Dear Mr. Dyke:

This letter is in response to your November 9, 2018 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-133A 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™) MASH16

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™) MASH16  
**Type of system:** Terminal  
**Test Level:** AASHTO MASH Test Level 3  
**Testing conducted by:** Safe Technologies, Inc.  
**Date of request:** October 30, 2018  
**Date initially acknowledged:** November 1, 2018  
**Date of completed package:** November 9, 2018

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 and will need to be tested in accordance with all recommended tests in AASHTO’s MASH as part of a new and separate submittal.

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**
Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number CC-133A 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.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

- 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

Date of Request: November 09, 2018
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

<table>
<thead>
<tr>
<th>System Type</th>
<th>Submission Type</th>
<th>Device Name / Variant</th>
<th>Testing Criterion</th>
<th>Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>'CC': Crash Cushions, Attenuators, &amp; Terminals</td>
<td>☑ Physical Crash Testing</td>
<td>MAX-Tension</td>
<td>AASHTO MASH</td>
<td>TL3</td>
</tr>
</tbody>
</table>

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:**

<table>
<thead>
<tr>
<th>Contact Name:</th>
<th>Gerrit A. Dyke, P.E.</th>
<th>Same as Submitter</th>
<th>☒</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Name:</td>
<td>Lindsay Transportation Solutions, Inc.</td>
<td>Same as Submitter</td>
<td>☒</td>
</tr>
<tr>
<td>Address:</td>
<td>180 River Road, Rio Vista, CA 94571</td>
<td>Same as Submitter</td>
<td>☒</td>
</tr>
<tr>
<td>Country:</td>
<td>USA</td>
<td>Same as Submitter</td>
<td>☒</td>
</tr>
</tbody>
</table>

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 per A2LA 17025 and 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. The STI staff does not receive any incentive, 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 perform testing or analysis on.

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 testing facility employee has any financial interest in LTS, STI, or the product being tested.
PRODUCT DESCRIPTION

New Hardware or Significant Modification

The MAX-Tension™ Guardrail Terminal System (MAX™) is a re-directive gating end terminal for corrugated W-beam barrier systems in tangent configurations. The MAX system utilizes tensioned cables, telescoping panels, 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 Gauge guardrail panels, posts, blockouts, and hardware. The system length is approximately 27 ft [8.2m] and has an effective length of approximately 50 ft [15.25m], with the anchor assembly extending forward approximately 4 ft [1.2m]. The Length of Need is at Post 3, 9 ft 4 in [2.86m] downstream of the first post.

The MAX 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 1/2 in [0.95m], 9ft 4 1/2 in [2.85m], or 15ft 7 1/2 in [4.75m] panels after the MAX system (minimum 50ft [15.25m] 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 system (minimum 50ft [15.25m] downstream of the first post).

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

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

The MAX may utilize standard AASHTO M-180 12 Gauge panels in 12ft -6in [3.8m] or 25ft [7.6m] lengths within the system. Reference Enclosure A.

The MAX 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 impact head. In addition, several variations of brackets may be utilized with the MAX. Reference Enclosure A.

The MAX 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. 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. The section titled “Soil Anchor Modification” details a reduction in length of stiffeners intended to support the post during installation. These components may be fabricated in either configurations with no effect on the capacity, function, or performance of the MAX.

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: Joseph Nagy

Address: 170 River Road, Rio Vista, CA 94571

Country: USA

Digitally signed by Joseph Nagy

Date: 2018.11.09 16:06:53 -08'00'
A brief description of each crash test and its result:

<table>
<thead>
<tr>
<th>Required Test Number</th>
<th>Narrative Description</th>
<th>Evaluation Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-30 (1100C)</td>
<td>This testing as per eligibility letter CC-133 dated June 15, 2017. The MAX-Tension End Terminal satisfied the MASH structural adequacy criteria for its intended function as an end terminal. The test article first captured and later redirected the 1100C 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 End Terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were well below the preferred limit of 30.0 ft/s (9.6 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. There was no deformation to the occupant compartment of the 1100C test vehicle. There were no intrusions into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll, pitch and yaw. The MAX-Tension End Terminal was judged as satisfying the applicable MASH vehicle trajectory criteria. The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-30.</td>
<td>PASS</td>
</tr>
<tr>
<td>Required Test Number</td>
<td>Narrative Description</td>
<td>Evaluation Results</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>3-31 (2270P)</td>
<td>This testing as per eligibility letter CC-133 dated June 15, 2017. Test MET015 and Test MET170105: The MAX-Tension End Terminal satisfied the MASH structural adequacy criteria for its intended function as an End Terminal in both tests. The test article captured the 2270P vehicles in a controlled manner. The vehicles did not penetrate, underride, or override the installation. The test articles exhibited controlled permanent and dynamic deflection in each test. All of the occupant risk criteria were satisfied in both tests. Theoretical occupant impact velocities in the longitudinal and lateral directions were all 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 tests. There was no deformation to the occupant compartments of the 2270P test vehicles. There were no intrusions into the occupant compartments. The test vehicles remained upright during and after the collision with minor roll, pitch and yaw. The vehicle did not intrude into adjacent lanes. The MAX-Tension End Terminal was judged as satisfying the applicable MASH vehicle trajectory criteria in both tests. The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-31 in each test.</td>
<td>PASS</td>
</tr>
<tr>
<td>3-32 (1100C)</td>
<td>This testing as per eligibility letter CC-133 dated June 15, 2017. The MAX-Tension End Terminal satisfied the MASH structural adequacy criteria for its intended function as an End Terminal. The test article captured the 1100C 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 End Terminal. Theoretical occupant impact velocities in the longitudinal and lateral directions were well below the maximum limit of 40.0 ft/s (12 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. There was no deformation to the occupant compartment of the 1100C test vehicle. There were no intrusions into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll, pitch and yaw. The MAX-Tension End Terminal was judged as satisfying the applicable MASH vehicle trajectory criteria. The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-32.</td>
<td></td>
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<td>---</td>
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<td></td>
</tr>
</tbody>
</table>
This testing as per eligibility letter CC-133 dated June 15, 2017.

The MAX-Tension End Terminal satisfied the MASH structural adequacy criteria for its intended function as an End Terminal. The test article captured the 2270P vehicle in a controlled manner and brought the vehicle to a safe and stop. The vehicle did not gate to the backside of the system. 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. 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. There was no deformation to the occupant compartment of the 2270P test vehicle. There were no intrusions into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll, pitch and yaw. The vehicle did not intrude into adjacent lanes. The MAX-Tension End Terminal was judged as satisfying the applicable MASH vehicle trajectory criteria. The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-33.
This testing as per eligibility letter CC-133 dated June 15, 2017.

The MAX-Tension End Terminal satisfied the MASH structural adequacy criteria for its intended function as an End Terminal. The test article redirected the 1100C vehicle in a controlled manner. The vehicle did not penetrate, underride, or override the installation. The test article exhibited some permanent and dynamic deflection in the test.

All of the occupant risk criteria were satisfied. 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. There was no deformation to the occupant compartment of the 1100C test vehicle. There were no intrusions into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll, pitch and yaw.

The MAX-Tension End Terminal was judged as satisfying the applicable vehicle trajectory criteria in MASH. There was no vehicle intrusion into adjacent lanes. The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-34.
| 3-35 (2270P) | This testing as per eligibility letter CC-133 dated June 15, 2017. The MAX-Tension End Terminal satisfied the MASH structural adequacy criteria for its intended function as an End Terminal. The test article contained the 2270P vehicle in a controlled manner and brought the vehicle to a safe and controlled stop. The vehicle did not penetrate, underride, override or gate the installation. The test article exhibited some permanent and dynamic deflection in the test. All of the occupant risk criteria were satisfied in testing the MAX-Tension 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. There was no deformation to the occupant compartment of the 2270P test vehicle. There were no intrusions into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll, pitch and yaw. The MAX-Tension End Terminal was judged as satisfying the applicable vehicle trajectory criteria in MASH. There was no vehicle intrusion into adjacent lanes. The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-35. **PASS** |
| 3-36 (2270P) | The MAX-Tension is applied only to corrugated W-profile guardrail barrier systems of equal lateral stiffness. Therefore this test is not relevant and was not conducted. **Non-Relevant Test, not conducted** |
The MAX-Tension end terminal satisfied the TL-3 MASH structural adequacy criteria for its intended function as a gating end terminal. The test article gated and partially redirected the 1100C vehicle in a controlled manner. 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 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.

There was some deformation to the passenger side toe pan area of the 1100C test vehicle but the deformation was within acceptable limits. There were no intrusions into the occupant compartment. The test vehicle remained upright during and after the collision with minor roll and pitch.

The MAX-Tension End Terminal was judged as satisfying the applicable vehicle trajectory criteria in MASH.

The Terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-37b.

Additional testing, MASH Test 3-37a was also performed as per eligibility letter CC-133 dated June 15, 2017. The terminal was judged to have successfully met all of the evaluation criteria for MASH Test 3-37a.

These calculations as per eligibility letter CC-133 dated June 15, 2017.

Calculations performed to demonstrate acceptable occupant risk values per MASH evaluation criteria. Reference Enclosure A, "MAX-Tension System Configurations Justification" section titled "1500A Vehicle Mathematical Simulation".

<table>
<thead>
<tr>
<th>Test Code</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-37b (1100C)</td>
<td>PASS</td>
</tr>
<tr>
<td>3-38 (1500A)</td>
<td>PASS</td>
</tr>
<tr>
<td>3-40 (1100C)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>3-41 (2270P)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>3-42 (1100C)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>3-43 (2270P)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>3-44 (2270P)</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>3-45 (1500A)</td>
<td>Not applicable.</td>
</tr>
</tbody>
</table>
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): 

<table>
<thead>
<tr>
<th>Laboratory Name:</th>
<th>Safe Technologies Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory Signature:</td>
<td>Joseph Nagy</td>
</tr>
<tr>
<td>Digitally signed by Joseph Nagy</td>
<td></td>
</tr>
<tr>
<td>Date: 2018.11.09 16:18:20 -08'00'</td>
<td></td>
</tr>
<tr>
<td>Address:</td>
<td>170 River Road, Rio Vista, CA 94571</td>
</tr>
<tr>
<td>Country:</td>
<td>USA</td>
</tr>
<tr>
<td>Accreditation Certificate Number and Dates of current Accreditation period:</td>
<td>1851.01, Valid through March 31, 2020</td>
</tr>
</tbody>
</table>

Submitter Signature*: Gerrit Dyke Digitally signed by Gerrit Dyke Date: 2018.11.09 16:18:55 -08'00' 

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:

<table>
<thead>
<tr>
<th>Eligibility Letter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
</tr>
<tr>
<td>-------</td>
</tr>
</tbody>
</table>
### General Information
- **Test Agency**: SAFE TECHNOLOGIES, INC.
- **Test Number**: MET161228
- **Test Designation**: MASH 3-30
- **Date**: 12/28/2016

### Test Article
- **Name**: Lindsay Transportation - MaX-Tension
- **Type**: Guardrail End Terminal
- **Installation Length**: 155.1 ft (47.3m)
- **Width**: 17.4 in (441.3mm)
- **Height**: 31 in (787mm)

### Soil Conditions
- **Type of Soil**: AASHTO Grade A/B Soil-Aggregate
- **Soil strength**: 12,933 lbs

### Test Vehicle
- **Type / Designation**: 1100C
- **Make and Model**: 2011 Kia Rio, 4-Door
- **Curb Weight**: 2463.7 lbs (1117.5 kg)
- **Test Inertial Weight**: 2280.7 lbs (1034.5 kg)
- **Gross Static Weight**: 2446.0 lbs (1109.5 kg)

### Impact Conditions
- **Speed**: 61.7 mph (99.3 km/h)
- **Angle**: 0 deg
- **Location / Orientation**: 1/4 Offset

### Exit Conditions
- **Speed (mph)**: 21.4 (34.5 km/h)
- **Angle (deg)**: 31

### Post Impact Trajectory
- **Vehicle Stability**: Satisfactory
- **Stopping Distance, ft (m)**: 41 (12.5) downstr and 28.2 (8.6) to the left

### Occupant risk Values
- **Longitudinal OIV**: 31.5 ft/s (9.6 m/s)
- **Lateral OIV**: 3.9 ft/s (1.2 m/s)
- **Longitudinal ORA**: 11.2 g's
- **Lateral ORA**: 5.8 g's
- **THIV**: 31.8 ft/s (9.7 m/s)
- **PHD**: 12.5 g's
- **ASI**: 1.22

### Test Article Damage
- **Substantial

### Test Article Deflections
- **Permanent**: 10.6 in (0.27 m) front
- **Dynamic**: 7.5 in (0.19 m) rear

### Vehicle Damage
- **VDS**: 12-FR-5
- **CDC**: 12FREN3
- **Interior Deformation**: No interior damage
General Information
Test Agency: SAFE TECHNOLOGIES, INC.
Test Number: MET015
Test Designation: MASH 3-31
Date: 11/22/2016

Test Article
Name: Lindsay Transportation - MAX-Tension Guardrail End Terminal
Installation Length: 155.1 ft (47.3m)
Width: 17.4 in (441.3mm)
Height: 31 in (787mm)

Soil Conditions
Type of soil: AASHTO Grade A/B Soil-Aggregate
Soil strength: 12,380 lbs

Test Vehicle
Type / Designation: 2270P
Make and Model: 2010 Dodge Ram 1500
Curb Weight: 4935.0 lbs (2238.5 kg)
Test Inertial Weight: 5002.3 lbs (2269.0 kg)
Gross Static Weight: 5002.3 lbs (2269.0 kg)

Impact Conditions
Speed: 61.7 mph (99.3 kph)
Angle: 0.0 deg
Location / Orientation: Front/Center

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

Post Impact Trajectory
Vehicle Stability: Satisfactory
Stopping Distance: 26.6 ft (8.1m)
Vehicle Snagging/Pocketing: Captured (See Figure 6)

Occupant risk Values
Longitudinal OIV: 25.3 ft/s (7.7 m/s)
Lateral OIV: 0.3 ft/s (0.1 m/s)
Longitudinal ORA: 7.6 g's
Lateral ORA: 2.6 g's
THIV: 25.3 ft/s (7.7 m/s)
PHD: 7.6 g's
ASI: 0.78

Test Article Damage: Substantial

Test Article Deflections
Longitudinal system stroke: 22.6 ft (6.9 m)
Permanent lateral deflection: 0.39 ft (0.12m)
Dynamic lateral deflection: 1.21 ft (0.37m)

Vehicle Damage
VDS: 12-FC-5
CDC: 12FCEN2
Maximum Deformation: No interior damage
General Information
Test Agency ............................................ SAFE TECHNOLOGIES, INC.
Test Number ........................................... MET170105
Test Designation ......................................... MASH 3-31
Date ......................................................... 1/5/2017

Test Article
Name ........................................................ Lindsay Transportation - MAX-Tension
Type ........................................................ Guardrail End Terminal
Installation Length ........................................ 155.1 ft (47.3m)
Width ....................................................... 17.4 in (441.3mm)
Height ....................................................... 31 in (787mm)

Soil Conditions
Type of soil ................................................. AASHTO Grade A/B Soil-Aggregate
Soil strength .............................................. 13,767 lbs

Test Vehicle
Type / Designation ........................................ 2270P
Make and Model ........................................ 2012 Dodge Ram 1500 Quad Cab Pickup
Curb Weight ............................................. 4790.6 lbs (2173.0 kg)
Test Inertial Weight .................................... 5022.1 lbs (2278.0 kg)
Gross Static Weight .................................... 5022.1 lbs (2278.0 kg)

Impact Conditions
Speed ...................................................... 62.6 mph (100.7 km/h)
Angle ...................................................... 0.0 deg
Location / Orientation .................................. Front/Center

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

Post Impact Trajectory
Vehicle Stability ......................................... Satisfactory
Stopping Distance ....................................... 22.8 ft (7.0 m)
Vehicle Snagging/Pocketing .................................. Captured

Occupant risk Values
Longitudinal OIV ........................................... 24.3 ft/s (7.4 m/s)
Lateral OIV ............................................... 1.6 ft/s (0.5 m/s)
Longitudinal ORA ......................................... 9.4 g's
Lateral ORA ............................................... 2.4 g's
THIV ....................................................... 24.3 ft/s (7.4 m/s)
PHD ......................................................... 9.9 g's
ASI ......................................................... 0.82

Test Article Damage ........................................ Substantial

Test Article Deflections
Permanent lateral deflection ................................ 2.38 ft (0.73 m)
Longitudinal system stroke ................................ 20.8 ft (6.3 m)

Vehicle Damage
VDS ......................................................... 12-FC-5
CDC ......................................................... 12FCEN2
Maximum Deformation .................................. No interior damage
General Information
Test Agency...................................................... SAFE TECHNOLOGIES, INC.
Test Number.................................................. MET161203
Test Designation............................................. MASH 3-32
Date................................................................. 12/3/2016
Test Article
Name ................................................................. Lindsay Transportation - Max - Tension
Type ............................................................... Guardrail End Terminal
Installation Length ........................................... 155.1 ft (47.3m)
Width .............................................................. 17.4 in (441.3mm)
Height ............................................................ 31 in (787mm)
Soil Conditions
Type of soil .................................................... AASHTO Grade A/B Soil-Aggregate
Soil strength ................................................... 17,198 lbs
Test Vehicle
Type / Designation .............................................. 1100C
Make and Model ............................................... 2011 Kia Rio
Curb Weight .................................................... 2428.4 lbs (1101.5 kg)
Test Inertial Weight .......................................... 2436.1 lbs (1105.0 kg)
Gross Static Weight ........................................... 2601.5 lbs (1180.0 kg)
Impact Conditions
Speed ............................................................. 61.6 mph (99.2 km/h)
Angle ............................................................. 5.0 deg
Location / Orientation ....................................... Front/Center
Exit Conditions
Speed (mph) .................................................. N/A
Angle (deg) .................................................. N/A
Post Impact Trajectory
Vehicle Stability ............................................. Satisfactory
Stopping Distance ........................................... 9.5 ft (2.9m)
Vehicle Snagging/Pocketing ................................ None
Occupant risk Values
Longitudinal OIV .............................................. 35.4 ft/s (10.8 m/s)
Lateral OIV .................................................... 0.7 ft/s (0.2 m/s)
Longitudinal ORA ............................................ 10.9 g’s
Lateral ORA .................................................. 3.3 g’s
THIV ........................................................... 35.4 ft/s (10.8 m/s)
PHD ............................................................ 11 g’s
ASI .............................................................. 1.49
Test Article Deformation .................................. Moderate
Test Article Deflections
Permanent ...................................................... 9.0 in (0.23 m) front
Dynamic ....................................................... 19.1 in (0.49 m) front
Vehicle Damage
VDS .............................................................. 12-FC-6
CDC ............................................................. 12FDEN3
Maximum Deformation .................................. No interior damage
<table>
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<tr>
<th><strong>General Information</strong></th>
<th><strong>Exit Conditions</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Test Agency</strong></td>
<td><strong>Speed (mph)</strong></td>
</tr>
<tr>
<td>SAFE TECHNOLOGIES, INC.</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Test Number</strong></td>
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<tr>
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<td><strong>Date</strong></td>
<td><strong>Vehicle Snagging/Pocketing</strong></td>
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<td><strong>Test Article</strong></td>
<td><strong>Occupant risk Values</strong></td>
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<tr>
<td><strong>Name</strong></td>
<td><strong>Longitudinal OIV</strong></td>
</tr>
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<td>Lindsay Transportation - MaX-Tension</td>
<td><strong>Lateral OIV</strong></td>
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<tr>
<td><strong>Type</strong></td>
<td><strong>Longitudinal ORA</strong></td>
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<td>Guardrail End Terminal</td>
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<td><strong>Height</strong></td>
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<td><strong>Soil Conditions</strong></td>
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<td>16,041 lbs</td>
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<td><strong>CDC</strong></td>
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<td><strong>Make and Model</strong></td>
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<tr>
<td>2010 Dodge Ram 1500 Quad Cab Pickup</td>
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<td><strong>Curb Weight</strong></td>
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<td>4968.1 lbs (2253.5 kg)</td>
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<tr>
<td>4973.6 lbs (2256.0 kg)</td>
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<td>4973.6 lbs (2256.0 kg)</td>
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<td><strong>Impact Conditions</strong></td>
<td><strong>Vehicle Snagging/Pocketing</strong></td>
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<td><strong>Speed</strong></td>
<td><strong>Post Impact Trajectory</strong></td>
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<td>62.3 mph (100.5 km/h)</td>
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<td>5.5 deg</td>
<td><strong>Vehicle Snagging/Pocketing</strong></td>
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<td><strong>Location / Orientation</strong></td>
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<td>Front/Center</td>
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<td><strong>Longitudinal OIV</strong></td>
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<td><strong>Longitudinal ORA</strong></td>
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<tr>
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<td><strong>Lateral ORA</strong></td>
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<td><strong>THIV</strong></td>
<td><strong>THIV</strong></td>
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<tr>
<td>24.9 ft/s (7.6 m/s)</td>
<td><strong>PHD</strong></td>
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<td><strong>ASI</strong></td>
<td><strong>ASI</strong></td>
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<tr>
<td>Type</td>
<td>Guardrail End Terminal</td>
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<td>Installation Length</td>
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<td>Width</td>
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<td>Height</td>
<td>31 in (787mm)</td>
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<td>Soil Conditions</td>
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<td>Gross Static Weight</td>
<td>2448.2 lbs (1110.5 kg)</td>
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<tr>
<td>Speed</td>
<td>62.2 mph (100.1 km/h)</td>
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<tr>
<td>Angle</td>
<td>15.0 deg</td>
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<tr>
<td>Location / Orientation</td>
<td>13° downstream from middle of post 1</td>
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<td>Vehicle Snagging/Pocketing</td>
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<td>Occupant risk Values</td>
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<td>Longitudinal OIV</td>
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<td>Lateral ORA</td>
<td>9.6 g's</td>
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<td>THIV</td>
<td>19.0 ft/s (5.8 m/s)</td>
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<tr>
<td>PHD</td>
<td>9.7 g's</td>
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<tr>
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<tr>
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<tr>
<td>Permanent</td>
<td>7.1 in (0.18m)</td>
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<tr>
<td>Dynamic</td>
<td>11.4 in (0.29m)</td>
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<th>Vehicle Damage</th>
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<tr>
<td>VDS</td>
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<td>CDC</td>
<td>01FREA3</td>
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<td>Interior Deformation</td>
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General Information
Test Agency .................................. SAFE TECHNOLOGIES, INC.
Test Number .................................. MET161212
Test Designation ............................ MASH 3-35
Date ......................................... 12/12/2016

Test Article
Name .......................................... Lindsay Transportation - MaX-Tension
Type .......................................... Guardrail End Terminal
Installation Length .......................... 155.1 ft (47.3m)
Width ......................................... 17.4 in (441.3mm)
Height ........................................ 31 in (787mm)

Soil Conditions
Type of soil .................................. AASHTO Grade A/B Soil-Aggregate
Soil strength ................................. 13,489 lbs

Test Vehicle
Type / Designation .......................... 2270P
Make and Model ............................. 2010 Dodge Ram 1500 Quad Cab Pickup
Curb Weight .................................. 4692.5 lbs (2128.5 kg)
Test Inertial Weight .......................... 4984.7 lbs (2261.0 kg)
Gross Static Weight .......................... 4984.7 lbs (2261.0 kg)

Impact Conditions
Speed ......................................... 62.3 mph (100.3 km/h)
Angle ......................................... 25.0 deg
Location / Orientation ....................... 2.86m downstream from middle of post 1

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

Post Impact Trajectory
Vehicle Stability ............................ Satisfactory
Stopping Distance .......................... 60.2 ft (18.33m)
Vehicle Snagging/Pocketing .............. Some (see Figure 8)

Occupant risk Values
Longitudinal OIV ............................ 17.4 ft/s (5.3 m/s)
Lateral OIV .................................. 13.8 ft/s (4.2 m/s)
Longitudinal ORA ........................... 10.7 g's
Lateral ORA .................................. 7.5 g's
THIV .......................................... 21.3 ft/s (6.5 m/s)
PHD .......................................... 12.7 g's
ASI ........................................... 0.64

Test Article Damage .......................... Substantial

Test Article Deflections
Permanent .................................... 4.27 ft (1.30m)
Dynamic ..................................... 5.25 ft (1.60m)

Vehicle Damage
VDS .......................................... 1-RFQ-4
CDC .......................................... 01FREA4
Maximum Deformation .................... No interior damage
General Information

**Test Agency** .................................................. SAFE TECHNOLOGIES, INC.
**Test Number** .................................................. MET161220
**Test Designation** ............................................. MASH 3-37
**Date** ............................................................. 12/20/2016

**Test Article**

**Name** .......................................................... Lindsay Transportation - Max-Tension
**Type** ............................................................ Guardrail End Terminal
**Installation Length** ........................................... 155.1 ft (47.3m)
**Width** ........................................................... 17.4 in (441.3mm)
**Height** .......................................................... 31 in (787mm)

**Soil Conditions**

**Type of soil** .................................................. AASHTO Grade A/B Soil-Aggregate
**Soil strength** .................................................. 14,705 lbs

**Test Vehicle**

**Type / Designation** .......................................... 2270P
**Make and Model** ............................................... 2011 Dodge Ram 1500 Quad Cab Pickup
**Curb Weight** ................................................... 5069.5 lbs (2299.5 kg)
**Test Inertial Weight** ........................................... 5006.7 lbs (2271.0 kg)
**Gross Static Weight** ........................................... 5006.7 lbs (2271.0 kg)

**Impact Conditions**

**Speed** .......................................................... 62.4 mph (100.4 km/h)
**Angle** ........................................................... 25.0 deg
**Location / Orientation** ........................................ 32.2 ft (9.8 m) from post 1

**Exit Conditions**

**Speed (mph)** .................................................. 23.1 (37.1 km/h)
**Angle (deg)** ................................................... 19

**Post Impact Trajectory**

**Vehicle Stability** ............................................. Satisfactory
**Stopping Distance** ........................................... 28.48 ft (8.7m)
**Vehicle Snagging/Pocketing** ............................... Some snagging and pocketing

**Occupant risk Values**

**Longitudinal OIV** ............................................... 16.7 ft/s (5.1 m/s)
**Lateral OIV** .................................................... 15.1 ft/s (4.6 m/s)
**Longitudinal ORA** ............................................ 6.5 g's
**Lateral ORA** .................................................... 7.2 g's
**THIV** ............................................................. 22.3 ft/s (6.8 m/s)
**PHD** ............................................................... 9.1 g's
**ASI** ............................................................... 0.66

**Test Article Damage** .......................................... Substantial

**Test Article Deflections**

**Permanent** .................................................... 1.87 ft (0.57m)
**Dynamic** ....................................................... 3.64 ft (1.11m)

**Vehicle Damage**

**VOS** ............................................................. 1-RFQ-4
**CDC** ............................................................ 01 FYEA3
**Maximum Deformation** ....................................... No interior damage
General Information

Test Agency: SAFE TECHNOLOGIES, INC.
Test Number: MET337b-C1
Test Designation: MASH 3-37b
Date: 9/7/2018

Test Article
Name: MAX-Tension Tangent, TL-3
Type: Guardrail End Terminal
Installation Length: 155.1 ft (47.3 m)
Width: 17 3/8 in (441 mm)
Height: 31 in (787 mm)

Soil Conditions
Type of soil: AASHTO Grade A/B Soil-Aggregate
Soil strength: 14,255 lb (63.4 kN)

Test Vehicle
Type / Designation: 1100C
Make and Model: 2011 Kia Rio
Curb Weight: 2,476 lb (1,123 kg)
Test Inertial Weight: 2,432 lb (1,103 kg)
Gross Static Weight: 2,597 lb (1,178 kg)

Impact Conditions
Speed: 63.3 mph (101.9 km/h)
Angle: 25 deg
Location / Orientation: 26.3 in (66.9 cm) from post 2

Exit Conditions
Speed: 48.8 mph (78.6 km/h)
Angle: 17 deg

Post Impact Trajectory
Vehicle Stability: Satisfactory
Longitudinal Stopping Distance (CG): 76.7 ft (23.4 m)
Vehicle Snagging/Pocketing: Minimal

Occupant Risk Values
Longitudinal OIV: 23.0 ft/s (7.0 m/s)
Lateral OIV: 7.5 ft/s (2.3 m/s)
Longitudinal ORA: 2.1 G
Lateral ORA: 3.2 G
THIV: 24.9 ft/s (7.6 m/s)
PHD: 3.2 G
ASI: 0.85

Test Article Damage: Moderate

Test Article Deflections
Longitudinal System Stroke: N/A
Permanent Lateral Deflection: 46.7 in (1.19 m)
Dynamic Lateral Deflection: 67.0 in (1.70 m)

Vehicle Damage
VDS: 1-RFQ-5
CDC: 01RF EW2
Maximum Deformation: 4.88 in (124 mm) - toe pan
INTENDED USE

The MAX-Tension™ Guardrail End Terminal (MAX) is a re-directive, 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 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 3. The MAX 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 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
- Four standard AASHTO 12 Ga. 12-6" 4-Space W-beam or two 25'-0" 8-Space W-beam rails
- 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 Tangent system has been fully tested in conformance with MASH Test Level 3 and is eligible for Federal reimbursement.

FHWA Eligibility Letters: CC-133, June 15, 2017

CONTACT INFORMATION

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