 kN)

**Test Vehicle**  
 Type / Designation.....2270P  
 Make and Model.....2012 Dodge Ram 1500  
 Curb Weight.....4,900 lb (2,222.5 kg)  
 Test Inertial Weight.....5,005 lb (2,270 kg)  
 Gross Static Weight.....5,005 lb (2,270 kg)

**Impact Conditions**  
 Speed.....42.6 mph (68.6 kph)  
 Angle.....15 deg  
 Location / Orientation.....Front/Center

**Exit Conditions**

Speed (mph).....N/A  
 Angle (deg).....N/A

**Post Impact Trajectory**  
 Vehicle Stability.....Satisfactory  
 Longitudinal Stopping Distance (CG).....13.3 ft (4.05 m)  
 Vehicle Snagging/Pocketing.....N/A

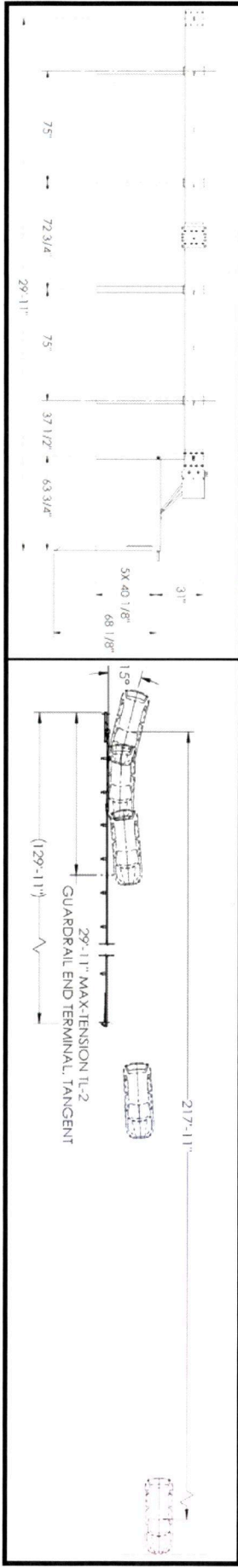
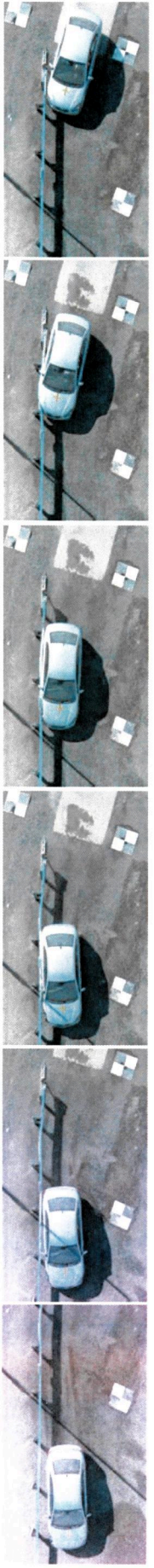
**Occupant risk Values**  
 Longitudinal OIV.....24.9 ft/s (7.6 m/s)  
 Lateral OIV.....1.31 ft/s (0.4 m/s)  
 Longitudinal ORA.....8.9 gs  
 Lateral ORA.....1.9 gs

THIV.....24.9 ft/s (7.6 m/s)  
 PHD.....9.0 gs  
 ASI.....0.70

**Test Article Damage:** Substantial

**Test Article Deflection**  
 Longitudinal system stroke.....6.23 ft (1.90 m)  
 Permanent lateral deflection.....0.76 ft (0.23 m)  
 Dynamic lateral deflection.....1.77 ft (0.54 m)

**Vehicle Damage**  
 VDS.....12-FC-3  
 CDC.....12FC-2  
 Maximum Interior Deformation.....0.44 in (11.1 mm) - floor pan



**General Information**

Test Agency: SAFE TECHNOLOGIES, INC.  
 Test Number: MET234-C1  
 Test Designation: MASH 2-34  
 Date: 8/24/2017  
 Test Article Name: Lindsay Transportation - Max-Tension TL-2  
 Type: Guardrail End Terminal  
 Installation Length: 129.9 ft (39.6 m)  
 Width: 17.5 in (445 mm)  
 Height: 31.0 in (787 mm)  
 Soil Conditions: AASHTO Grade A/B Soil-Aggregate  
 Type of soil: AASHTO Grade A/B Soil-Aggregate  
 Soil strength: 9,636 lb (42.9 kN)  
 Test Vehicle Type / Designation: 1100C  
 Make and Model: 2011 Kia Rio  
 Curb Weight: 2,438.3 lb (1,106.0 kg)  
 Test Inertial Weight: 2,449.3 lb (1,111.0 kg)  
 Gross Static Weight: 2,614.7 lb (1,186.0 kg)  
 Impact Conditions: Speed: 43.8 mph (70.5 kph)  
 Angle: 15.0 deg  
 Location / Orientation: 1.77 ft (0.54 m) downstream from post 1

**Exit Conditions**

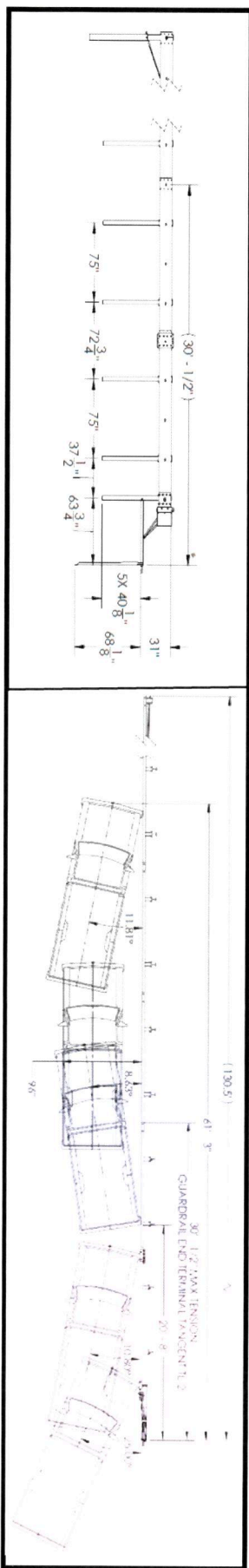
Speed: 35.9 mph (57.8 kph)  
 Angle: 4.8 degrees

**Post Impact Trajectory**

Vehicle Stability: Satisfactory  
 Longitudinal Stopping Distance (CG): Approximately 218 ft (66.4 m), stopped by containment barrier

**Occupant risk Values**

Vehicle Snagging/Pocketing: N/A  
 Longitudinal OIV: 8.2 ft/s (2.5 m/s)  
 Lateral OIV: 15.1 ft/s (4.6 m/s)  
 Longitudinal ORA: 2.7 gs  
 Lateral ORA: 3.7 gs  
 THIV: 17.1 ft/s (5.2 m/s)  
 PHD: 4.6 gs  
 ASI: 0.54  
 Test Article Damage: Minimal  
 Test Article Deflection: N/A  
 Longitudinal system stroke: 0.35 ft (0.11 m)  
 Permanent lateral deflection: 0.52 ft (0.16 m)  
 Dynamic lateral deflection: 0.52 ft (0.16 m)  
 Vehicle Damage: VDS: 1-RFQ-1  
 CDC: 01RFEN1  
 Maximum Interior Deformation: 0.88 in (22.2 mm) - dashboard



**General Information**

Test Agency: SAFE TECHNOLOGIES, INC.

Test Number: MET170224

Test Designation: MASH 2-35

Date: 2/24/2017

Test Article Name: Lindsay Transportation - Max-Tension TL-2

Type: Guardrail End Terminal

Installation Length: 129.9 ft (39.6 m)

Width: 17.5 in (444.5 mm)

Height: 31 in (787 mm)

**Soil Conditions**

Type of soil: AASHTO Grade A/B Soil-Aggregate

Soil strength: 15,708 lb (69.9 kN)

**Test Vehicle**

Type / Designation: 2270P

Make and Model: 2011 Dodge Ram 1500 Quad Cab Pickup

Curb Weight: 4,986.0 lb (2,261.5 kg)

Test Inertial Weight: 5,019.0 lb (2,276.5 kg)

Gross Static Weight: 5,019.0 lb (2,276.5 kg)

**Impact Conditions**

Speed: 42.5 mph (68.4 kph)

Angle: 25.0 deg

Location / Orientation: BLON, Post 1

**Exit Conditions**

Speed: 15.6 mph (25.1 kph)

Angle: 8.6 degrees

**Post Impact Trajectory**

Vehicle Stability: Satisfactory

Stopping Distance: 58.25 ft (17.75 m)

Vehicle Snagging/Pocketing: Minimal

**Occupant risk Values**

Longitudinal OIV: 11.5 ft/s (3.5 m/s)

Lateral OIV: 13.8 ft/s (4.2 m/s)

Longitudinal ORA: 8.0 g/s

Lateral ORA: 6.4 g/s

THV: 17.4 ft/s (5.3 m/s)

PHD: 9.0 g/s

ASI: 0.57

Test Article Damage: Substantial

**Test Article Deflections**

Longitudinal system stroke: N/A

Permanent: 1.08 ft (0.33 m)

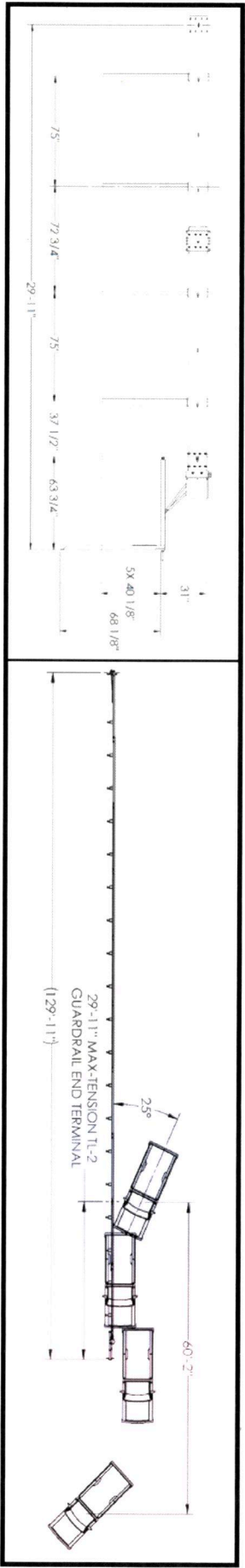
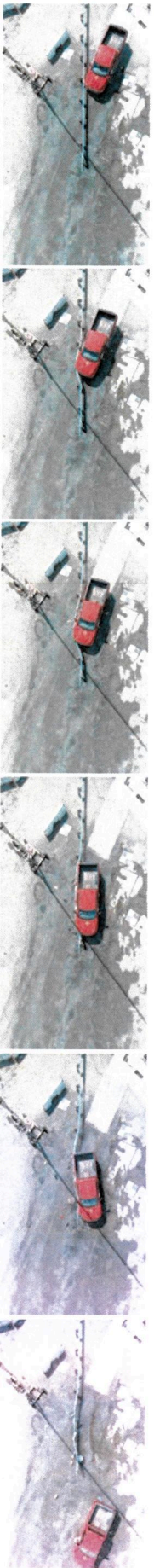
Dynamic: 1.44 ft (0.44 m)

**Vehicle Damage**

VDS: 1-RFQ-4

CDC: 01FREAA

Maximum Deformation: No interior damage



**General Information**

Test Agency: SAFE TECHNOLOGIES, INC.  
 Test Number: MET237a-C1  
 Test Designation: MASH 2-37a  
 Date: 8/18/2017  
 Test Article Name: Lindsay Transportation - Max-Tension TL-2  
 Type: Guardrail End Terminal  
 Installation Length: 129.9 ft (39.6 m)  
 Width: 17.5 in (444.5 mm)  
 Height: 31.0 in (787.4 mm)  
 Soil Conditions: AASHTO Grade A/B Soil-Aggregate  
 Type of soil: 16,037 lb (71.3 kN)  
 Soil strength: 16,037 lb (71.3 kN)  
 Test Vehicle Type / Designation: 2270P  
 Make and Model: 2011 Dodge Ram 1500  
 Curb Weight: 4,768 lb (2,162.5 kg)  
 Test Inertial Weight: 5,006 lb (2,270.5 kg)  
 Gross Static Weight: 5,006 lb (2,270.5 kg)  
 Impact Conditions: 42.7 mph (68.7 kph)  
 Speed: 42.7 mph (68.7 kph)  
 Angle: 25.0 deg  
 Location / Orientation: 19.7 ft (6.00 m) from post 1

**Exit Conditions**

Speed (mph): 19.0 mph (30.6 kph)  
 Angle (deg): 9.5 degrees

**Post Impact Trajectory**

Vehicle Stability: Satisfactory  
 Longitudinal Stopping Distance (CG): 60.2 ft (18.3 m)  
 Vehicle Snagging/Pocketing: Minimal

**Occupant risk Values**

Longitudinal OIV: 16.4 ft/s (5.0 m/s)  
 Lateral OIV: 12.1 ft/s (3.7 m/s)  
 Longitudinal ORA: 9.4 gs  
 Lateral ORA: 7.5 gs  
 THIV: 19.4 ft/s (5.9 m/s)  
 PHD: 11.9 gs  
 ASI: 0.52

**Test Article Damage:**

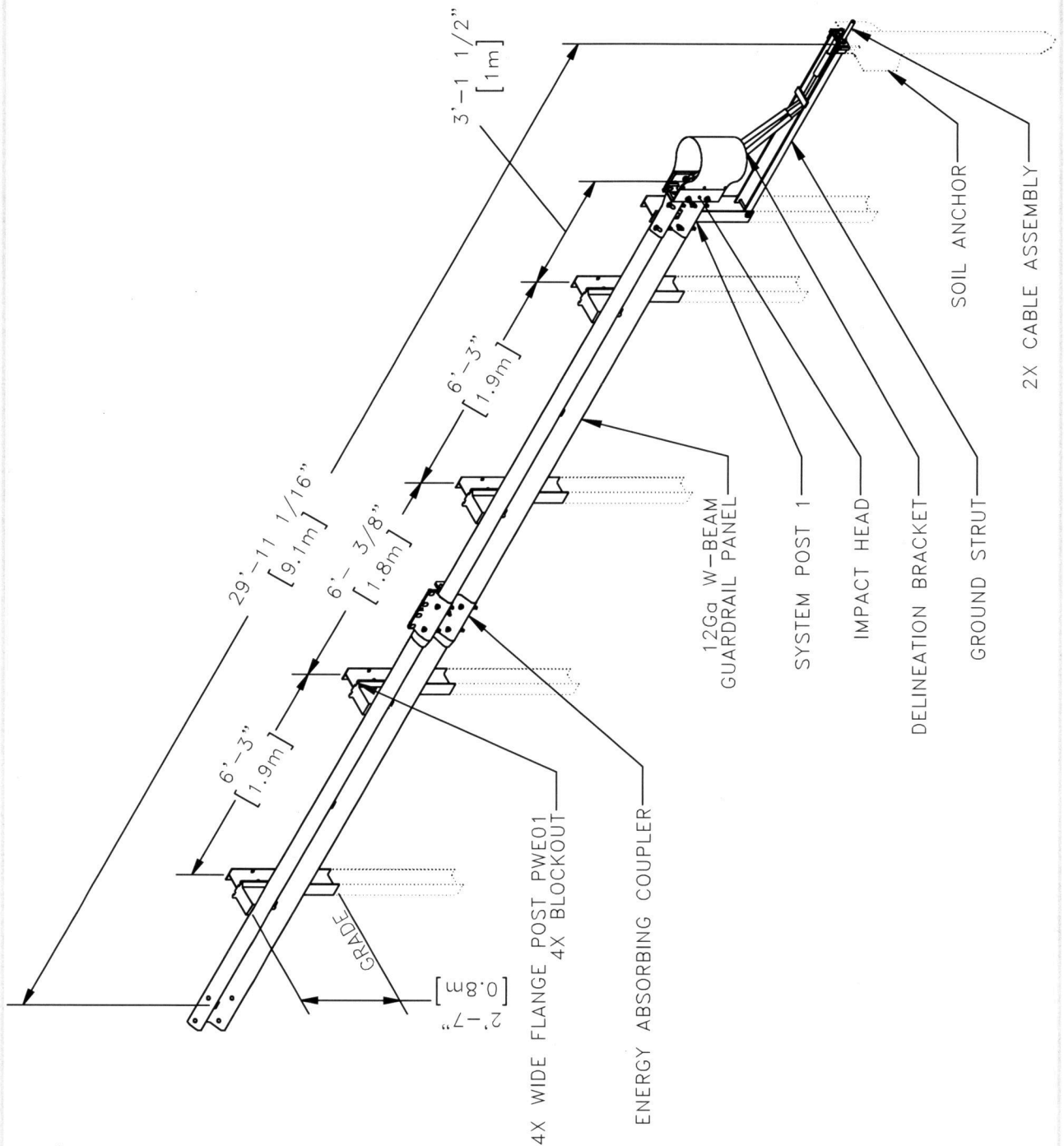
Substantial

**Test Article Deflection**

Longitudinal system stroke: N/A  
 Permanent lateral deflection: 1.18 ft (0.36 m)  
 Dynamic lateral deflection: 2.16 ft (0.66 m)

**Vehicle Damage**

VDS: 1-RFQ-3  
 CDC: 01REFW1  
 Maximum Interior Deformation: 0.88 in (22.2 mm) - floor pan



MAX-TENSION TL-2 GUARDRAIL END TERMINAL, TANGENT



Lindsay Transportation Solutions, 180 River Rd., Rio Vista CA. 94571, 888-800-3691  
[www.theroadzipper.com](http://www.theroadzipper.com)

SHEET NO.  
1 OF 2

DATE:

## INTENDED USE

The MAX-Tension™ TL-2 Guardrail End Terminal (MAX-Tension TL-2) is a re-directive, non-gating tension-based end terminal for corrugated W-Beam barrier systems in tangent configurations. It can be used to protect motorists from unforgiving terminations of longitudinal barriers. The MAX-Tension TL-2 system absorbs the energy and gradually decelerates an impacting vehicle when impacted head-on and contains and redirects a vehicle during side impacts. The BLON is at post 1. The MAX-Tension TL-2 system integrates directly into a corrugated W-Beam guardrail system.

The system consists of an impact head, energy absorbing coupler, two tension cables, soil anchor and ground strut, in addition to standard guardrail components such as posts, blockouts, and rails. The system can be installed on any guardrail system transitioned to a rail height of 31" [787] with mid-span splices. Contact the manufacturer for further information and installation instructions.

The MAX-Tension TL-2 can be applied in the following configurations:

- 8" or 12" blockouts, wood or composite
- Standard AASHTO line post can be 8.5 or 9 lb/ft
- Two standard AASHTO 12 Ga. 12'-6" 4-Space W-beam or one AASHTO 12 Ga. 12'-6" 4-Space W-beam and one 25'-0" 4-Space W-beam
- Transition to 27 1/2" downstream guardrail with or without mid-span splice
- Transition directly to thrie-beam or other bridge rail transition
- Up to 2 ft. offset

## APPROVALS

The MAX-Tension TL-2 Tangent system has been fully tested in conformance with MASH Test Level 2 and is eligible for Federal reimbursement.

FHWA Eligibility Letters: XXXXXXXX

## CONTACT INFORMATION

Lindsay Transportation Solutions  
180 River Rd.  
Rio Vista, CA 94571  
www.barriersystemsinc.com  
Phone: 888-800-3691 or 707-374-6800  
Fax: 707-374-6801  
Email: info@barriersystemsinc.com

## MAX-TENSION TL-2 GUARDRAIL END TERMINAL, TANGENT

SHEET NO.

DATE:

2 OF 2



Lindsay Transportation Solutions, 180 River Rd., Rio Vista CA. 94571, 888-800-3691  
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