U.S. Department
of Transportation
Federal Highway
Administration

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

December 19, 2017

In Reply Refer To:
HSST-1/CC-140

Mr. Gregory A. Neece
Trinity Highway Products, LLC
2525 N. Stemmons Fwy
Dallas, TX 75204

Dear Mr. Neece:

This letter is in response to your October 17, 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-140 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- Slotted Rail Terminal (SRT)-MASH 2016

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: Slotted Rail Terminal (SRT)-MASH 2016
Type of system: Terminal
Test Level: MASH Test Level 3 (TL3)
Testing conducted by: Texas A&M Transportation Institute
Date of request: October 19, 2017
Date initially acknowledged: October 20, 2017

FHWA concurs with the recommendation of the accredited crash testing laboratory on 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-140 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

Submitter	Date of Request:	October 17, 2017	◉ New ○ Resubmission
	Name:	Roger Bligh	
	Company:	Texas A&M Transportation Institute	
	Address:	3135 TAMU, College Station, TX 77843-3135	
	Country:	U.S.A.	
	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	◉ Physical Crash Testing ○ Engineering Analysis	Slotted Rail Terminal (SRT)-MASH 2016	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:	Gregory A. Neece	Same as Submitter ☐
Company Name:	Trinity Highway Products, LLC	Same as Submitter ☐
Address:	2525 N. Stemmons Fwy, Dallas, TX 75204	Same as Submitter ☐
Country:	U.S.A.	Same as Submitter ☐

Enter below all disclosures of financial interests as required by the FHWA `Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.
The SRT-MASH 2016 system technology is covered by patents that were applied for by The Texas A&M University System (TAMUS). Trinity Highway Products, LLC (THP) has a license agreement to manufacture and sell SRT systems, which are commercial embodiments of those patents. The tests were performed by the Texas A&M Transportation Institute (TTI) Proving Ground. TTI Proving Ground is an International Standards Organization ("ISO") 17025 accredited laboratory with American Association for Laboratory Accreditation (A2LA) Mechanical Testing certificate 2821.01. The SRT systems were designed and developed by engineers who are currently or were previously employed by TTI. The associated United States Patent Office patent numbers are assigned to TAMUS. The patent holders of record for the associated patents are listed below: Cable Release Anchor - US Patent Number 6,729,607: Dean C. Alberson, D. Lance Bullard, Jr., Roger P. Bligh, C. Eugene Buth Steel Yielding Guardrail Support Post - US Patent Number 6,902,150: Dean C. Alberson, D. Lance Bullard, Jr., Roger P. Bligh, C. Eugene Buth Slot Guard for Slotted Rail Terminal - US Patent Number 6,435,761: Roger P. Bligh, King K. Mak, Hayes E. Ross, Jr. Slotted Rail Terminal - US Patent Number 5,547,309 (expired): Dean L. Sicking, Roger P. Bligh, King K. Mak, Hayes E. Ross, Jr. THP pays royalties to TAMUS for sales of the SRT systems and parts, pursuant to an executed license agreement.

PRODUCT DESCRIPTION

(•) New Hardware or Significant Modification ( ) Modification to Existing Hardware

The SRT-MASH terminal became eligible via letter CC-100B dated December 5, 2012. With the publication of MASH 2016, the test matrix for W-beam guardrail terminals was modified to include Test 3-37b. This test involves an 1100C vehicle impacting the terminal at the critical impact point in the reverse direction at a speed of 62 mph and an angle of 25 degrees. Additional testing was performed in accordance with MASH 2016 to develop the SRT-MASH 2016 system.

The SRT-MASH 2016 terminal has a linear flare with a 4-ft offset over a length of 37.5 ft. The anchor post (post 1) is a cable release post (CRP) embedded 6 ft-6 inches below grade. Steel yielding terminal posts (SYTPs) are used for post 2 through post 10. The SYTPs are 6 ft long and embedded 40 inches below grade. Post 1 and post 2 are spaced 75 inches on center and connected at the ground line with a 3-inch × 3-inch × ¼-inch angle strut. The spacing between post 2 and post 3 is 56.25 inches. Post 3 through post 10 are spaced at 37.5 inches. The last post spacing in the terminal between post 10 and post 11 (the first standard line post) is 56.25 inches. Slotted 12 gauge W-beam rail is used in the first 25 ft of the SRT-MASH 2016 system. A single 3/4-inch x 13½-inch long slot is in the rail at post 1. Two sets of slots are located in the first 12 ft-6 inches of rail between post 1 and post 3. Each set of slots consists of three slots that are ½-inch wide × 27-inches long. The next 12 ft-6 inches of rail contains two additional sets of slots located between post 4 and post 7. These sets of three slots are ½-inch wide × 12-inch long. Slot guards are bolted to the field side of the slotted rail at the downstream end of each set of slots with the raised, narrow portion of the slot guard oriented towards post 1.

Posts 4 through 10 are offset from the rail using nominal 6-inch × 8-inch × 14-inch routed wood offset blocks. No offset blocks are used on posts 1, 2 and 3. Posts 2 through 7 are not bolted to the slotted W-beam rail panels. A shelf angle fabricated from ½-inch steel plate is used at post 2 to provide vertical reaction for the cable anchor system. W-beam flange protectors are used at posts 2 through 7 to provide additional vertical support to the slotted W-beam rail sections. A cable anchor bracket is bolted to the slotted rail panel between post 1 and post 2. A 9¼-inch long section of 1¼-inch diameter schedule 40 pipe is positioned inside the cable anchor bracket against the downstream bearing plate. The pipe insert positions the swaged fitting against the end of the cable anchor bracket where it turns down to post 1.

The SRT-MASH 2016 incorporates a deflector bracket upstream of post 2 that is attached to the back of the W-beam rail using four of the anchor bracket attachment bolts. This deflector bracket eliminates contact between post 2 and the anchor cable assembly when the terminal is impacted in the reverse direction as in Test 3-37b. The SRT-MASH 2016 also incorporates post 1 deflector plates on the downstream side of the flanges of the post 1 stub. When the terminal is impacted in the reverse direction as in Test 3-37b, the post 1 deflector plates permit the undercarriage of the vehicle to slide up and across the post 1 stub after the release of the top of the CRP post. This mitigates snagging potential between the vehicle and post 1 stub.

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:	Roger P. Bligh, Ph.D., P.E.	
Engineer Signature:	Bligh, Roger P — Digitally signed by Bligh, Roger P DN: postalCode=77843, o=TAMU-SIGN, street=Texas A&M University, st=TX, l=College Station, c=US, cn=Bligh, Roger P, email=rbligh@tamu.edu Date: 2017.10.16 16:40:57 -05'00'	
Address:	3135 TAMU, College Station, TX 77843-3135	Same as Submitter ☐
Country:	U.S.A.	Same as Submitter ☐

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-30 (1100C)	TTI Test Report No. 400001-SRT6, "MASH Test 3-30 on the SRT-MASH." The 1100C, traveling at an impact speed of 61.4 mi/h, impacted the nose of the SRT-MASH 2016 at 1.2 degrees with the left quarterpoint aligned with the center of post 1. The SRT-MASH 2016 activated as designed, slowed the 1100C vehicle, and permitted its controlled penetration behind the test article. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-30.	PASS
3-31 (2270P)	TTI Test Report No. 400001-SRT5, "MASH Test 3-31 on the SRT-MASH." The 2270P vehicle, traveling at an impact speed of 61.0 mi/h, impacted the nose of the SRT-MASH 2016 at 0.6 degrees with the center of the vehicle aligned with the center of post 1. The SRT-MASH 2016 activated as designed, slowed the 2270P vehicle, and permitted its controlled penetration behind the test article. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-31.	PASS
3-32 (1100C)	TTI Test Report No. 400001-SRT8, "MASH Test 3-32 on the SRT-MASH." The 1100C, traveling at an impact speed of 61.5 mi/h, contacted the nose of the SRT-MASH 2016 at post 1 at an impact angle of 5.4 degrees. The SRT-MASH 2016 activated as designed and permitted controlled gating of the 1100C. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-32.	PASS
3-33 (2270P)	TTI Test Report No. 690900-SRT9, "MASH Test 3-33 on the SRT M10." The 2270P, traveling at an impact speed of 63.2 mi/h, contacted the nose of the SRT-MASH 2016 with the centerline of the vehicle aligned with the centerline of post 1 at an impact angle of 4.2 degrees. The SRT-MASH 2016 activated as designed and permitted controlled gating of the 2270P vehicle. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-33.	PASS

Required Test Number	Narrative Description	Evaluation Results
3-34 (1100C)	TTI Test Report No. 400001-SRT4, "MASH Test 3-34 on the SRT-MASH." The 1100C, traveling at an impact speed of 62.2 mi/h, impacted the SRT-MASH 2016 24 inches downstream of post 1 at an impact angle of 14.5 degrees. The SRT-MASH 2016 contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-34.	PASS
3-35 (2270P)	TTI Report No. 403371-SRT3, "MASH Test 3-35 on SRT-MASH." The 2270P, traveling at an impact speed of 62.4 mi/h, impacted the SRT-MASH 2016 6.8 inches downstream of post 4 at an impact angle of 24.3 degrees. The SRT-MASH 2016 contained and redirected the 2270P vehicle. The vehicle did not penetrate or override the installation. The SRT-MASH performed acceptably according to the evaluation criteria for MASH 2016 Test 3-35.	PASS
3-36 (2270P)	MASH 2016 Test Designation 3-36 is designed to examine the behavior of terminals and redirective crash cushions attached to a rigid barrier or backup structure. As a W-beam guardrail terminal, the SRT-MASH 2016 is not attached directly to a stiff barrier or backup structure. Therefore, Test 3-36 is not relevant.	Non-Relevant Test, not conducted
3-37b (1100C)	TTI Test Report No. 190140-SRT12, "MASH Test 3-37b on the SRT M10." The 1100C, traveling at an impact speed of 61.7 mi/h, impacted the SRT-MASH 2016 15 ft-6 3/4 inches upstream of the downstream anchor post in the reverse direction at an impact angle of 25.2 degrees. The SRT-MASH 2016 slowed the 1100C vehicle and permitted the vehicle to gate through the system in a controlled manner. The SRT-MASH 2016 performed acceptably according to the evaluation criteria for MASH 2016 Test 3-37b.	PASS

3-38 (1500A)	MASH 2016 Test Designation 3-38 is designed to evaluate the performance of staged energy-absorbing attenuators and end terminals when impacted by a mid-size vehicle. The SRT-MASH 2016 is not a staged energy absorbing device. The slots of the slotted rail sections buckle at a prescribed level of force and is not dependent on vehicle mass. Therefore, Test 3-38 is not relevant.	Non-Relevant Test, not conducted
3-40 (1100C)	MASH 2016 Test Designation 3-40 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-40 is not relevant.	Non-Relevant Test, not conducted
3-41 (2270P)	MASH 2016 Test Designation 3-41 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-41 is not relevant.	Non-Relevant Test, not conducted
3-42 (1100C)	MASH 2016 Test Designation 3-42 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-42 is not relevant.	Non-Relevant Test, not conducted
3-43 (2270P)	MASH 2016 Test Designation 3-43 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-43 is not relevant.	Non-Relevant Test, not conducted
3-44 (2270P)	MASH 2016 Test Designation 3-44 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-44 is not relevant.	Non-Relevant Test, not conducted
3-45 (1500A)	MASH 2016 Test Designation 3-45 evaluates non-redirective crash cushions. The SRT-MASH 2016 is not a non-redirective crash cushion and, therefore, Test 3-45 is not relevant.	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:	Darrell L. Kuhn Darrell L. Kuhn 2017.10.16 16:54:30 -05'00'	
Address:	3135 TAMU, College Station, TX 77843-3135	Same as Submitter ☐
Country:	USA	Same as Submitter ☐
Accreditation Certificate Number and Dates of current Accreditation period :	A2LA Certificate No. 2821.01, April 30, 2019	

Submitter Signature*: Bligh, Roger P Digitally signed by Bligh, Roger P DN: postalCode=77843, o=TAMU-SIGN, street=Texas A&M University, st=TX, l=College Station, c=US, cn=Bligh, Roger P, email=rbligh@tamu.edu Date: 2017.10.19 10:03:42 -05'00'

Submit Form

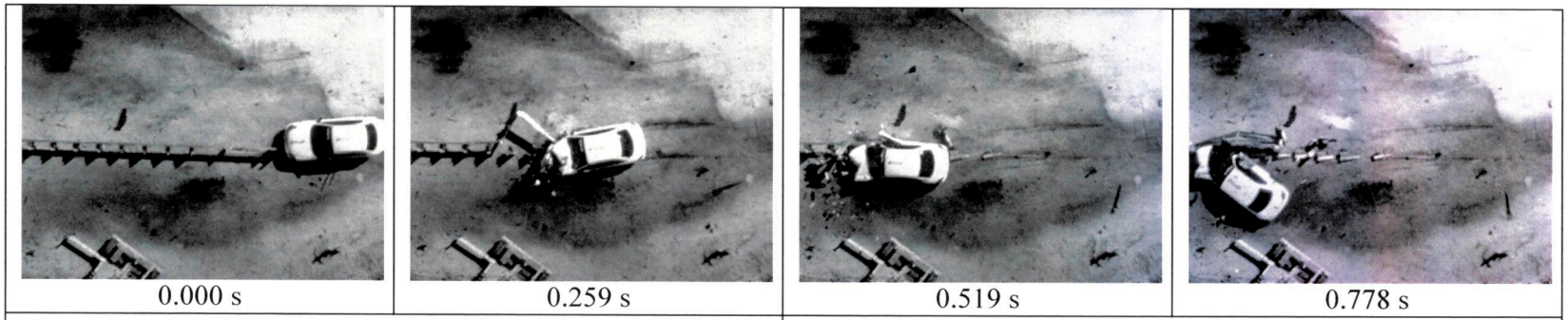
ATTACHMENTS

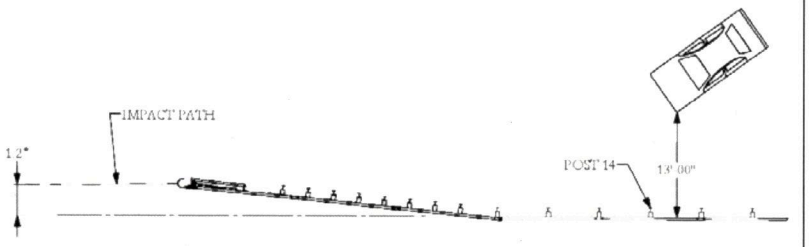
Attach to this form:

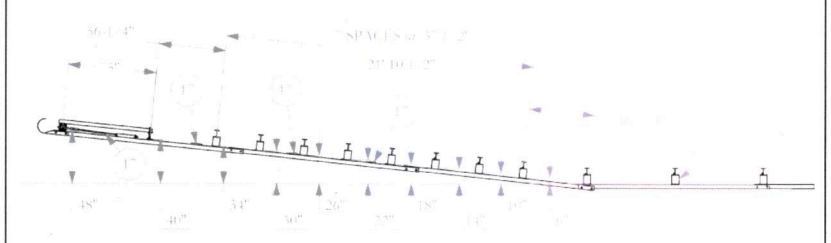
1) Additional disclosures of related financial interest as indicated above.
2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware 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	Texas Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-30
TTI Test No.	400001-SRT6
Date	October 29, 2010

Test Article

Type	Terminal
Name	SRT-MASH
Installation Length	131 ft-3 inches
Material or Key Elements	Slotted rail, CRP post 1, SYTP, anchor bracket and cable
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type/Designation	1100C
Make and Model	2005 Kia Rio
Curb	2385 lb
Test Inertial	2423 lb
Dummy	178 lb
Gross Static	2601 lb

Impact Conditions

Speed	61.4 mi/h
Angle	1.2 degrees
Location/Orientation	Nose
Kinetic Energy	305 kip-ft

Exit Conditions

Speed	12.0 mi/h
Angle	45.4 degrees

Occupant Risk Values

Impact Velocity	
Longitudinal	24.3 ft/s
Lateral	1.0 ft/s
Ridedown Accelerations	
Longitudinal	10.9 g
Lateral	6.6 g
THIV	26.9 km/h
PHD	11.4 g
ASI	0.66
Max. 0.050-s Average	
Longitudinal	-7.6 g
Lateral	-1.9 g
Vertical	-3.1 g

Post-Impact Trajectory

Stopping Distance	43.75 ft dwnstrm 26.3 ft twd field side

Vehicle Stability

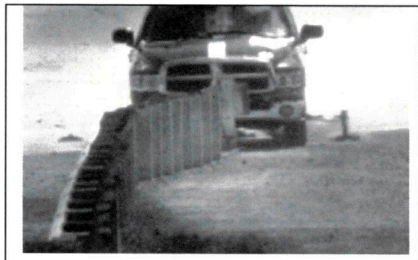
Maximum Yaw Angle	151 degrees
Maximum Pitch Angle	-10 degrees
Maximum Roll Angle	10 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

Test Article Deflections

Dynamic	5.3 ft
Permanent	5.3 ft

Vehicle Damage

VDS	12RFQ6
CDC	12FREW4
Max. Exterior Deformation	12.0 inches
OCDI	RF1000100
Max. Occupant Compartment Deformation	6.25 inches



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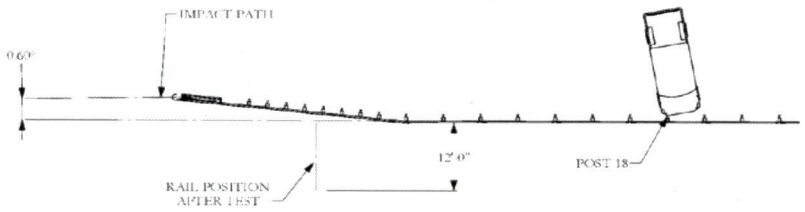
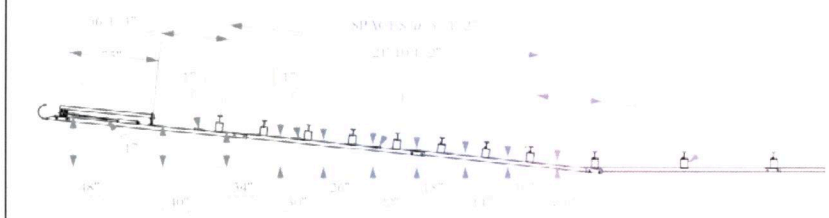




General Information

Test Agency	Texas Transportation Institute (TTI)
Test Standard Test No.	MASH 3-31
TTI Test No.	400001-SRT5
Date	October 21, 2010

Test Article

Type	Terminal
Name	SRT-MASH
Installation Length	131 ft-3 inches
Material or Key Elements	Slotted rail, CRP post 1, SYTP, anchor bracket and cable
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type/Designation	2270P
Make and Model	2003 Dodge Ram 1500 Pickup Truck
Curb	4774 lb
Test Inertial	5021 lb
Dummy	No dummy
Gross Static	5021 lb

Impact Conditions

Speed	61.0 mi/h
Angle	0.6 degrees
Location/Orientation	Nose
Kinetic Energy	624 kip-ft

Exit Conditions

Speed	Not obtainable
Angle	Not obtainable

Occupant Risk Values

Impact Velocity	
Longitudinal	18.0 ft/s
Lateral	2.0 ft/s
Ridedown Accelerations	
Longitudinal	11.8 G
Lateral	7.6 G
THIV	20.0 km/h
ASI	0.50
Max. 0.050-s Average	
Longitudinal	-4.7 G
Lateral	1.5 G
Vertical	-3.0 G

Post-Impact Trajectory

Stopping Distance	81.0 ft dwnstrm Against field side

Vehicle Stability

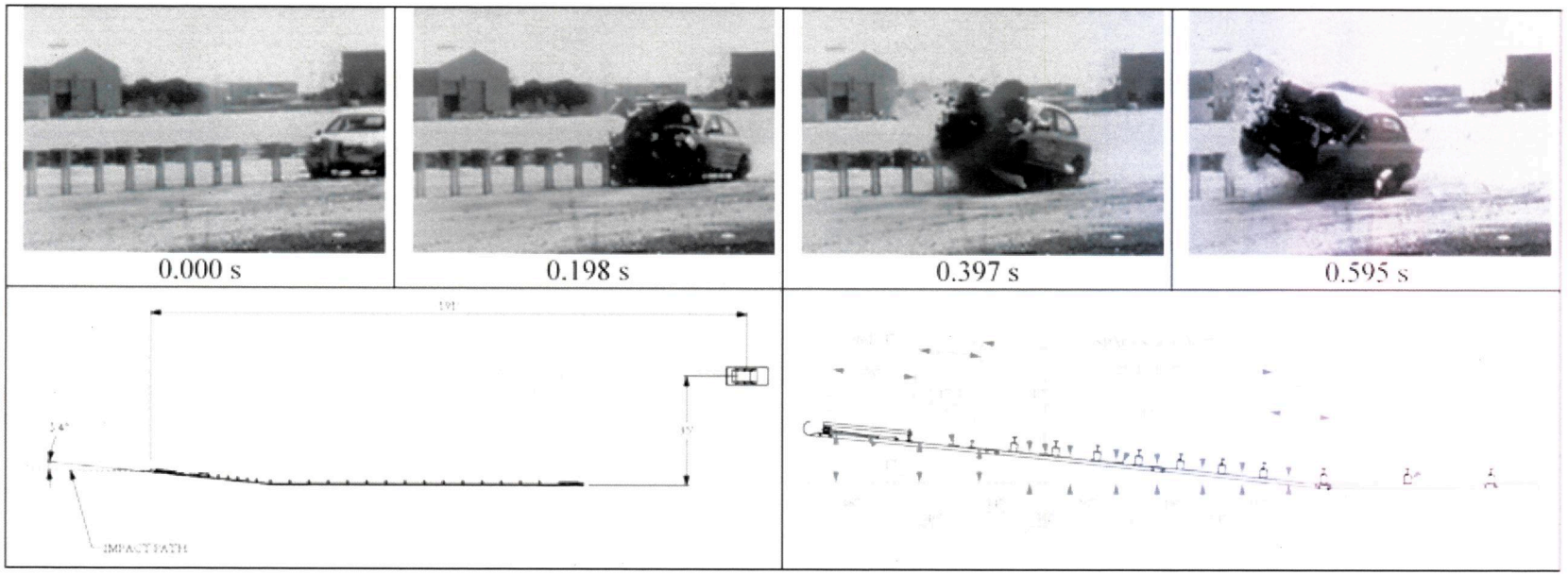
Maximum Yaw Angle	72 degrees
Maximum Pitch Angle	5 degrees
Maximum Roll Angle	7 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

Test Article Deflections

Dynamic	13.3 ft
Permanent	12.5 ft
Working Width	20.25 ft

Vehicle Damage

VDS	12FC4
CDC	12FCEW4
Max. Exterior Deformation	17.0 inches
OCDI	FS0000000
Max. Occupant Compartment Deformation	0



* Corrected 2015-11-17

General Information

Test Agency	Texas Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-32
TTI Test No.	400001-SRT8
Date	January 21, 2011

Test Article

Type	Terminal
Name	SRT-MASH
Installation Length	125 ft
Material or Key Elements	Slotted rail, CRP post 1, SYTP, anchor bracket and cable
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type/Designation	1100C
Make and Model	2005 Kia Rio
Curb	2385 lb
Test Inertial	2412 lb
Dummy	172 lb
Gross Static	2584 lb

Impact Conditions

Speed	61.5 mi/h
Angle	5.4 degrees
Location/Orientation	Nose
Kinetic Energy	305 kip-ft*

Exit Conditions

Speed	40.0 mi/h
Angle	2.0 degrees

Occupant Risk Values

Longitudinal OIV	24.6 ft/s
Lateral OIV	3.3 ft/s
Longitudinal RDA	5.0 g
Lateral RDA	5.6 g
THIV	27.3 km/h
PHD	7.4 g
ASI	0.64
Max. 0.050-s Average	
Longitudinal	-6.7 g
Lateral	1.8 g
Vertical	-5.2 g

Post-Impact Trajectory

Stopping Distance	191 ft dwnstrm 35 ft twd field side

Vehicle Stability

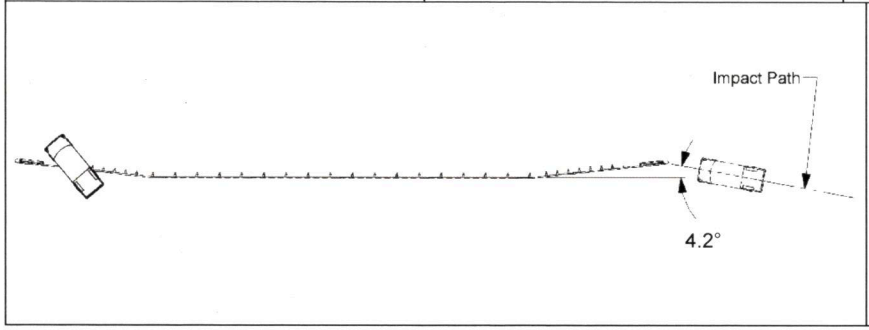
Maximum Yaw Angle	-8 degrees
Maximum Pitch Angle	14 degrees
Maximum Roll Angle	-32 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

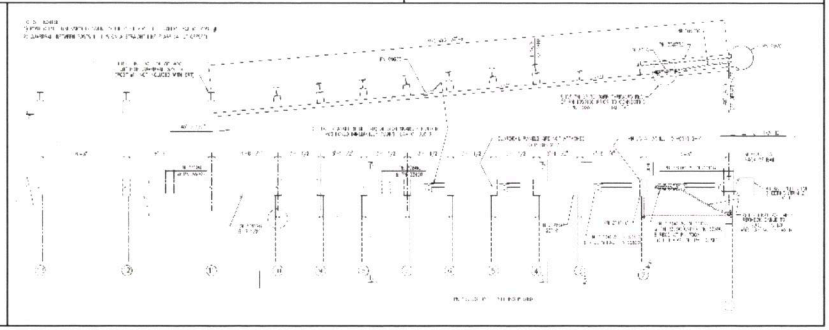
Test Article Deflections

Dynamic	4.0 ft
Permanent	4.0 ft
Working Width	NA

Vehicle Damage

VDS	12FD6
CDC	12FDEW4
Max. Exterior Deformation	7.0 inches
OCDI	FS0000000
Max. Occupant Compartment Deformation	0





General Information

Test Agency	Texas A&M Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-33
TTI Test No.	690900-SRT9
Test Date	2017-02-09

Test Article

Type	Terminal
Name	SRT M10
Installation Length	181 ft-3 inches
Material or Key Elements	37 ft-6-inch long SRT M10 terminal with steel posts and 8-inch deep routered wood offset blocks
Soil Type and Condition	AASHTO M147-65(2004), grading B Soil (crushed limestone), damp

Test Vehicle

Type/Designation	2270P
Make and Model	2012 Dodge RAM 1500
Curb	4934 lb
Test Inertial	5040 lb
Dummy	No dummy
Gross Static	5040 lb

Impact Conditions

Speed	63.2 mi/h
Angle Relative to LON	4.2 degrees
Location/Orientation	Post 1
Impact Severity	673 kip-ft

Exit Conditions

Speed	51.5 mi/h
Angle Relative to LON	4.9 degrees

Occupant Risk Values

Longitudinal OIV	14.1 ft/s
Lateral OIV	3.0 ft/s
Longitudinal Ridedown	6.9 g
Lateral Ridedown	6.5 g
THIV	15.9 km/h
PHD	7.6 g
ASI	0.30
Max. 0.050-s Average	
Longitudinal	−3.8 g
Lateral	−1.9 g
Vertical	−2.1 g

Post-Impact Trajectory

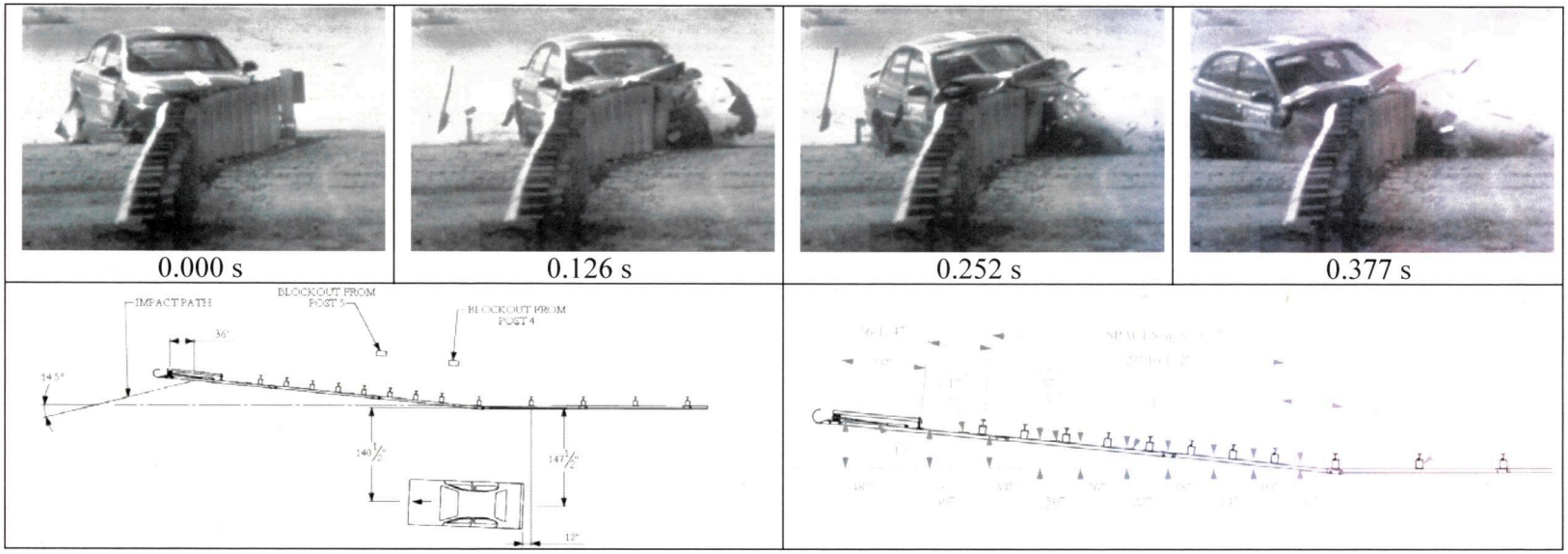
Stopping Distance	173 ft dwnstrm 10 ft twd traffic side

Vehicle Stability

Maximum Yaw Angle	27 degrees
Maximum Pitch Angle	3 degrees
Maximum Roll Angle	11 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

Vehicle Damage

VDS	01RFQ6
CDC	01RFEW4
Max. Exterior Deformation	16.0 inches
OCDI	FS0000000
Max. Occupant Compartment Deformation	None



General Information

Test Agency	Texas Transportation Institute (TTI)
Test Standard Test No.	MASH 3-34
TTI Test No.	400001-SRT4
Date	October 19, 2010

Test Article

Type	Terminal
Name	SRT-MASH
Installation Length	131 ft-3 inches
Material or Key Elements	Slotted rail, CRP post 1, SYTP, anchor bracket and cable
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type/Designation	1100C
Make and Model	2004 Kia Rio
Curb	2428 lb
Test Inertial	2431 lb
Dummy	174 lb
Gross Static	2605 lb

Impact Conditions

Speed	62.2 mi/h
Angle	14.5 degrees
Location/Orientation	24 inches dwnstrm post 1
Impact Severity	19 kip-ft,

Exit Conditions

Speed	13.3 mi/h
Angle	64.6 degrees

Occupant Risk Values

Impact Velocity	
Longitudinal	34.8 ft/s
Lateral	13.4 ft/s
Ridedown Accelerations	
Longitudinal	12.0 g
Lateral	5.4 g
THIV	41.1 km/h
PHD	13.0 g
ASI	1.08
Max. 0.050-s Average	
Longitudinal	-11.9 g
Lateral	3.9 g
Vertical	3.0 g

Post-Impact Trajectory

Stopping Distance	43.8 ft

Vehicle Stability

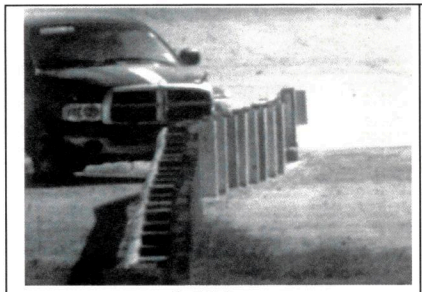
Maximum Yaw Angle	-166 degrees
Maximum Pitch Angle	2 degrees
Maximum Roll Angle	11 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

Test Article Deflections

Dynamic	2.62 ft
Permanent	2.62 ft
Working Width	2.62 ft

Vehicle Damage

VDS	11LFQ6
CDC	11FLEW4
Max. Exterior Deformation	15.5 inches
OCDI	FS0000000
Max. Occupant Compartment Deformation	0



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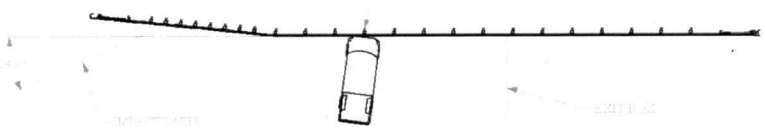
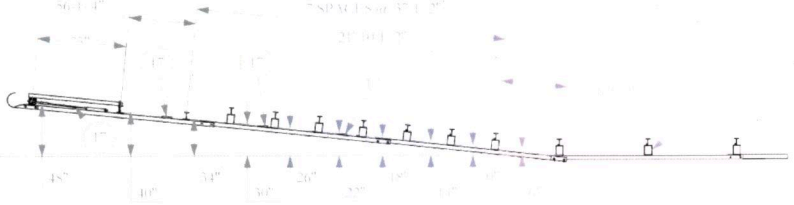




General Information

Test Agency	Texas Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-35
TTI Test No.	403371-SRT3
Date	2010-10-04

Test Article

Type	Terminal
Name	SRT-MASH
Installation Length	137 ft-6 inches
Material or Key Elements	Slotted rail, CRP post 1, SYTP, anchor bracket and cable
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type/Designation	2270P
Make and Model	2003 Dodge Ram 1500 Pickup
Curb	4712 lb
Test Inertial	4948 lb
Dummy	No dummy
Gross Static	4948 lb

Impact Conditions

Speed	62.4 mi/h
Angle	24.3 degrees
Location/Orientation	Post 4
Impact Severity	3507 kip-ft (-4.9%)

Exit Conditions

Speed	Not obtainable
Angle	Not obtainable

Occupant Risk Values

Impact Velocity	
Longitudinal	21.6 ft/s
Lateral	16.7 ft/s
Ridedown Accelerations	
Longitudinal	8.1 G
Lateral	5.2 G
THIV	29.5 km/h
PHD	9.4 G
ASI	0.77
Max. 0.050-s Average	
Longitudinal	-6.7 G
Lateral	5.1 G
Vertical	1.6 G

Post-Impact Trajectory

Stopping Distance	81.3 ft

Vehicle Stability

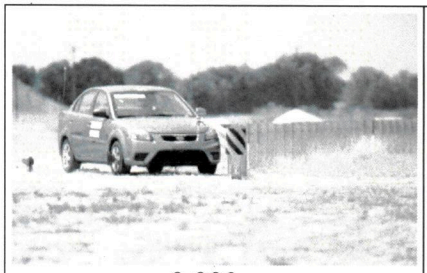
Maximum Yaw Angle	-43 degrees
Maximum Pitch Angle	-5 degrees
Maximum Roll Angle	9 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

Test Article Deflections

Dynamic	3.8 ft
Permanent	3.8 ft
Working Width	4.0 ft

Vehicle Damage

VDS	11LFQ5
CDC	11FLEW4
Max. Exterior Deformation	16.0 inches
OCDI	LF0000000
Max. Occupant Compartment Deformation	1.5 inches



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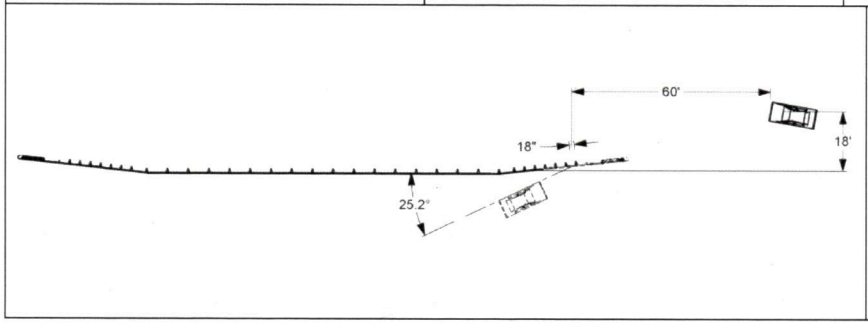
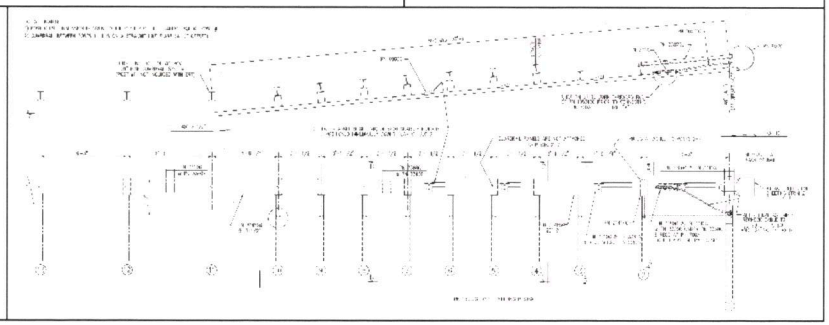




General Information

Test Agency	Texas A&M Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-37b
TTI Test No.	190140-SRT12
Test Date	2017-06-21

Test Article

Type	Terminal
Name	SRT M10
Installation Length	181 ft 3 inches
Material or Key Elements	37 ft-6-inch long, 31-inch tall, SRT M10 terminal with steel posts and 8-inch deep routered wood offset blocks
Soil Type and Condition	AASHTO M147-65(2004), grading B Soil (crushed limestone), damp

Test Vehicle

Type/Designation	1100C
Make and Model	2011 Kia Rio
Curb	2470 lb
Test Inertial	2432 lb
Dummy	165 lb
Gross Static	2597 lb

Impact Conditions

Speed	61.7 mi/h
Angle Relative to LON	25.2 degrees
Location/Orientation	15 ft 6 ¾ inches upstream end Rev Direction
Impact Severity	54 kip-ft

Exit Conditions

Speed	30.8 mi/h
Angle Relative to LON	0.1 degrees

Occupant Risk Values

Longitudinal OIV	18.7 ft/s
Lateral OIV	14.8 ft/s
Longitudinal Ridedown	12.9 g
Lateral Ridedown	7.4 g
THIV	25.7 km/h
PHD	13.0 g
ASI	0.85
Max. 0.050-s Average	
Longitudinal	-9.3 g
Lateral	6.0 g
Vertical	-4.5 g

Post-Impact Trajectory

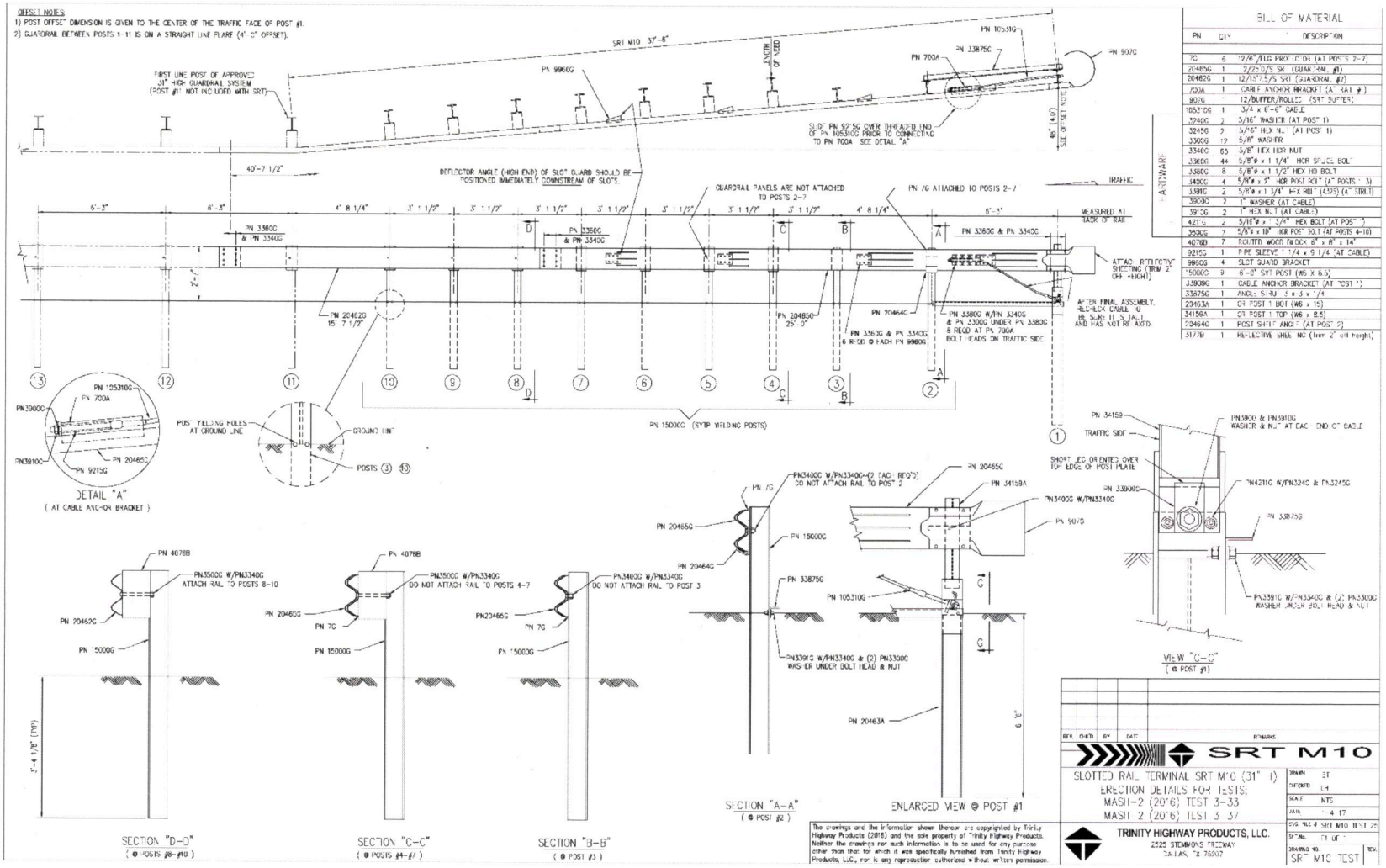
Stopping Distance	60 ft downstream 18 ft twd field side

Vehicle Stability

Maximum Yaw Angle	115 degrees
Maximum Pitch Angle	6 degrees
Maximum Roll Angle	13 degrees
Vehicle Snagging	No
Vehicle Pocketing	No

Vehicle Damage

VDS	11LFQ3
CDC	11LFEW2
Max. Exterior Deformation	12.0 inches
OCDI	LF0000000
Max. Occupant Compartment Deformation	0.5 inch



BILL OF MATERIAL

PN	QTY	DESCRIPTION
7G	6	12/8"/FLG PROTECTOR (AT POSTS 2-7)
20465G	1	7/25 D/S SR (GUARDRAIL #1)
20462G	1	12/15'-5/S SRT (GUARDRAIL #2)
700A	1	CABLE ANCHOR BRACKET (A" RAIL #)
907G	1	12/BUFFER/ROLLED (SRT BUTTER)
105310G	1	3/4 x 8'-6" CABLE
3240G	2	5/16" WASHER (AT POST 1)
3245G	2	5/16" HEX NUT (AT POST 1)
3300G	12	5/8" WASHER
3340G	65	5/8" HEX HDR NUT
3360G	44	5/8"Ø x 1 1/4" HDR SPLICE BOLT
3380G	8	5/8"Ø x 1 1/2" HEX HD BOLT
3400G	4	5/8"Ø x 3" HDR POST BOLT (AT POSTS 1, 3)
3391G	2	5/8"Ø x 1 3/4" HEX HDL (A325) (AT SBRT)
3900G	2	1" WASHER (AT CABLE)
3910G	2	1" HEX NUT (AT CABLE)
4211G	2	5/16"Ø x 1 3/4" HEX BOLT (AT POST 1)
3500G	7	5/8"Ø x 10" HDR POST BOLT (AT POSTS 4-10)
4078B	7	ROUTED WOOD BLOCK 8" x 8" x 14"
9215G	1	PIPE SLEEVE 1 1/4 x 9 1/4 (AT CABLE)
9960G	4	SLOT GUARD BRACKET
15000G	9	6'-0" SYT POST (W6 X 8.5)
33809G	1	CABLE ANCHOR BRACKET (AT POST 1)
33875G	1	ANGLE S-RU 3 x 3 x 1/4
20463A	1	SYT POST 1 BOT (W6 x 15)
34159A	1	SYT POST 1 TOP (W6 x 8.5)
20464G	1	POST SPLIT ANGLE (AT POST 2)
3178	1	REFLECTIVE SHEETING (trim 2" off height)

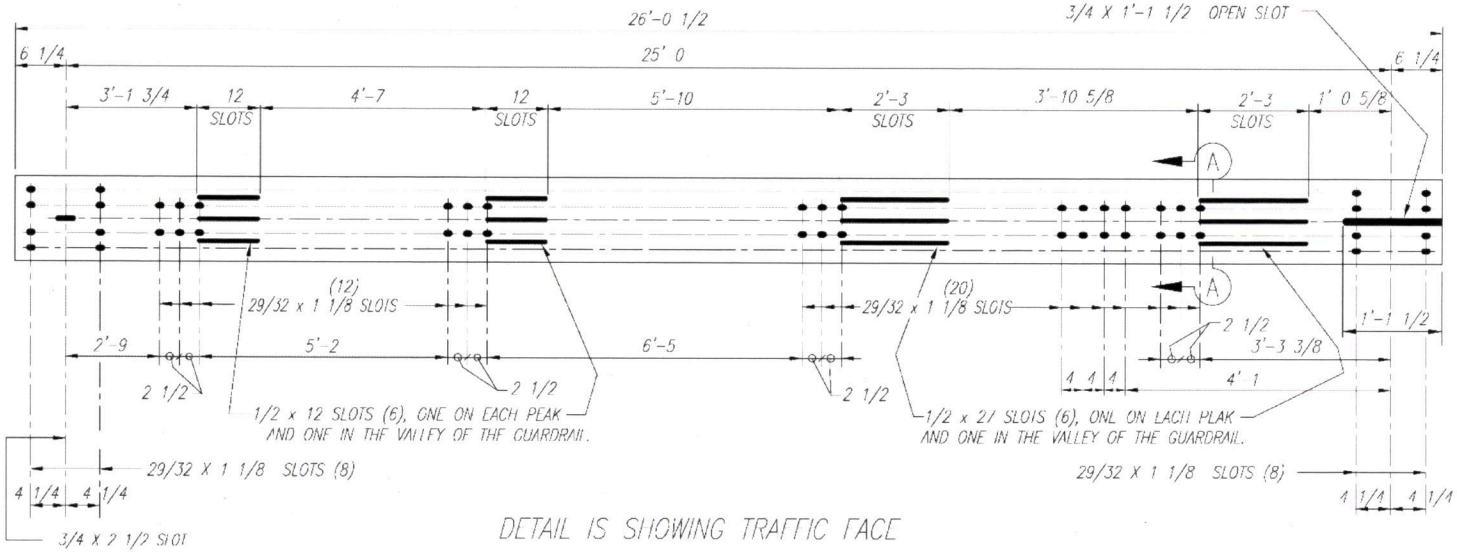
REV.	CHKD.	BY	DATE	REMARKS

SRT M10

SLOTTED RAIL TERMINAL SRT M10 (31" H)
ERECTION DETAILS FOR TESTS:
MASH-2 (20'6) TEST 3-33
MASH 2 (20'6) TEST 3-37

DRAWN: BT
CHECKED: LH
SCALE: NTS
DATE: 11 4 17
DWG FILE # SRT M10 TEST 2S
SHEET No.: 01 OF 1
DRAWING NO.: SRT M10 TEST
REV.

TRINITY HIGHWAY PRODUCTS, LLC.
2525 STEMMONS FREEWAY
DALLAS, TX 75207



DETAIL IS SHOWING TRAFFIC FACE

SECTION A. – A

This part combines SRT M10 Rails #1 & #2. (PN 20460 & 20461)

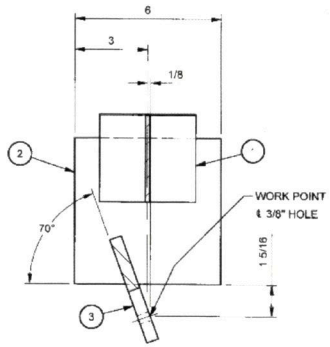
APPROX. SHPG. WT.: 185#

MK	BY	DATE	REVISION

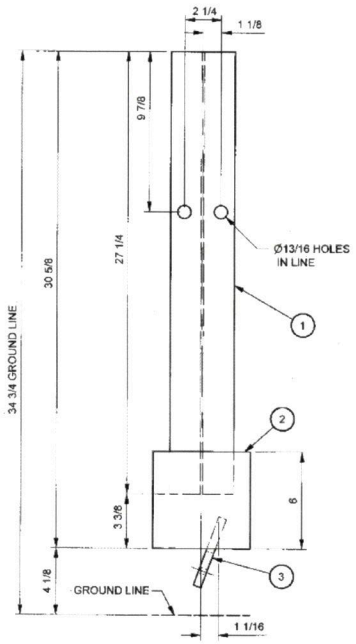
MATERIAL: AASHTO M. 180 (12 Ga.)		FINISH M-180	
TRINITY HIGHWAY PRODUCTS, LLC. 2525 STEMMONS FREEWAY DALLAS, TX 75207			
12/25'-0"/SPEC AL/S SR – MASH RAIL #1 & #2 COMBINED			
DRAWN: EF	CHKD: LH	SCALE: N. S.	DATE: 12-5-16
DRAWING NO: 20465			REV. 0

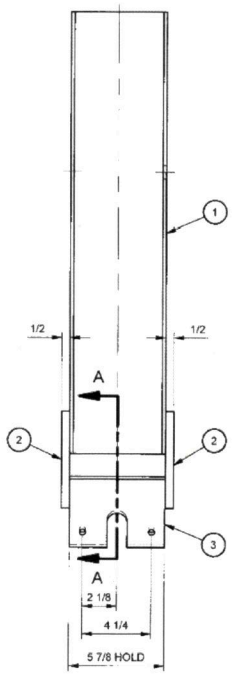
F:\Rf\Share\Engineering\SS\WIP\SRT MASH\20465 Combo Rail.dwg

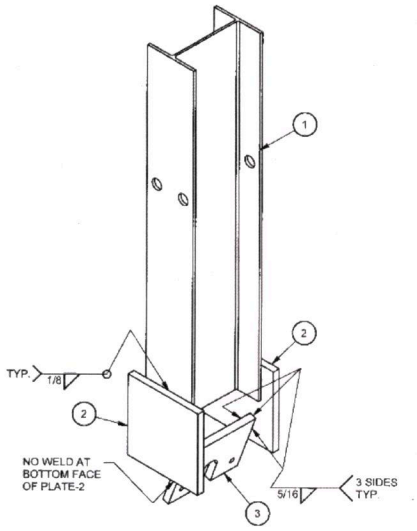
PARTS LIST				
ITEM	PART NO.	DESCRIPTION		QTY.
1	34158	W6 x 8.5X 2'- 3 1/4"	A36	1
2	625565	PL 1/2 x 6" x 6"	A36	2
3	625566	PL 1/2 x 4 1/2" x 5 7/8"	A36	1



SECTION A-A







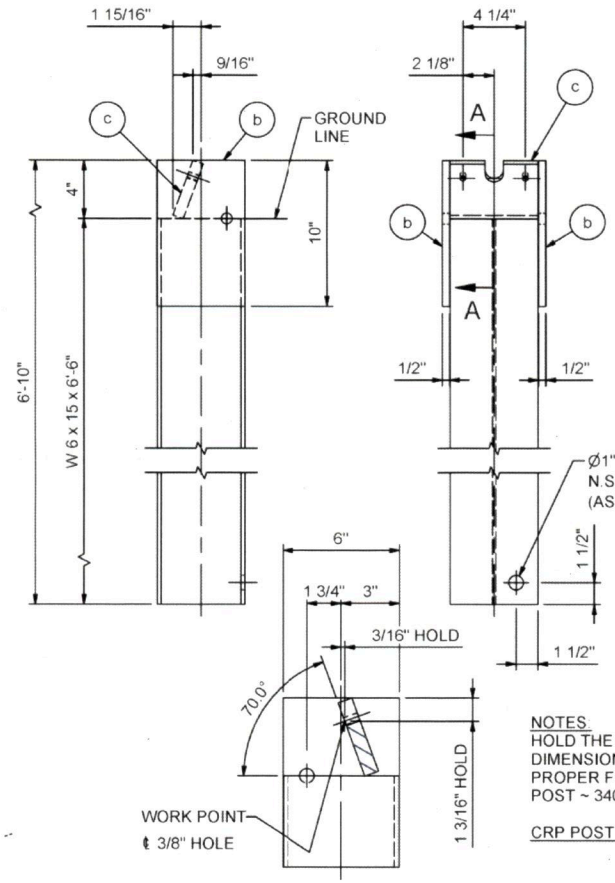
NOTES:
1. HOLD THE NOTED DIMENSION TO ENSURE A PROPER FIT WITH LOWER POST ~ 20463A. AFTER GALVANIZING.

CPR POST PATENT: 7556242

MATERIAL: SEE PARTS LIST	DRAWN: C.C.	DATE: 9/8/2016	TOLERANCES PER CEMC-THP-SF-001, UNLESS OTHERWISE SPECIFIED.	SRT-M10 TERMINAL POST CRP - POST W6 X 8.5 - UPPER POST	TRINITY HIGHWAY PRODUCTS
FINISH: GALVANIZE,ASTM A123	CHECKED: B.T.	DATE: 9/8/2016	DO NOT SCALE DRAWING	PROTOTYPE FOR TEST	
	UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE IN INCHES. DIMENSIONS ACCORDING TO ASME Y14.5M AND CEMC-THP-SF-003 UNLESS OTHERWISE SPECIFIED.		ECO / Date / Rev / By / Chk.		
EST UNFINISHED WT: 31.2 lbs	Revision			DRAWING: 034159 TST	REV: -	SHEET: 1 of 1

BILL OF MATERIAL				
QTY	PC NO.	DESCRIPTION	Lbs / Each	MATERIAL
1	a	W 6 x 15 x 6'-6"	97.43	SEE NOTE
2	b	PL 1/2 x 6 x 10	8.46	A36
1	c	PL 3/4 x 4 x 6	4.77	A36

W 6 x 15 MATERIAL SPEC.: A992 / A572 OR A36.



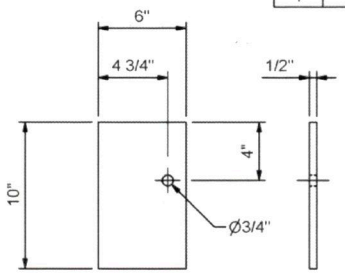


PLATE - b

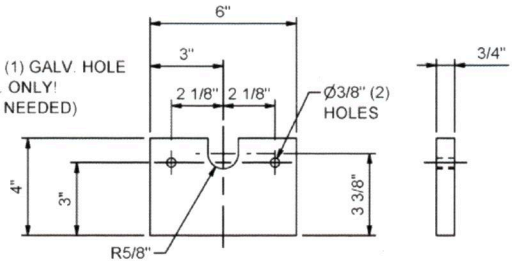
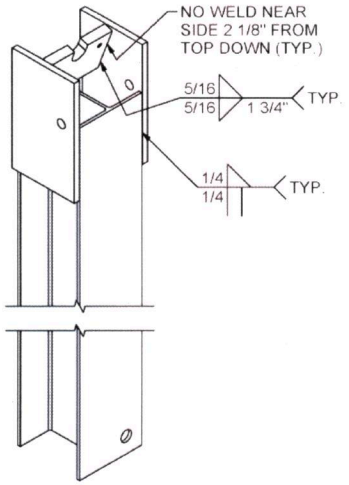


PLATE - c



SECTION A-A

NOTES:
HOLD THE NOTED DIMENSIONS TO ENSURE A PROPER FIT WITH UPPER POST ~ 34053.

CRP POST PATENT: 7556242

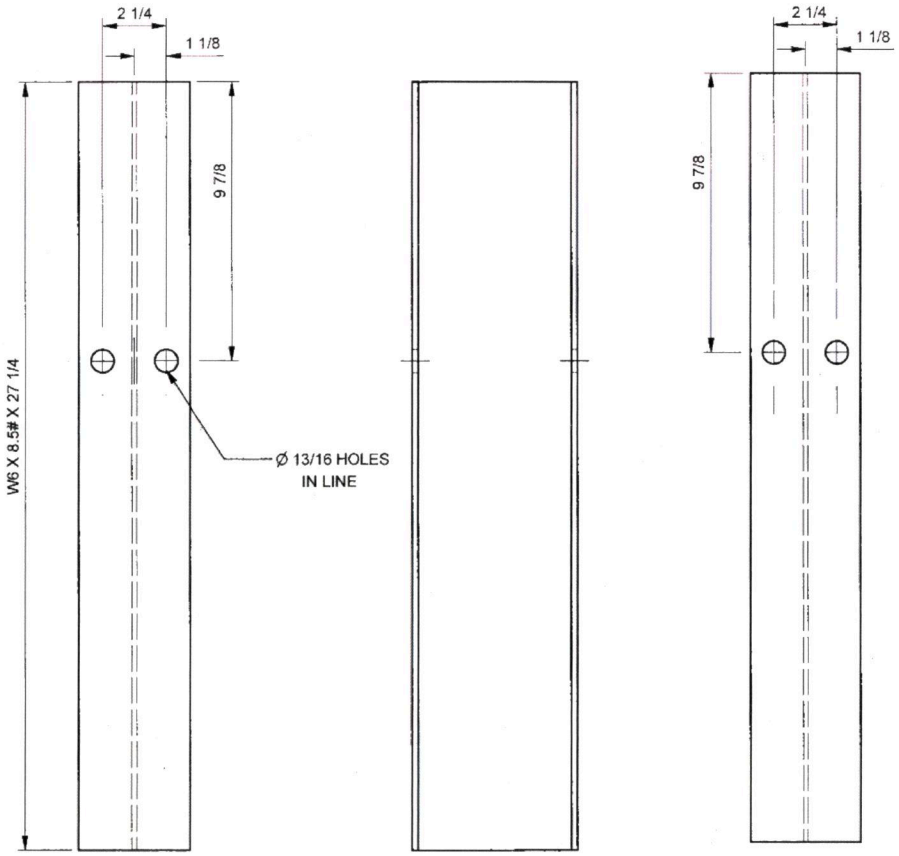
PROJ | SRT-MASH POST

SRT-MASH TERMINAL POST
CRP - POST
W6 x 15 - LOWER POST

TRINITY HIGHWAY PRODUCTS, LLC

SPEC:	A123	
SHIP WT:	126 lb	
DRW: E.A.S	3/4/2013	
CHK: B.T	3/6/2013	
SHT: 1 OF 1	SIZE: B	
DWG NO: 020463	REV: 0	

file: 020463.idw



MATERIAL: ASTM A36	
FINISH: GALVANIZE,ASTM A123	
EST UNFINISHED WT:-	20.3 lbs

NOTES:
1. FINISH AND GENERAL WORKMANSHIP PER CEMC-THP-SF-004, UNLESS OTHERWISE SPECIFIED.

DRAWN: cortesc	DATE: 9/9/2016
CHECKED: BT	DATE: 9-9-16

UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE IN INCHES
DIMENSIONS ACCORDING TO ASME Y14.5M AND CEMC-THP-SE-003 UNLESS OTHERWISE SPECIFIED.

TOLERANCES PER CEMC-THP-SF-001, UNLESS OTHERWISE SPECIFIED.

DO NOT SCALE DRAWING

Revision	ECO	Date	Rev	By	Chk.

W6 x 8.5X 2' -31/4"

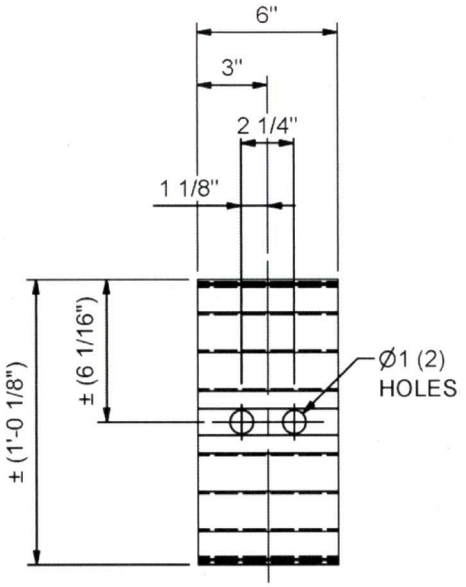
PROTOTYPE FOR TEST

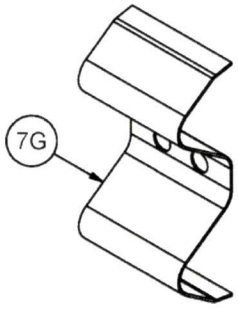
TRINITY HIGHWAY

DRAWING: 034158 TST | REV: - | SHEET: 1 of 1

CEMC-THP-FE-044 Rev E, 1/22/2018

BILL OF MATERIAL				
QTY	PART No	DESCRIPTION	Lbs / Each	MATERIAL
1	7G	12 GA W-BEAM GUARDRAIL x 6"	3.32	M180





REVISION HISTORY			
REV	DESCRIPTION	DATE	BY
1	HOLES FROM 13/16 TO 1"	7/13/2006	E.A.S.

All material must be melted and manufactured in the U.S.A. Original raw material producing mill test reports are required. All mill test reports must be signed by an authorized representative of the producing mill. All material must have full traceability from all sources. All receipts must be identified by quantity, either in pounds or pieces, by heat number. All welding shall be in accordance with ANSI/AWS D1.1 section 5 and D1.5 section 3.

FLANGE PROTECTOR
T31 & T39 GUARDRAIL
SYSTEM - 12 GA W-BEAM x 6"

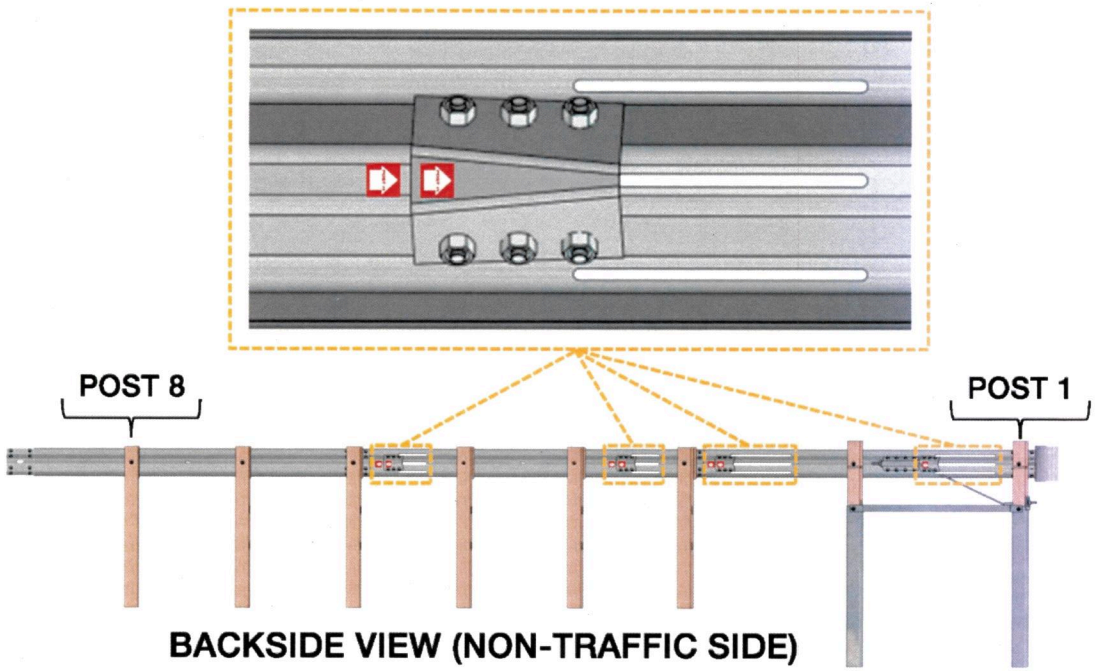
SPEC:	A123
SHIP WT:	3.52 lb
DRW: E.A.S.	5/21/2006
CHK: B.S.	5/22/2006
SHT: 1 OF 1	SIZE: A

TRINITY HIGHWAY PRODUCTS, LLC

DWG NO: 000007 REV 1

PROJ. T31 & T39 SYSTEM

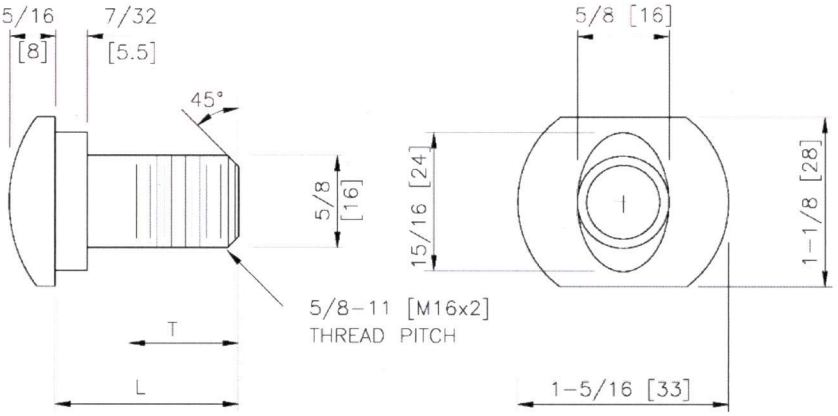
000007.idw



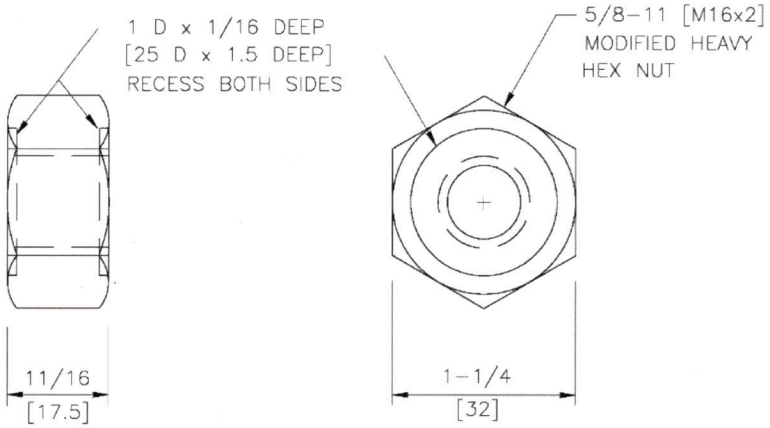
BACKSIDE VIEW (NON-TRAFFIC SIDE)

NOTE: APPLIES TO BOTH WOOD & STEEL POST SRT CONFIGURATIONS.

NOTES: 1. ALL FILLETS SHALL HAVE A MINIMUM RADIUS OF 1/16 [2].
2. IF THE BOLT EXTENDS MORE THAN 1/4 [6] FROM THE NUT THE BOLT SHOULD BE TRIMMED BACK.



DESIGNATOR	L	T (MIN)
FBB01	1–1/4 [35]	1–1/8 [30]
FBB02	2 [50]	1–3/4 [45]
FBB03	10 [255]	4 [100]
FBB04	18 [460]	4 [100]
FBB05	25 [640]	4 [100]



1976

GUARDRAIL BOLT AND RECESSED NUT

FBB01–05

SHEET NO.	DATE:
1 of 2	6/30/2005

SPECIFICATIONS

The geometry and material specifications for this oval shoulder button-headed bolt and hex nut are found in AASHTO M 180. The bolt shall have 5/8-11 [M16x2] threads as defined in ANSI B1.1 [ANSI B1.13M] for Class 2A [6g] tolerances. Bolt material shall conform to ASTM A307 Grade A [ASTM F 568M Class 4.6], with a tensile strength of 60 ksi [400 MPa] and yield strength of 36 ksi [240 MPa]. Material for corrosion-resistant bolts shall conform to ASTM A325 Type 3 [ASTM F 568M Class 8.8.3], with tensile strength of 120 ksi [830 MPa] and yield strength of 92 ksi [660 MPa]. This bolt material has corrosion resistance comparable to ASTM A588 steels. Metric zinc-coated bolt heads shall be marked as specified in ASTM F 568 Section 9 with the symbol "4.6."

Nuts shall have ANSI B1.1 Class 2B [ANSI B1.13M Class 6h] 5/8-11 [M16x2] threads. The geometry of the nuts, with the exception of the recess shown in the drawing, shall conform to ANSI B18.2.2 [ANSI B18.2.4.1M Style 1] for zinc-coated hex nuts (shown in drawing) and ANSI B18.2.2 [ANSI B18.2.4.6M] for heavy hex corrosion-resistant nuts (not shown in drawing). Material for zinc-coated nuts shall conform to the requirements of AASHTO M 291 (ASTM A 563) Grade A [AASHTO M 291M (ASTM A 563M) Class 5], and material for corrosion-resistant nuts shall conform to the requirements of AASHTO M 291 (ASTM A 563) Grade C3 [AASHTO M 291M (ASTM A 563M) Class 8S3].

When zinc-coated bolts and nuts are required, the coating shall conform to either AASHTO M 232 (ASTM A 153/A 153M) for Class C or AASHTO M 298 (ASTM B 695) for Class 50. Zinc-coated nuts shall be tapped over-size as specified in AASHTO M 291 (ASTM A 563) [AASHTO M 291M (ASTM A 563M)], except that a diametrical allowance of 0.020 inch [0.510 mm] shall be used instead of 0.016 inches [0.420 mm].

Designator	Stress Area of Threaded Bolt Shank (in^2 [mm^2])	Min. Bolt Tensile Strength (kips [kN])
FBB01-05	0.226 [157.0]	13.6 [62.8]

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

INTENDED USE

These bolts and nuts are used in numerous guardrail and median barrier designs.

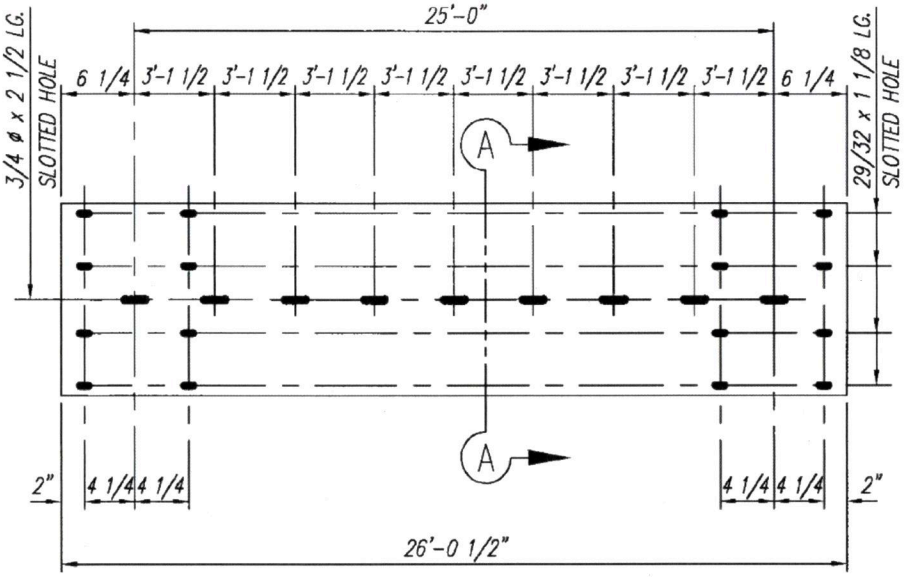
GUARDRAIL BOLT AND RECESSED NUT

FBB01-05

SHEET NO.	DATE
2 of 2	6/30/2005

BILL OF MATERIAL

TOTAL REQ'D	PIECE MARK	MATERIAL	LENGTH FEET	LENGTH INCHES	WEIGHT	REMARKS
1		12 GA. DP. BM. GUARDRAIL	25	0	192	M180



SECTION A–A

⚠1 REVISED FORMAT ONLY

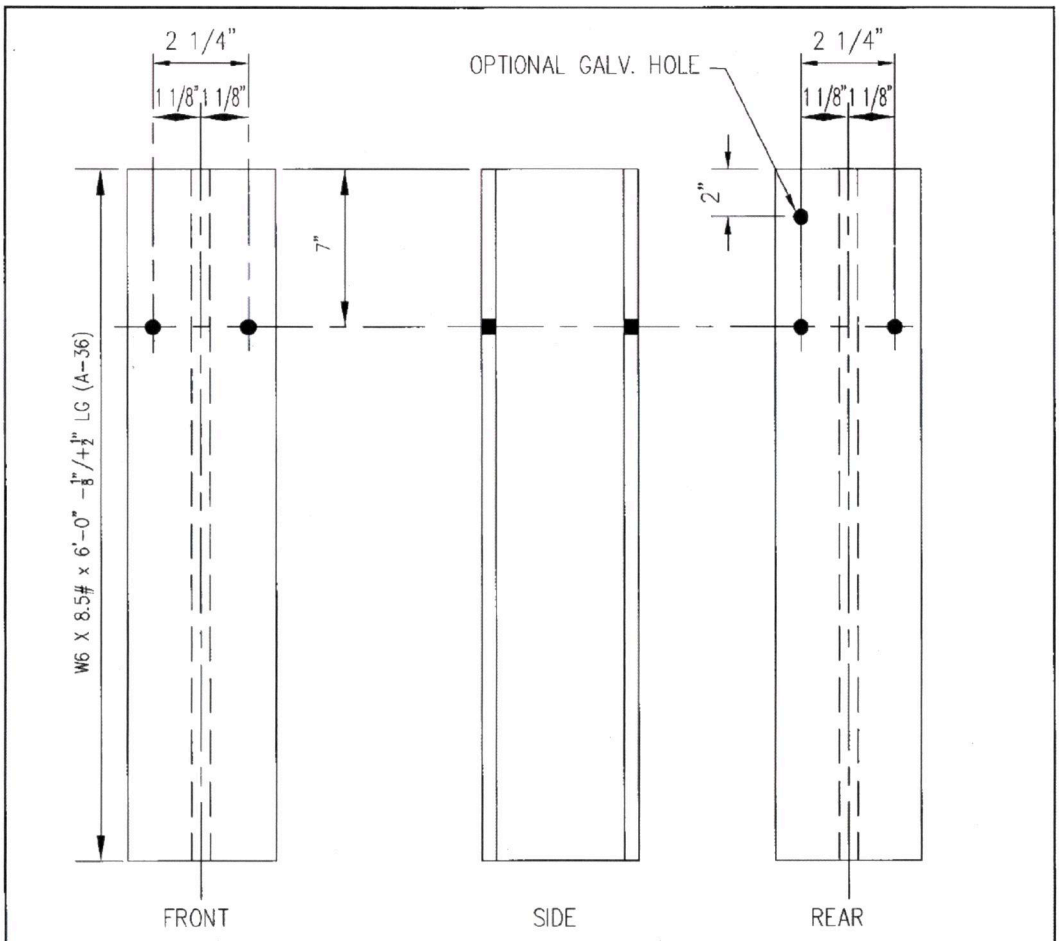
USED ON	
A/R	STANDARD

REVISION #	BY	DATE	CHK.
⚠1	D.B.W.	2-3-93	J.L.S.

GUARDRAIL, W-BEAM – 12 GA X 25'-0 WITH INTERMITTENT HOLES @ 3'-1 1/2

TRINITY INDUSTRIES, INC. SYRO

GALV. SPEC.	A123
SHIPPING WT.	192
DRWN. E.S.	9-25-89
CHK. J.L.S.	9-26-89
SK REFERENCE	1534
	61 ⚠1



ALL HOLES 13/16" ø DIA.

STATE:

APPROX. SHPG. WT.; 54 #

MK	BY	DATE	REVISION
3	LH	4/24/09	ADDED OPTIONAL GALV HOLE
2	SAR	3/11/05	ADDED TOLERANCE TO LENGTH
1	LH	01/09/02	REDRAWN W/O CHANGE

ITEM CLASS:

MATERIAL: A-36 | FINISH A-123

TRINITY HIGHWAY PRODUCTS, LLC.
2525 STEMMONS FREEWAY
DALLAS, TX 75207

6'-0" POST/W6X8.5# DDR

DRAWN: L.R.	CHKD: T.P.	SCALE: N.T.S.	DATE: 09/26/85
DRAWING NO: 533			REV. 3

TRINITY HIGHWAY

MATERIAL SPECIFICATION

Doc #: ENG-FE-018 Page 1 of 1
Rev: 4 By: ENG-TM
Doc Type: Form App'd:

Part Number: **003300**

Description: **5/8" WASHER F844 A/W**

Specification:

WASHER, STEEL FLAT, 0.656" ID X 1.750" OD X 0.100" THK.
WASHER DIMENSIONS TO BE PER ANSI-B18.22.1 - TYPE A, SERIES W.

003300G - SHALL BE HOT DIPPED GALVANIZED PER ASTM-A153 CLASS C, OR MECHANICALLY GALVANIZED PER ASTM-B695 CLASS 50.

003300C - WASHER, (CORTEN - WEATHERING) STEEL FLAT, SPECIFICATION ASTM-F844.

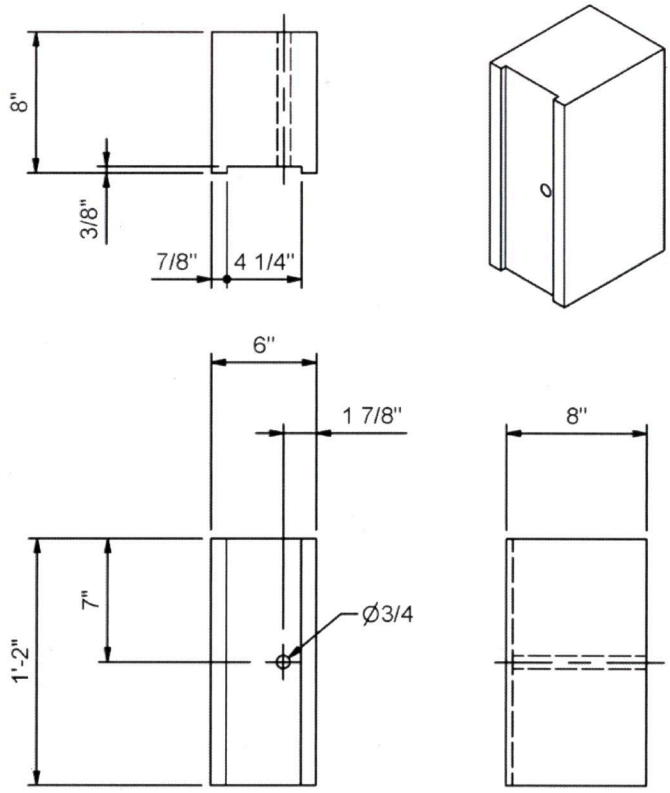
☒ Apply: ☐ Does Not Apply:
ALL STEEL AND/OR IRON MUST BE MELTED AND MANUFACTURED IN THE USA, IN COMPLIANCE WITH THE FEDERAL HIGHWAY ADMINISTRATION BUY AMERICA REQUIREMENTS. ORIGINAL RAW MATERIAL PRODUCING MILL TEST REPORTS ARE REQUIRED. ALL MATERIAL MUST HAVE FULL TRACEABILITY BY HEAT NUMBER FROM ALL SOURCES, INCLUDING 3RD PARTY PROCESSORS AND GALVANIZERS. ALL RECEIPTS MUST BE IDENTIFIED BY QUANTITY, EITHER IN POUNDS OR PIECES, BY HEAT NUMBER.

☐ Approved Manufacturer(s): ☐ Vendor Reference:

Prepared:	R. VENZON	09/25/14
Engineer:	C. BACKHAUS	10/15/14
Purchasing:	S. Brasher	10/17/14

Revision Description	ECO	Rev	By	Date	Eng	Pur
Rev B to match Romacs	-	B	-	-	-	-

BILL OF MATERIAL				
QTY	PART No	DESCRIPTION	Lbs / Each	REMARKS
1	4076B	WOOD BLOCK 6 x 8 x 1'-2"	17.06	AASHTO M168



NOTES:
SUPPLY WOOD BLOCKS PER AASHTO M168.
TREAT WITH PRESERVATIVE PER AASHTO M133.

REVISION HISTORY						
REV	REVISION	ECO	DATE	BY	APPR.	AP. DATE
1	REDRAWN IN INVENTOR		6/30/2014	EAS		6/30/2014

All material must be melted and manufactured in the U.S.A. Original raw material producing mill test reports are required. Mill test reports must be signed by an authorized representative of the producing mill. Material must have full traceability from all sources. Receipts must be identified by quantity, either in pounds or pieces, by heat number. Welding shall be in accordance with ANSI/AWS D1.1 section 5 and D1.5 section 3.
Tolerances per QMS-SF-001 (U.N.O.). Finish and general workmanship per QMS-SF-004 (U.N.O.).

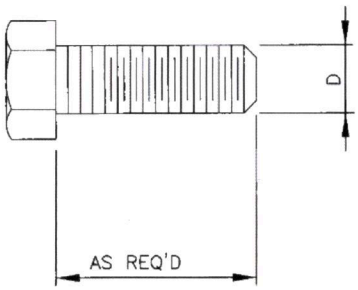
PROJ.

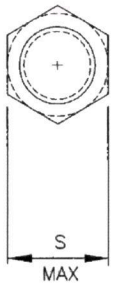
WOOD BLOCK - WBEAM RECESSED
FOR USE W/ STEEL POST ONLY
WD BLK RTD 6X8X14

SPEC:		
SHIP WT:	17.1 lb	
DRW:	RMH	8/27/1998
CHK:	EAS	8/27/1998
SHT: 1 OF 1	SIZE:	A
DWG NO: 4076		REV 1

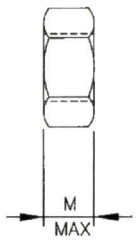
TRINITY HIGHWAY

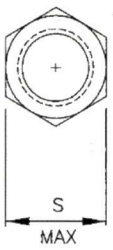
004076.idw





DESIGNATOR	ANSI SIZE	D	M	S
FBX06a	1/4–20 [M6x1]	4/16 [6]	13/64 [5.2]	25/64 [10.0]
FBX08a	5/16–18[M8x1.25]	5/16 [8]	17/64 [6.8]	32/64 [13.0]
FBX10a	3/8–16 [M10x1.5]	6/16 [10]	21/64 [8.4]	40/64 [16.0]
FBX12a	7/16–14 [M12x1.75]	8/16 [12]	27/64 [10.8]	45/64 [18.0]
FBX14a	1/2–13[M14x2]	9/16 [14]	32/64 [12.8]	53/64 [21.0]
FBX16a	5/8–11 [M16x2]	10/16 [16]	37/64 [14.8]	60/64 [24.0]
FBX20a	3/4–10 [M20x2.5]	12/16 [20]	45/64 [18.0]	1 12/64 [30.0]
FBX24a	1–8 [M24x3]	15/16 [24]	54/64 [21.5]	1 26/64 [36.0]





CLASS 4.6 HEX BOLT & NUT

FBX06a–24a

SHEET NO.	DATE:
1 OF 2	2006

SPECIFICATIONS

Class 4.6 bolts shall be manufactured according to the geometric specifications included in ANSI B18.2.3.5M. Threads shall conform to ANSI B1.13M for Class 6g threads. Material for zinc-coated bolts shall conform to ASTM F568 for Class 4.6 (400 MPa tensile strength and 240 MPa yield strength). Material for corrosion resistant bolts shall conform to ASTM F568 for Class 8.8.3 (830 MPa tensile strength and 660 MPa yield strength). Bolt heads shall be marked as specified in ASTM F568 Section 9 with the manufacturer's identification symbol and the symbol "4.6" if zinc-coated and "8.8.3" if corrosion resistant steel is used. ASTM F569 Class 4.6 bolts are essentially equivalent to SAE J429 Grade 2 bolts.

Zinc-coated nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.4.1M for metric Style 1 hex nuts (show in drawing). Corrosion resistant nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.4.6M for heavy hex nuts (not shown in drawing). Threads shall conform to ANSI B1.13M for Class 6H. Zinc-coated nuts shall conform to the requirements of AASHTO M291M (ASTM A563M) for Class 5 nuts. Corrosion resistant nuts shall conform to the requirements of AASHTO M291M (ASTM A563M) for Class 8S3 nuts.

Zinc-coated bolts and nuts shall be treated according to either AASHTO M232 (ASTM A153) or AASHTO M298 (ASTM B695) for Class 50.

Designator	Stress Area of Threaded Bolt Shank (mm^2)	Minimum Bolt Strength (kN)
FBX06a	20.1	8.0
FBX08a	36.6	14.6
FBX10a	58.0	23.2
FBX12a	84.3	33.7
FBX14a	115.0	46.0
FBX16a	157.0	62.8
FBX20a	245.0	98.0
FBX24a	353.0	141.0

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

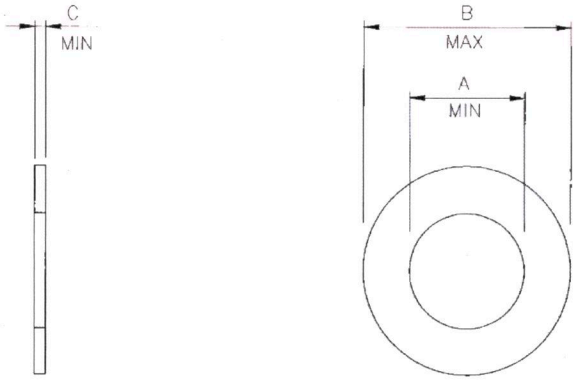
INTENDED USE

These bolts and nuts are used in various sign systems.

CLASS 4.6 HEX BOLT AND NUT

FBX06a-24a

SHEET NO.	DATE
2 of 2	



DESIGNATOR	A MIN	B MAX	C MIN	ANSI SIZE
FWC12b	15/32 [14.0]	61/64 [27.0]	0.051 [3.1]	7/16 [12]
FWC14b	17/32 [16.0]	1-3/32 [30.0]	0.097 [3.1]	1/2 [14]
FWC16b	11/16 [18.0]	1-11/32 [34.0]	0.122 [3.1]	5/8 [16]
FWC20b	13/16 [22.0]	1-1/2 [42.0]	0.122 [3.1]	3/4 [20]
FWC22b	15/16 [24.0]	1-25/32 [44.0]	0.136 [3.4]	7/8 [22]
FWC24b	1-1/8 [26.0]	2-1/32 [50.0]	0.136 [3.4]	1 [24]
FWC27b	1-1/4 [30.0]	2-9/32 [56.0]	0.136 [3.4]	1-1/8 [27]
FWC30b	1-3/8 [33.0]	2-17/32 [60.0]	0.136 [3.4]	1-1/4 [30]
FWC36b	1-1/2 [39.0]	2-25/32 [72.0]	0.136 [3.4]	1-3/8 [36]

HARDENED ROUND WASHER

FWC12b-36b

SHEET NO.	DATE:
1 of 2	7/14/2005

SPECIFICATIONS

Hardened steel washers shall be manufactured according to the requirements of AASHTO M 293 (ASTM F 436) [AASHTO M 293M (ASTM F 436M)]. If galvanized washers are required, they shall be treated according to either AASHTO M 232 (ASTM A153) for Class D or AASHTO M 298 (ASTM B695) for Class 50.

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

INTENDED USE

Hardened steel washers are used in a variety of applications in several barrier systems. These washers are generally used with high-strength structural bolts and high-strength heavy hex nuts as shown in this guide for FBX16b-36b.

HARDENED ROUND WASHER

FWC12b-36b	
SHEET NO.	DATE
2 of 2	7/14/2005

DESIGNATOR	ANSI SIZE	D	M MAX	S MAX
FNX06a	1/4–20 [M6x1]	1/4 [6]	7/32 [5.2]	7/16 [10.0]
FNX08a	5/16–18 [M8x1.25]	5/16 [8]	17/64 [6.8]	1/2 [13.0]
FNX10a	3/8–16 [M10x1.5]	3/8 [10]	21/64 [8.4]	9/16 [16.0]
FNX12a	7/16–14 [M12x1.75]	7/16 [12]	3/8 [10.8]	11/16 [18.0]
FNX14a	1/2–13 [M14x2]	1/2 [14]	7/16 [12.8]	3/4 [21.0]
FNX16a	5/8–11 [M16x2]	5/8 [16]	35/64 [14.8]	15/16 [24.0]
FNX20a	3/4–10 [M20x2.5]	3/4 [20]	41/64 [18.0]	1–1/8 [30.0]
FNX24a	1–8 [M24x3]	1 [24]	55/64 [21.5]	1–1/2 [36.0]
FNX30a	1–1/4–7 [M30x3.5]	1–1/4 [30]	1–1/16 [25.6]	1–7/8 [46.0]
FNX36a	1–3/8–6 [M36x4]	1–3/8 [36]	1–11/64 [31.0]	2–1/16 [55.0]

HEX NUTS

FNX06a–36a

SHEET NO.	DATE:
1 of 2	8/18/2005

SPECIFICATIONS

Zinc-coated nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.2 [ANSI B18.2.4.1M Style 1] for hex nuts (shown in drawing). Corrosion-resistant nuts shall be manufactured according to the dimensions and tolerances in ANSI B18.2.2 [ANSI B18.2.4.6M] for heavy hex nuts (not shown in drawing). Nuts shall conform to the requirements of AASHTO M 291 (ASTM A 563) Grade A [AASHTO M 291M (ASTM A 563M) Class 5]. Corrosion-resistant nuts shall have geometric properties defined in ANSI B18.2.2 [ANSI B18.2.4.1M] but shall have mechanical and material properties conforming to AASHTO M 291 (ASTM A 563) Grade C3 [AASHTO M 291M (ASTM A 563M) Class 8S3]. Threads shall conform to ANSI B1.1 Class 2B [ANSI B1.13M Class 6h]. Zinc-coated nuts shall be treated according to either AASHTO M 232 (ASTM A 153/A 153M) for Class C or AASHTO M 298 (ASTM B 695) for Class 50.

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

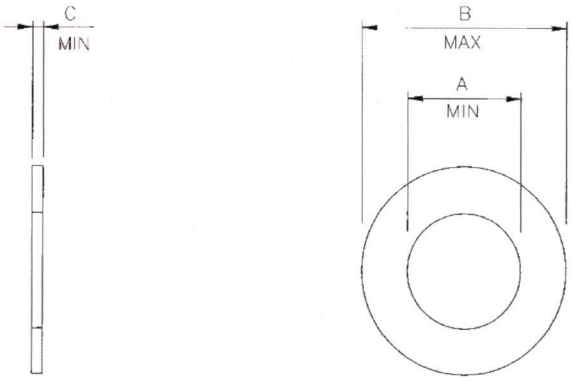
INTENDED USE

These nuts are used in numerous barrier designs.

HEX NUT

FNX06a-36a

SHEET NO.	DATE
2 of 2	8/18/2005



DESIGNATOR	A MIN	B MAX	C MIN	ANSI SIZE
FWC06a	0.276 [6.65]	0.749 [18.80]	0.056 [1.20]	1/4 [6]
FWC08a	0.339 [8.90]	0.890 [25.40]	0.056 [1.60]	5/16 [8]
FWC10a	0.401 [10.85]	1.015 [28.00]	0.056 [2.00]	3/8 [10]
FWC12a	0.526 [13.30]	1.280 [34.00]	0.090 [2.50]	1/2 [12]
FWC14a	0.589 [15.25]	1.499 [39.00]	0.090 [2.50]	9/16 [14]
FWC16a	0.649 [17.25]	1.780 [44.00]	0.090 [3.00]	5/8 [16]
FWC20a	0.805 [21.80]	2.030 [50.00]	0.090 [3.50]	3/4 [20]
FWC24a	1.055 [25.60]	2.530 [56.00]	0.146 [4.00]	1 [24]
FWC30a	1.305 [32.40]	3.030 [72.00]	0.146 [4.50]	1-1/4 [30]
FWC36a	1.552 [38.30]	3.545 [90.00]	0.234 [5.00]	1-1/2 [36]

PLAIN ROUND WASHER

FWC06a-36a

SHEET NO.	DATE:
1 of 2	6/27/2005

SPECIFICATIONS

Plain round steel washers shall be manufactured according to the dimensions and tolerances in ANSI B18.22 [B18.22M] for regular (Type B) series washers. Unless corrosion-resistant steel is used, washers shall be zinc-coated according to AASHTO M 232 (ASTM A153) for Class D or AASHTO M 298 (ASTM B695) for Class 50.

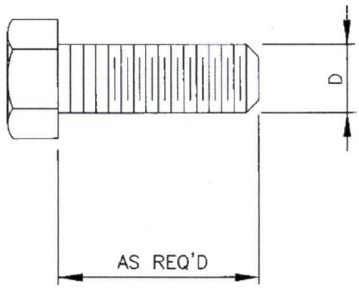
Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

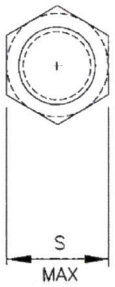
INTENDED USE

Plain round steel washers are used in a variety of applications in several barrier systems. These washers are usually used with standard-strength bolts and nuts as shown in this guide for FBX06a-36a.

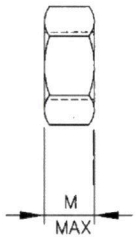
PLAIN ROUND WASHER

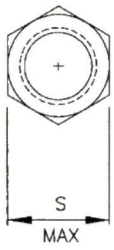
FWC06a-36a	
SHEET NO.	DATE
2 of 2	6/27/2005





DESIGNATOR	ANSI SIZE	D	M	S
FBX16b	5/8–11 [M16x2]	10/16 [16]	43/64 [17.1]	1 1/64 [27.0]
FBX20b	3/4–10 [M20x2.5]	12/16 [20]	52/64 [20.7]	1 22/64 [34.0]
FBX22b	7/8–9 [M22x2.5]	14/16 [22]	60/64 [23.6]	1 27/64 [36.0]
FBX24b	1–8 [M24x3]	15/16 [24]	6/64 [24.2]	1 39/64 [41.0]
FBX27b	1 1/8–7[M27x3]	1 1/16 [27]	1 6/64 [27.6]	1 52/64 [46.0]
FBX30b	1 1/4–7[M30x3.5]	1 3/16 [30]	1 13/64 [30.7]	1 62/64 [50.0]
FBX36b	1 3/8–6[M36x4]	1 6/16 [36]	1 28/64 [36.6]	2 23/64 [60.0]





STRUCTURAL HEX BOLT & NUT

FBX16b–36b

SHEET NO.	DATE:
1 OF 2	2006

INTENDED USE

High-strength heavy hex structural bolts shall conform to the requirements of AASHTO M164M (ASTM A325M) and shall be manufactured according to the geometric specifications included in ANSI B18.2.3.7M. Threads shall conform to ANSI B1.13M for Class 6g. Material for zinc-coated bolts shall conform to AASHTO M164M (ASTM A325M) for Type 1 bolts (800 MPa tensile strength and 660 MPa yield strength) and shall bear the head identification marking "8S" and "A-325M." Material for corrosion resistant bolts shall conform to AASHTO M164M (ASTM A325M) Type 3 bolts and shall bear the head identification marks "8S3", "A 325M", and a symbol identifying the manufacturer.

Heavy hex nuts shall be manufactured according to AASHTO M291M (ASTM A563M) using the geometry of ANSI B18.2.4.6M. Threads shall conform to ANSI B1.13M for class 6H threads. Zinc-coated nuts shall conform to AASHTO M291M (ASTM A563M) for Class 10s nuts and shall bear the identification mark "lOSn, and the manufacturer's identification symbol. Corrosion resistant nuts shall comply to AASHTO M291M (ASTM A563M) for Class 8S3 nuts and shall bear the identification mark "8S3" and the manufacturer's identification symbol.

Zinc-coated bolts and nuts shall be treated according to either AASHTO M232 (ASTM A153) for Class C or AASHTO M298 (ASTM B695) for Class 50, Type 1.

Designator	Stress Area of Threaded Bolt Shank (mm^2)	Minimum Bolt Strength (kN)
FBX16b	157.0	130.0
FBX20b	245.0	203.0
FBX22b	303.0	251.0
FBX24b	353.0	293.0
FBX27b	459.0	381.0
FBX30b	561.0	466.0
FBX36b	817.0	678.0

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

INTENDED USE

These bolts and nuts are used in various sign systems.

HIGH-STRENGTH STRUCTURAL HEX BOLT & NUT

FBX16b-36b

SHEET NO.	DATE
2 of 2	