



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

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

September 27, 2017

In Reply Refer To:  
HSST-1/B-288

Mr. Mark G. Fellows  
Nucor Steel Marion, Inc.  
912 Cheney Avenue  
Marion, OH. 43302

Dear Mr. Mark Fellows:

This letter is in response to your June 30, 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 B-288 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:

- Nu-Guard<sup>®</sup> 31

### **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 AASHTO's 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: Nu-Guard® 31  
Type of system: Longitudinal Barrier  
Test Level: MASH Test Level 3 (TL3)  
Testing conducted by: Texas A&M Transportation Institute  
Date of request: July 1, 2017  
Date initially acknowledged: July 11, 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 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**

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-288 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,

A handwritten signature in blue ink that reads "Robert Ritter". The signature is written in a cursive style with a large, prominent "R" at the beginning.

Robert Ritter  
Acting 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:	June 30, 2017	<input checked="" type="radio"/> New <input type="radio"/> Resubmission
	Name:	Mark G. Fellows	
	Company:	Nucor Steel Marion, Inc.	
	Address:	912 Cheney Avenue, Marion OH 43302	
	Country:	U.S.	
	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
'B': Rigid/Semi-Rigid Barriers (Roadside, Median, Bridge Railings)	<input checked="" type="radio"/> Physical Crash Testing <input type="radio"/> Engineering Analysis	Nu-Guard 31 Guardrail System	AASHTO MASH	TL3

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:	Steven J. Conway	Same as Submitter <input type="checkbox"/>
Company Name:	Nucor Steel Marion, Inc.	Same as Submitter <input checked="" type="checkbox"/>
Address:	912 Cheney Avenue, Marion OH 43302	Same as Submitter <input checked="" type="checkbox"/>
Country:	U.S.	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.		
There are no shared financial interests in the Nu-Guard 31 System between Nucor Steel Marion, Inc., and Texas A&M Transportation Institute, other than the costs involved in the actual crash tests and reports for this submission to FHWA.		



## PRODUCT DESCRIPTION

New Hardware or Significant Modification
  Modification to Existing Hardware

The test installation was comprised of a 31-inch tall W-beam guardrail system utilizing 78-inch long, 4 lb/ft Nu-Guard® guardrail posts (posts 3-28) with a 9 ft-4½ inches long TxDOT Downstream Anchor Terminal (DAT-14) on each end, for a total installation length of 181 ft-3 inches. Posts 3 to 28 were equally spaced at 6 ft-3 inches. Standard 12-gauge W-beam guardrail (type RWM04a) was used in the system, and guardrail splices were located mid-span between every other post. Recessed guardrail nuts on the posts were tightened to 96 ft-lb of torque. The posts were installed in 18-inch diameter drilled shafts to the embedment depth of 47 inches and backfilled with AASHTO M147-65(2004) grade B crushed limestone base, compacted to MASH standard.

In Test 3-10 the height of the guardrail system was raised to 32 inches and the embedment depth of the posts was 46 inches. This was done to allow a range of rail height construction. Further explanation is provided in the test descriptions. No other elements of the system were changed for Test 3-10.

### 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:	Nathaniel D. Schulz	
Engineer Signature:	<b>Nathaniel D. Schulz</b>	Digitally signed by Nathaniel D. Schulz Date: 2017.06.27 14:10:29 -05'00'
Address:	3135 TAMU, College Station, Texas 77843-3135	Same as Submitter <input type="checkbox"/>
Country:	United States	Same as Submitter <input type="checkbox"/>

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-10 (1100C)	<p>For this test the guardrail system was raised to a height of 32 inches. This was done to provide a range for rail mounting height. As stated in MASH section 2.2.1.1, small car tests should be conducted with barrier rail elements at the the maximum acceptable height and light truck tests should be conducted with rail elements at the minimum acceptable height. No other changes were made to the guardrail system.</p> <p>The results of the test conducted on February 7, 2017 are found in TTI Test Report No. 690900-NSM16. The Nu-Guard® 31 contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 4.0 ft. The tops of several posts fractured and the rail element released from several posts. These detached elements and fragments did not penetrate or show potential for penetrating the occupant compartment, or present undue hazard to others in the area. Maximum occupant compartment deformation was 1.75 inches in the right front instrument panel area. The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 9 degrees and 6 degrees, respectively. Occupant risk factors were within the preferred limits specified in MASH.</p>	PASS
3-11 (2270P)	<p>The results of the test conducted on April 25, 2017 are found in TTI Test Report No. 690900-NSM17. The Nu-Guard® 31 contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection was 87.6 inches. Small fragments from the test article were present but did not penetrate or show potential for penetrating the occupant compartment, nor present hazard to others in the area. No occupant compartment deformation or intrusion occurred. The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 18 degrees and 6 degrees, respectively. Occupant risk factors were within the preferred limits specified in MASH.</p>	PASS
3-20 (1100C)	Test 3-20 is not applicable for this type of system.	Non-Relevant Test, not conducted

Required Test Number	Narrative Description	Evaluation Results
3-21 (2270P)	Test 3-21 is not applicable for this type of system.	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:	Texas AM Transportation Institute	
Laboratory Signature:	<b>Darrell L. Kuhn</b>	Darrell L. Kuhn 2017.06.29 18:58:20 -05'00'
Address:	Roadside Safety & Physical Security Texas A&M University System 3135 TAMU, College Station, TX 77843	Same as Submitter <input type="checkbox"/>
Country:	USA	Same as Submitter <input type="checkbox"/>
Accreditation Certificate Number and Dates of current Accreditation period :	ISO 17025 Laboratory, A2LA Testing Certificate #2821.01 Expires April 30, 2019	

Submitter Signature\*: Mark Fellows

Digitally signed by Mark Fellows  
DN: cn=Mark Fellows, o=Nucor Steel  
Marion, Inc., ou=Nucor Highway Products,  
email=mark.fellows@nucor.com, c=US  
Date: 2017.07.01 11:42:23 -0400

**Submit Form**

## ATTACHMENTS

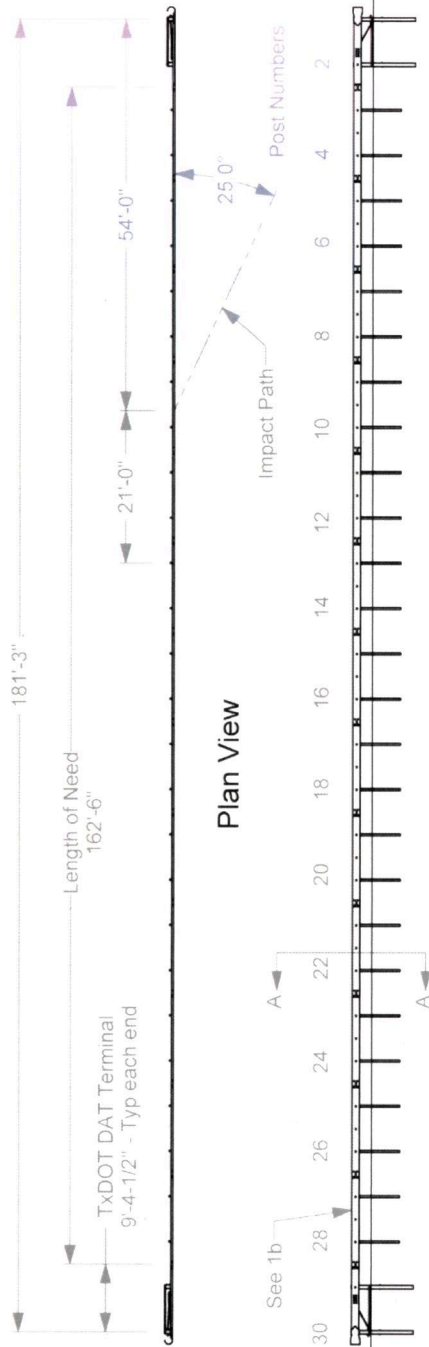
Attach to this form:

- 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.

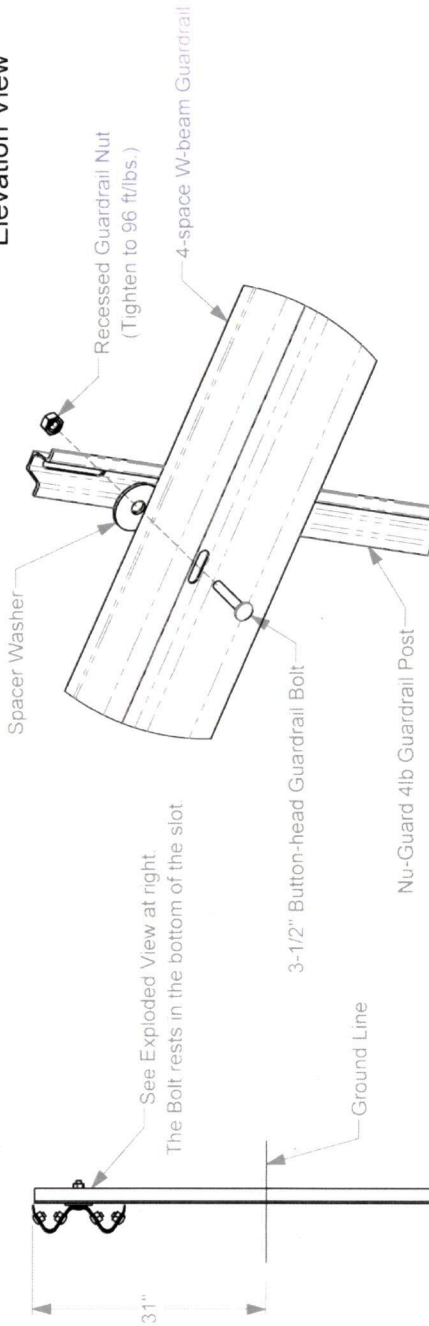
**FHWA Official Business Only:**

Eligibility Letter		
Number	Date	Key Words

**Test Installation**



**Elevation View**



**Section A-A**  
Scale 1 : 20

1a. Backfill Post holes with AASHTO M147-65(2004), grade B crushed limestone road base, compacted to MASH standard.

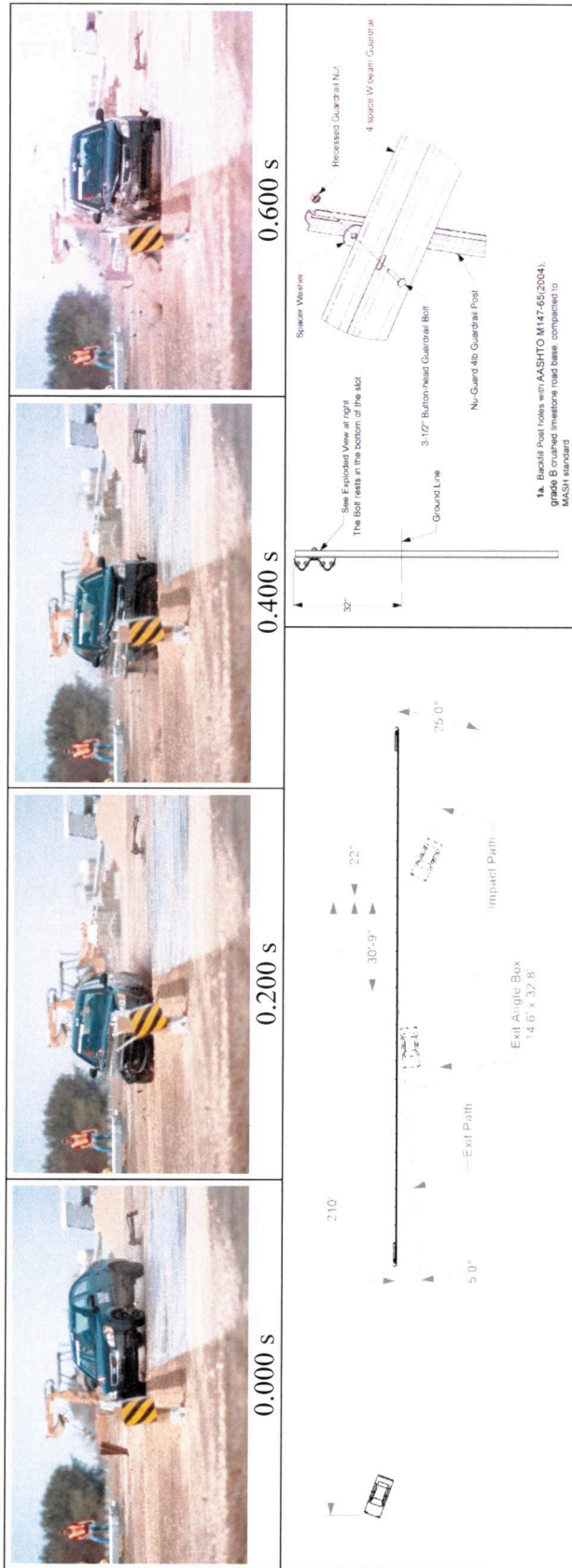


Roadside Safety and  
Physical Security Division -  
Proving Ground

Project 690900-NSM-17 Nucor W-beam Rail / MASH 3-11 2017-03-24  
Drawn By GES Scale: 1:250 Sheet 1 of 1 Test Installation

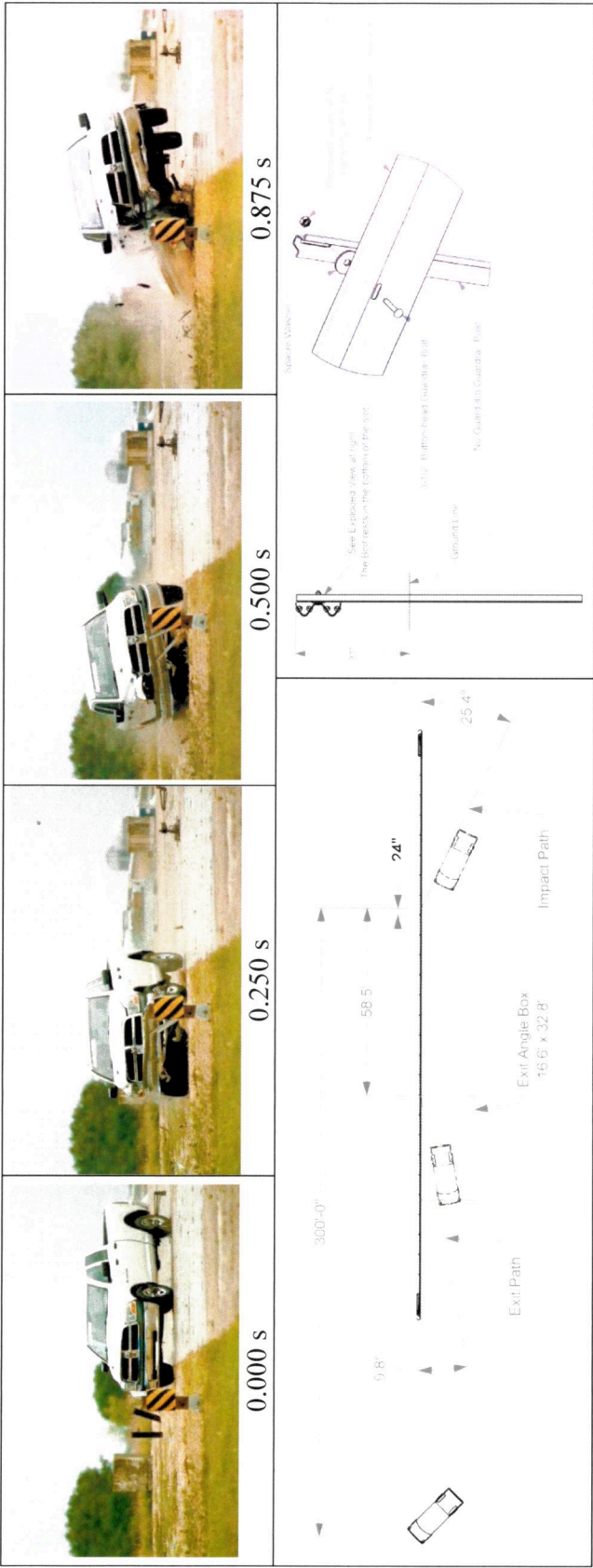
**Figure 2.1. Details of the Nu-Guard® 31.**





<b>General Information</b>		<b>Impact Conditions</b>		<b>Post-Impact Trajectory</b>	
Test Agency.....	Texas A&M Transportation Institute (TTI)	Speed .....	63.5 mi/h	Stopping Distance .....	210 ft downstream
Test Standard Test No. ....	MASH Test 3-10	Angle .....	24.6 degrees		8 ft twd field side
TTI Test No. ....	690900-NSM16	Location/Orientation .....	16 ft 2 inches	<b>Vehicle Stability</b>	
Test Date.....	2017-02-07	<b>Impact Severity</b> .....	57 kip-ft	Maximum Yaw Angle .....	360 degrees
<b>Test Article</b>		<b>Exit Conditions</b>		Maximum Pitch Angle .....	6 degrees
Type .....	Guardrail	Speed .....	44.6 mi/h	Maximum Roll Angle .....	9 degrees
Name .....	Nu-Guard® 31	Angle .....	16.0 degrees	Vehicle Snagging .....	Yes
Installation Length .....	181 ft 3 inches	<b>Occupant Risk Values</b>		Vehicle Pocketing .....	No
Material or Key Elements .....	32-inch tall W-beam guardrail system with 4 lb/ft Nu-Guard® guardrail posts and TxDOT DAT-14 terminal	Longitudinal OIV .....	16.4 ft/s	<b>Test Article Deflections</b>	
	AASHTO M147-65(2004), grade B Soil (crushed limestone), Damp	Lateral OIV .....	14.8 ft/s	Dynamic .....	4.0 ft
<b>Soil Type and Condition</b> .....		Longitudinal Ridedown .....	5.5 g	Permanent .....	2.4 ft
		Lateral Ridedown .....	8.2 g	Working Width .....	4.6 ft
<b>Test Vehicle</b>		THIV .....	23.2 km/h	<b>Vehicle Damage</b>	
Type/Designation .....	1100C	PHD .....	8.5 g	VDS .....	01RFQ4
Make and Model .....	2011 Kia Rio	ASI .....	0.74	CDC .....	01RFEW3
Curb .....	2474 lb	Max. 0.050-s Average .....		Max. Exterior Deformation .....	7.5 inches
Test Inertial .....	2444 lb	Longitudinal .....	-4.3 g	OCDI .....	RF0000000
Dummy .....	165 lb	Lateral .....	-6.5 g	Max. Occupant Compartment .....	
Gross Static .....	2609 lb	Vertical .....	-2.3 g	Deformation .....	1.75 inches

Figure 5.9. Summary of Results for MASH Test 3-10 on Nu-Guard® 31.



<b>General Information</b>	Test Agency ..... Texas A&M Transportation Institute (TTI) Test Standard Test No. .... MASH Test 3-11 TTI Test No. .... 690900-NSM17 Test Date ..... 2017-04-25 <b>Test Article</b> Type ..... Guardrail Name ..... Nu-Guard® 31 Installation Length ..... 181 ft 3 inches Material or Key Elements ..... 31-inch tall W-beam guardrail system with 4-lb/ft Nu-Guard® guardrail posts and TXDOT DAT-14 terminal <b>Soil Type and Condition</b> ..... AAASHTO M147-65(2004), grade B Soil (crushed limestone), Damp <b>Test Vehicle</b> Type/Designation ..... 2270P Make and Model ..... 2011 Dodge RAM 1500 Curb ..... 4885 lb Test Inertial ..... 5038 lb Dummy ..... No dummy Gross Static ..... 5038 lb
<b>Impact Conditions</b>	Speed ..... 64.4 mi/h Angle ..... 25.4 degrees Location/Orientation ..... 24 inches upstream of post 10 <b>Impact Severity</b> <b>Exit Conditions</b> Speed ..... 41.1 mi/h Angle ..... 9.8 degrees <b>Occupant Risk Values</b> Longitudinal OIV ..... 12.8 ft/s Lateral OIV ..... 12.5 ft/s Longitudinal Ridedown ..... 4.3 g Lateral Ridedown ..... 6.3 g THIV ..... 18.6 km/h PHD ..... 7.4 g ASI ..... 0.52 Max. 0.050-s Average Longitudinal ..... -3.8 g Lateral ..... -4.4 g Vertical ..... -2.3 g
<b>Post-Impact Trajectory</b>	Stopping Distance ..... 300 ft downstrm 1 ft twd field side <b>Vehicle Stability</b> Maximum Yaw Angle ..... 49 degrees Maximum Pitch Angle ..... 6 degrees Maximum Roll Angle ..... 18 degrees Vehicle Snagging ..... No Vehicle Pocketing ..... No <b>Test Article Deflections</b> Dynamic ..... 87.6 inches Permanent ..... 45.0 inches Working Width ..... 96.8 inches <b>Vehicle Damage</b> VDS ..... 01RFQ5 CDC ..... 01FREW4 Max. Exterior Deformation ..... 12.0 inches OCDI ..... FS0000000 Max. Occupant Compartment Deformation ..... None

Figure 5.10. Summary of Results for MASH Test 3-11 on Nu-Guard® 31.