U.S. Department of Transportation
Federal Highway Administration

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

August 19, 2011

In Reply Refer To:
HSST/ CC-68A

Mr. Dean L. Sicking, Ph.D., P.E. Director,
Midwest Roadside Safety Facility University
of Nebraska - Lincoln P.O. Box 880601
Lincoln, NE 68588-0601

This letter is in response to Messrs. Bielenburg's and Faller's request for the Federal Highway Administration (FHWA) acceptance of an alternative post design for the Thrie beam bullnose median barrier (bullnose attenuator) for use on the National Highway System (NHS).

Name of system:	Thrie beam bullnose guardrail system
Type of system:	Non-Gating Crash Cushion/Impact Attenuator
Test Level:	NCHRP Report 350 Test Level 3
Testing conducted by:	Midwest Roadside Safety Facility
Date of request:	December 21, 2010
Date initially acknowledged:	December 22, 2010
Task Force 13 Designator:	SET03b

You requested that we find a steel post design to be an acceptable alternative to the previously-accepted wood post Thrie beam bullnose attenuator for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350.

Requirements
Roadside safety devices should meet the guidelines contained in NCHRP Report 350 if tested prior to January 1, 2011, and the guidelines in American Association of State Highway Transportation Official's (AASHTO) Manual for Assessing Safety Hardware if tested after that date. The FHWA memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 24, 1997, provides further guidance on crash testing requirements of longitudinal barriers and crash cushions.

Decision
The following device was found acceptable, with details provided below:

- Thrie beam Bullnose Barrier with Universal Breakaway Steel Posts (UBSP)

FHWA: HSSI: WLongstreet: ms: x60087:6/8/11
File: h: //directory folder/HSST/ CC-68A Thrie Beam Bullnose Guardrail System.docx
cc: HSST Will Longstreet

Description
The steel post design of the bullnose attenuator is essentially identical to the original wood post design that was accepted for use on the NHS in FHWA acceptance letter CC-68, dated November 8, 2000. The design consists of five **slotted** Thrie beam rail elements: the nose piece with a 1580-mm (62-3/16-inch) radius, two sections (one on each end of the nose section) with 10400-mm (409-7/16-inch) radii, and one straight rail section on each end of the second sections. Two 5/8-inch diameter steel cables are set behind the top two corrugations in the nose piece. Posts 1 and 2 are wood BCT-type posts and effectively anchor the bullnose in side impacts. In the modified design, the original CRT posts (numbered 3 through 8) have been replaced with the new UBSP. The lower section of the UBSP consists of a 6 inch x 8 inch x 3/16 inch ASTM A500 Grade B steel foundation tube with the lower base plate. The upper portion of the UBSP is a W6 x 8.5 post with the upper base plate. The plates are connected with 7/16-inch diameter ASTM A325 threaded hex bolts. Drawings showing the overall layout of the Bullnose design and the UBSP posts are shown in Enclosure **1.**

Crash Testing
Since the UBSP design of the bullnose attenuator was essentially unchanged from the previously accepted CRT post version, you needed only to show that the new post system would not adversely affect the crash performance of the unit. You concluded that NCHRP Report 350 tests 3-30,3-31, and 3-38 were those most likely to be effected by the post substitution and that the remaining tests for a redirective crash cushion need not be rerun. After discussing the test matrix with Mr. Bielenberg, FHWA agreed that the remaining tests would be redundant and accepted the three tests described below as adequate and sufficient to verify crashworthiness of the UBSP design.

Test 3-30 required a 100 km/h impact by a 1800 lb (820-kg) passenger car impacting at 62 mph (100 km/h) directly into the nose of the barrier with a 1/4-point offset. In test no. USPBN-3, the car was captured by the bullnose with little roll or pitch. As shown in Enclosure 2, maximum occupant impact velocity was 33.6 feet/s (10.2 m/s) and the ridedown acceleration was 7.7 g's. The vehicle was brought to a stop approximately 21 ft from the first impact point.

Test 3-31 was run as test no. USPBN-4 and consisted of a 4429-lb (2009-kg) pickup truck impacting the Bullnose Attenuator head-on at 64.5 mph (103.7 km/h). The truck was captured by the barrier and brought to a stop in approximately 51 feet. Occupant Impact Velocity (OIV) was reported to be 21.8 feet/s (6.6 m/s) and the maximum acceleration was under 8 g's. Enclosure 3 is the summary sheet for this test.

Test 3-38 also required a 100 km/h 2000-kg pickup truck test, but into the side of the Bullnose Attenuator at its critical impact point (CIP). The Midwest Roadside Safety Facility test number USPBN-2 reported a 2029-kg (4472-lb) truck struck the barrier at 101.3 km/h (62.9 km/h) and 21.7 degrees. The OIV was 8.6 m/sec (longitudinal) and the Ridedown Acceleration was approximately 15 g's. Vehicular roll, pitch and yaw were recorded as 12.6, 5.9, and 20.7 degrees, respectively. The truck came to rest within the bullnose envelope, 28 feet (8.7 m) downstream from the initial impact point. Enclosure 4 is the summary sheet for this test.

Findings
The Thrie beam Bullnose Attenuator with UBSP as described above is acceptable for use on the NHS as a non-gating crash cushion primarily used to shield rigid objects located in the medians of divided highways.

The conditions listed in the original acceptance letter remain in effect and are repeated here for ready reference:

- The leading edge of the bullnose should be installed a minimum distance of 19 m in advance of any shielded object or hazard.
- If transitioned to a bridge railing or parapet, the transition should begin no sooner than post 9, measured from the nose of the installation
- If an asymmetrical design is used (refer to CC-68 for details), the barrier flare rates on the approaching traffic side should not exceed the AASHTO Roadside Design Guide recommendations
- The bullnose attenuator should be installed on relatively flat ground (e.g. 10H:1V or flatter) to ensure optimal crash performance.

Please note the following standard provisions that generally apply to all FHWA letters of acceptance:

- This acceptance letter includes an AASHTO/ARTBA/AGC Task Force 13 designator that should be used when creating a new or revised Task Force 13 drawing.
- This acceptance is limited to the crash worthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices (when applicable).
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-68 A and 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 at our office upon request.
- The Thrie beam Bullnose Attenuator is not a patented product, nor is it considered proprietary. However, if any proprietary devices are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS 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.

- This acceptance 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. The FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

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

Enclosures

U.S. Department of Transportation
Federal Highway Administration

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

August 19, 2011

In Reply Refer To:
HSST/ CC-68A

Mr. Dean L. Sicking, Ph.D., P.E. Director,
Midwest Roadside Safety Facility University
of Nebraska - Lincoln P.O. Box 880601
Lincoln, NE 68588-0601

This letter is in response to Messrs. Bielenburg's and Faller's request for the Federal Highway Administration (FHWA) acceptance of an alternative post design for the Thrie beam bullnose median barrier (bullnose attenuator) for use on the National Highway System (NHS).

Name of system:	Thrie beam bullnose guardrail system
Type of system:	Non-Gating Crash Cushion/Impact Attenuator
Test Level:	NCHRP Report 350 Test Level 3
Testing conducted by:	Midwest Roadside Safety Facility
Date of request:	December 21, 2010
Date initially acknowledged:	December 22, 2010
Task Force 13 Designator:	SET03b

You requested that we find a steel post design to be an acceptable alternative to the previously-accepted wood post Thrie beam bullnose attenuator for use on the NHS under the provisions of the National Cooperative Highway Research Program (NCHRP) Report 350.

Requirements
Roadside safety devices should meet the guidelines contained in NCHRP Report 350 if tested prior to January 1, 2011, and the guidelines in American Association of State Highway Transportation Official's (AASHTO) Manual for Assessing Safety Hardware if tested after that date. The FHWA memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 24, 1997, provides further guidance on crash testing requirements of longitudinal barriers and crash cushions.

Decision
The following device was found acceptable, with details provided below:

- Thrie beam Bullnose Barrier with Universal Breakaway Steel Posts (UBSP)

Description
The steel post design of the bullnose attenuator is essentially identical to the original wood post design that was accepted for use on the NHS in FHWA acceptance letter CC-68, dated November 8, 2000. The design consists of five **slotted** Thrie beam rail elements: the nose piece with a 1580-mm (62-3/16-inch) radius, two sections (one on each end of the nose section) with 10400-mm (409-7/16-inch) radii, and one straight rail section on each end of the second sections. Two 5/8-inch diameter steel cables are set behind the top two corrugations in the nose piece. Posts 1 and 2 are wood BCT-type posts and effectively anchor the bullnose in side impacts. In the modified design, the original CRT posts (numbered 3 through 8) have been replaced with the new UBSP. The lower section of the UBSP consists of a 6 inch x 8 inch x 3/16 inch ASTM A500 Grade B steel foundation tube with the lower base plate. The upper portion of the UBSP is a W6 x 8.5 post with the upper base plate. The plates are connected with 7/16-inch diameter ASTM A325 threaded hex bolts. Drawings showing the overall layout of the Bullnose design and the UBSP posts are shown in Enclosure **1.**

Crash Testing
Since the UBSP design of the bullnose attenuator was essentially unchanged from the previously accepted CRT post version, you needed only to show that the new post system would not adversely affect the crash performance of the unit. You concluded that NCHRP Report 350 tests 3-30,3-31, and 3-38 were those most likely to be effected by the post substitution and that the remaining tests for a redirective crash cushion need not be rerun. After discussing the test matrix with Mr. Bielenberg, FHWA agreed that the remaining tests would be redundant and accepted the three tests described below as adequate and sufficient to verify crashworthiness of the UBSP design.

Test 3-30 required a 100 km/h impact by a 1800 lb (820-kg) passenger car impacting at 62 mph (100 km/h) directly into the nose of the barrier with a 1/4-point offset. In test no. USPBN-3, the car was captured by the bullnose with little roll or pitch. As shown in Enclosure 2, maximum occupant impact velocity was 33.6 feet/s (10.2 m/s) and the ridedown acceleration was 7.7 g's. The vehicle was brought to a stop approximately 21 ft from the first impact point.

Test 3-31 was run as test no. USPBN-4 and consisted of a 4429-lb (2009-kg) pickup truck impacting the Bullnose Attenuator head-on at 64.5 mph (103.7 km/h). The truck was captured by the barrier and brought to a stop in approximately 51 feet. Occupant Impact Velocity (OIV) was reported to be 21.8 feet/s (6.6 m/s) and the maximum acceleration was under 8 g's. Enclosure 3 is the summary sheet for this test.

Test 3-38 also required a 100 km/h 2000-kg pickup truck test, but into the side of the Bullnose Attenuator at its critical impact point (CIP). The Midwest Roadside Safety Facility test number USPBN-2 reported a 2029-kg (4472-lb) truck struck the barrier at 101.3 km/h (62.9 km/h) and 21.7 degrees. The OIV was 8.6 m/sec (longitudinal) and the Ridedown Acceleration was approximately 15 g's. Vehicular roll, pitch and yaw were recorded as 12.6, 5.9, and 20.7 degrees, respectively. The truck came to rest within the bullnose envelope, 28 feet (8.7 m) downstream from the initial impact point. Enclosure 4 is the summary sheet for this test.

Findings
The Thrie beam Bullnose Attenuator with UBSP as described above is acceptable for use on the NHS as a non-gating crash cushion primarily used to shield rigid objects located in the medians of divided highways.

The conditions listed in the original acceptance letter remain in effect and are repeated here for ready reference:

- The leading edge of the bullnose should be installed a minimum distance of 19 m in advance of any shielded object or hazard.
- If transitioned to a bridge railing or parapet, the transition should begin no sooner than post 9, measured from the nose of the installation
- If an asymmetrical design is used (refer to CC-68 for details), the barrier flare rates on the approaching traffic side should not exceed the AASHTO Roadside Design Guide recommendations
- The bullnose attenuator should be installed on relatively flat ground (e.g. 10H:1V or flatter) to ensure optimal crash performance.

Please note the following standard provisions that generally apply to all FHWA letters of acceptance:

- This acceptance letter includes an AASHTO/ARTBA/AGC Task Force 13 designator that should be used when creating a new or revised Task Force 13 drawing.
- This acceptance is limited to the crash worthiness characteristics of the systems and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices (when applicable).
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number CC-68 A and 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 at our office upon request.
- The Thrie beam Bullnose Attenuator is not a patented product, nor is it considered proprietary. However, if any proprietary devices are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS 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.

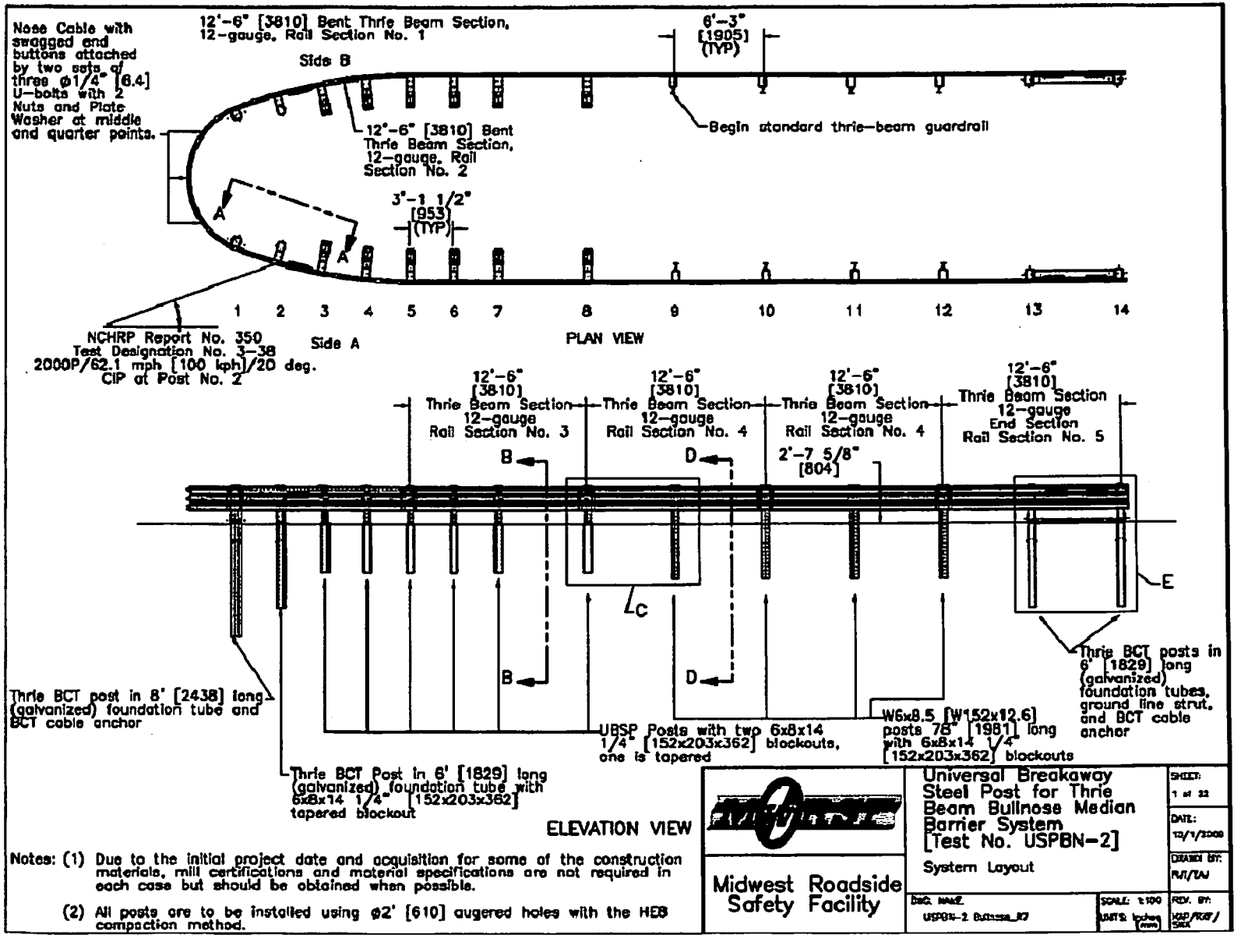
- This acceptance letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

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

Enclosures

Enclosure 1 (1 of 3)



Notes: (1) Due to the initial project date and acquisition for some of the construction materials, mill certifications and material specifications are not required in each case but should be obtained when possible.

(2) All posts are to be installed using ø2' [610] augered holes with the HEB compaction method.

Midwest Roadside Safety Facility

Universal Breakaway Steel Post for Thrie Beam Bullnose Median Barrier System [Test No. USPBN-2]

System Layout

SHEET: 1 of 22

DATE: 12/1/2008

DRAWN BY: RJT/TAJ

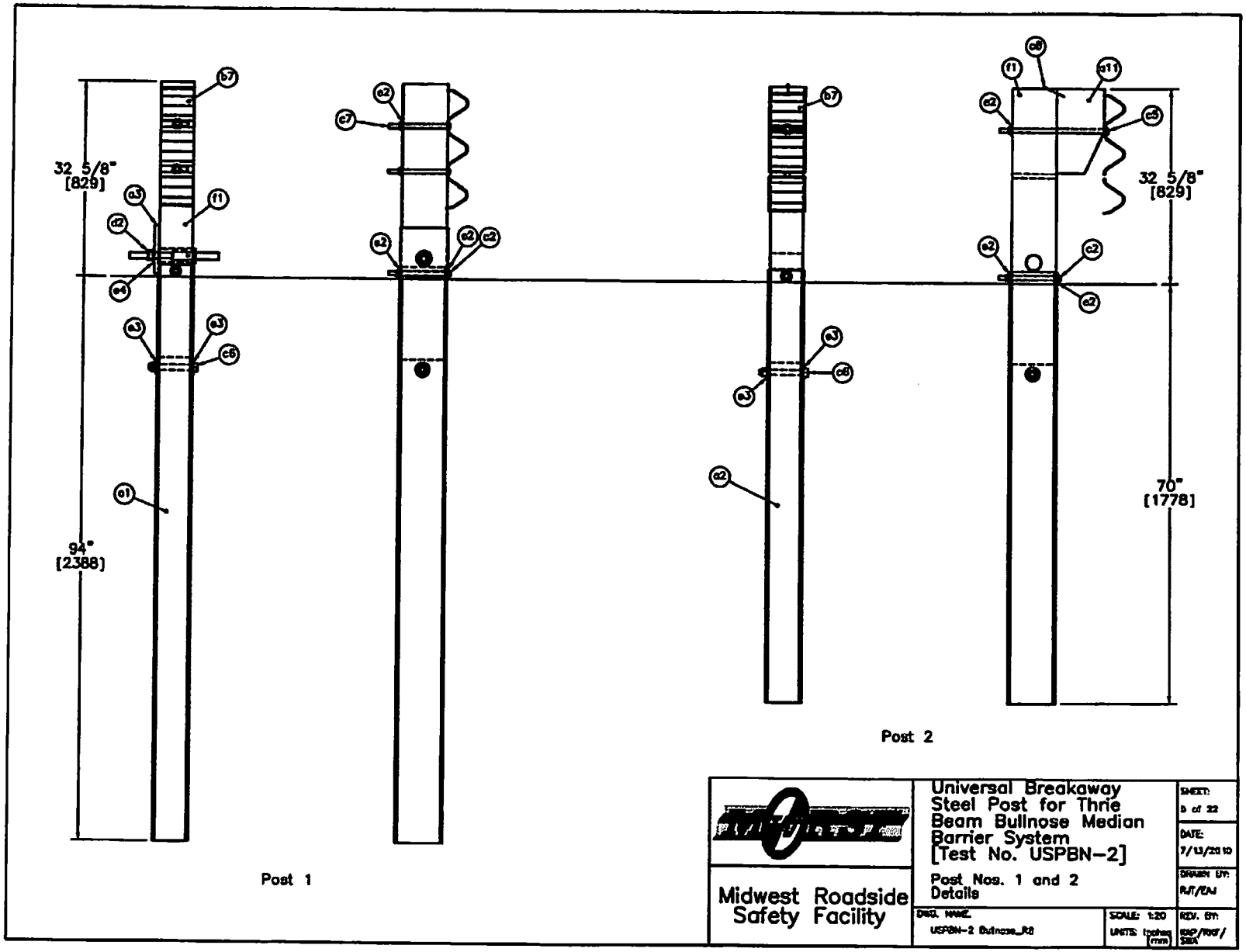
DWG. NAME: USPBN-2 Bullnose_07

SCALE: 1:100

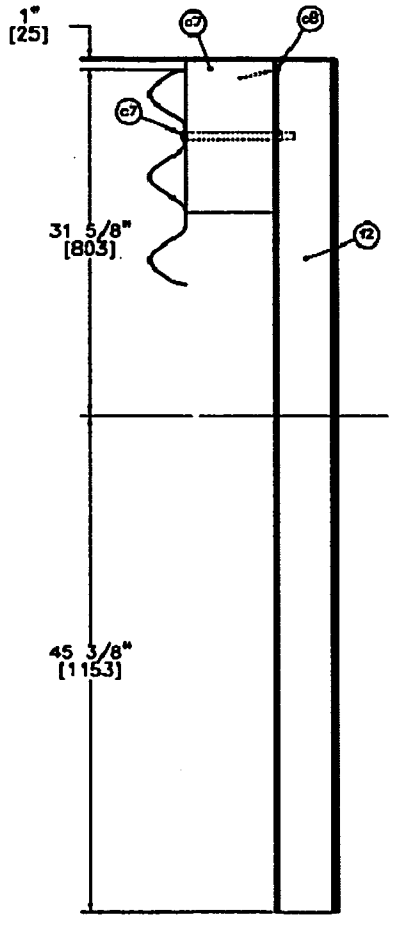
UNITS: inches (mm)

REV. BY: KSP/RDR/ SWK

Enclosure 1 (2 of 3)

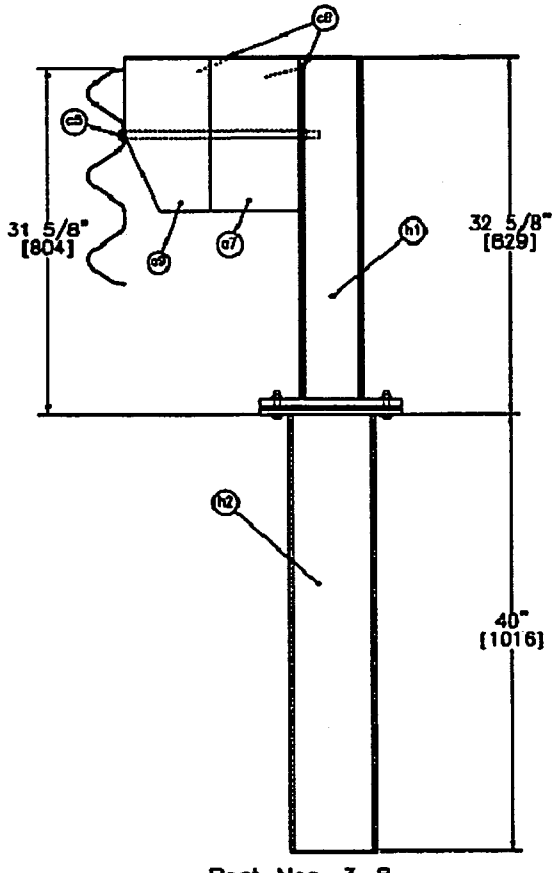


Enclosure 1 (3 of 3)



Post Nos. 9–12

SECTION D–D



Post Nos. 3–8

SECTION B–B

Midwest Roadside Safety Facility

Universal Breakaway Steel Post for Thrie Beam Bullnose Median Barrier System [Test No. USPBN-2]

Post Nos. 3–8 and 9–12 Details

SHEET: 6 of 22

DATE: 7/13/2010

DRAWN BY: RJT/EAJ

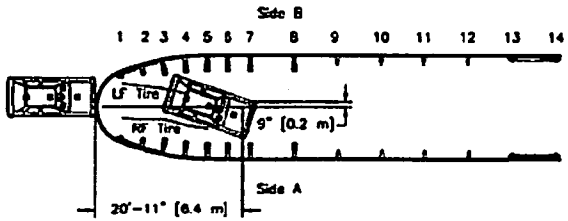
DWG. NAME: USPBN-2 Bullnose_R2

SCALE: 1:14

UNITS: inches [mm]

REV. BY: KAP/RJT/SMA

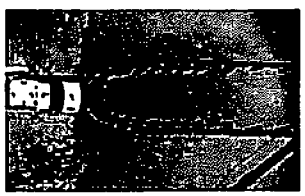
Enclosure 2



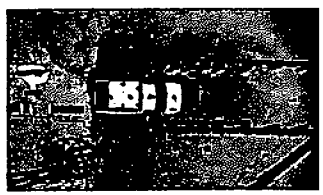
- Test Agency ..... MwRSF
- Test Number USPBN-3
- Date 9/13/10
- NCHRP Report No. 350 Test Designation 3-30
- Test Article ..... Bullnose Median Barrier
- Key Component – Rail
  - Type ..... 12 ga. (2.66 mm) Thrie Beam
  - Top Mounting Height ..... 31⅛ in. (803 mm)
  - Section Nos. 1-2 ..... 12 ft – 6 in. (3.81 m) length, bent and slotted
  - Section No. 3 ..... 12 ft – 6 in. (3.81 m) length, slotted
  - Section Nos. 4-5 ..... 12 ft – 6 in. (3.81 m) length, standard
- Key Component – Post Nos. 1-2, 13-14
  - Type ..... Thrie BCT Wood Posts
- Key Component – Post Nos. 3-8
  - Type ..... Universal Steel Breakaway Posts
  - Shape W6x8.5 (W152x12.6)
  - Base Plates ..... 2¼ x 10 in. (64 x 254 mm) bolt spacing
  - Fracturing Bolts ..... ⅞-in. (11.1-mm) diameter ASTMA325 hex tap
  - Base Tubes ..... TS 6 x 8 x ⅜ x 40 in. (152 x 203 x 4.8 x 1016 mm)
- Key Component – Post Nos. 9-12
  - Type ..... Standard Thrie Beam Posts
  - Shape W6x8.5 (W152x12.6)
- Soil Type ..... Grading B AASHTO M147-65 (1990)
- Vehicle Make /Model ..... Suzuki Swift passenger car
  - Curb ..... 1,857 lb (842 kg)
  - Test Inertial ..... 1,854 lb (841 kg)
  - Gross Static ..... 2,024 lb (918 kg)
- Impact Conditions
  - Speed ..... 63.3 mph (101.9 km/h)
  - Angle ..... 0 deg
  - Impact Location ..... passenger's side quarter point offset
- Exit Conditions
  - Speed ..... NA
  - Angle ..... NA
- Exit Box Criterion ..... Pass
- Vehicle Stability ..... Satisfactory
- Vehicle Stopping Distance ..... 20 ft – 11 in. (6.4 m) downstream of impact
  9 in. (0.2 m) to the left of center
- Vehicle Damage ..... Moderate
  - VDS[9] 12-FD-5
  - CDC[15] 12FDEW3
  - Maximum Interior Deformation ..... ½ in. (13 mm)
- Test Article Damage ..... Severe
- Working Width Envelope ..... 22 ft – 9 in. (6.9 m) longitudinally
  14 ft – 9¾ in. (4.5 m) laterally
- Maximum Angular Displacements (DTS)
  - Roll ..... -5.82 deg
  - Pitch ..... -3.71 deg
  - Yaw ..... 26.67 deg
- Transducer Data

Evaluation Criteria		Transducer		NCHRP Report No. 350 Limits
		EDR-3	DTS	
OIV ft/s (m/s)	Longitudinal	-33.63 (-10.25)	-32.18 (-9.81)	≤ 39.4 (12)
	Lateral	3.60 (1.10)	4.08 (1.24)	≤ 39.4 (12)
ORA g's	Longitudinal	-7.70	-7.70	≤ 20
	Lateral	5.01	-5.75	≤ 20
THIV ft/s (m/s)		-	32.58 (9.93)	not required
PHD g's		-	8.62	not required
ASI		0.93	0.88	not required

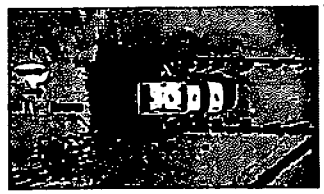
Enclosure 3



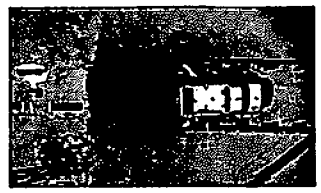
0.000 sec



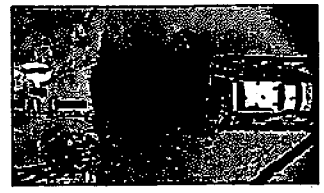
0.200 sec



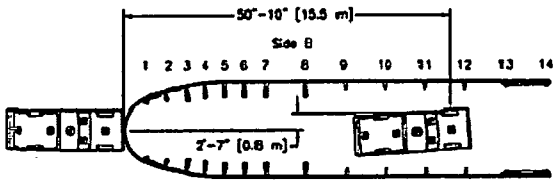
0.324 sec



0.472 sec



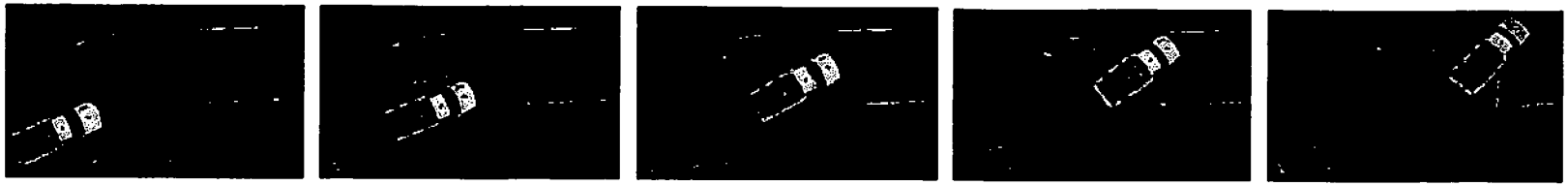
0.692 sec



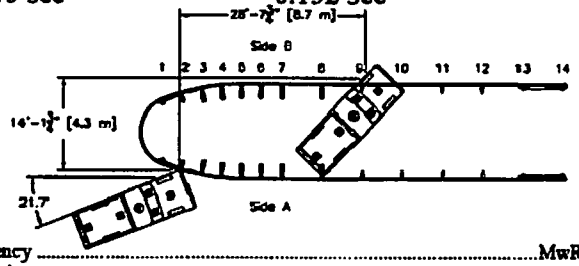
- Test Agency ..... MwRSF
- Test Number USPBN-4
- Date 10/6/10
- NCHRP Report No. 350 Test Designation 3-31
- Test Article ..... Bullnose Median Barrier
- Key Component – Rail
  - Type ..... 12 ga. (2.66 mm) Thrie Beam
  - Top Mounting Height ..... 31⅛ in. (803 mm)
  - Section Nos. 1-2 ..... 12 ft – 6 in. (3.81 m) length, bent and slotted
  - Section No. 3 ..... 12 ft – 6 in. (3.81 m) length, slotted
  - Section Nos. 4-5 ..... 12 ft – 6 in. (3.81 m) length, standard
- Key Component – Post Nos. 1-2, 13-14
  - Type ..... Thrie BCT Wood Posts
- Key Component – Post Nos. 3-8
  - Type ..... Universal Steel Breakaway Posts
  - Shape W6x8.5 (W152x12.6)
  - Base Plates ..... 2¼ x 10 in. (64 x 254 mm) bolt spacing
  - Fracturing Bolts ..... ⅞-in. (11.1-mm) diameter ASTMA325 hex tap
  - Base Tubes ..... TS 6 x 8 x ⅜ x 40 in. (152 x 203 x 4.8 x 1016 mm)
- Key Component – Post Nos. 9-12
  - Type ..... Standard Thrie Beam Posts
  - Shape W6x8.5 (W152x12.6)
- Soil Type ..... Grading B AASHTO M147-65 (1990)
- Vehicle Make /Model ..... GMC C2500 pickup truck
  - Curb ..... 4,581 lb (2,078 kg)
  - Test Inertial ..... 4,429 lb (2,009 kg)
  - Gross Static ..... 4,429 lb (2,009 kg)
- Impact Conditions
  - Speed ..... 64.5 mph (103.7 km/h)
  - Angle ..... 0 deg
  - Impact Location ..... centerline of the system
- Exit Conditions
  - Speed ..... NA
  - Angle ..... NA
- Exit Box Criterion ..... Pass
- Vehicle Stability ..... Satisfactory
- Vehicle Stopping Distance ..... 50 ft – 10 in. (15.5 m) downstream of impact
  2 ft – 7 in. (0.8 m) to the left of impact
- Vehicle Damage ..... Moderate
  - VDS[9] 12-FD-2
  - CDC[10] 12FDEW2
  - Maximum Interior Deformation ..... ½ in. (13 mm)
- Test Article Damage ..... Severe
- Working Width Envelope ..... 54 ft – ½ in. (16.5 m) longitudinally
  14 ft – 9¼ in. (4.5 m) laterally
- Maximum Angular Displacements (DTS)
  - Roll ..... 5.68 deg
  - Pitch ..... -7.02 deg
  - Yaw ..... -5.89 deg
- Transducer Data

Evaluation Criteria		Transducer		NCHRP Report No. 350 Limits
		EDR-3	DTS	
OIV ft/s (m/s)	Longitudinal	-21.82 (-6.65)	-21.75 (-6.63)	≤ 39.4 (12)
	Lateral	0.19 (0.06)	0.21 (0.06)	≤ 39.4 (12)
ORA g's	Longitudinal	-7.97	-7.84	≤ 20
	Lateral	7.46	7.34	≤ 20
THIV ft/s (m/s)		-	21.75 (6.63)	not required
PHD g's		-	8.99	not required
ASI		0.44	0.43	not required

Enclosure 4



0.000 sec 0.152 sec 0.344 sec 0.492 sec 1.110 sec



- Test Agency ..... MwRSF
- Test Number USPBN-2
- Date 12/21/09
- NCHRP Report No. 350 Test Designation 3-38
- Test Article ..... Bullnose Median Barrier
- Key Component – Rail
  - Type ..... 12 ga. (2.66 mm) Thrie Beam
  - Top Mounting Height ..... 31⅝ in. (803 mm)
  - Section Nos. 1-2 ..... 12 ft – 6 in. (3.81 m) length, bent and slotted
  - Section No. 3 ..... 12 ft – 6 in. (3.81 m) length, slotted
  - Section Nos. 4-5 ..... 12 ft – 6 in. (3.81 m) length, standard
- Key Component – Post Nos. 1-2, 13-14
  - Type ..... Thrie BCT Wood Posts
- Key Component – Post Nos. 3-8
  - Type ..... Universal Steel Breakaway Posts
  - Shape W6x8.5 (W152x12.6)
  - Base Plates ..... 2½ x 10 in. (64 x 254 mm) bolt spacing
  - Fracturing Bolts ..... ⅞-in. (11.1-mm) diameter ASTMA325 hex tap
  - Foundation Tubes ..... TS 6 x 8 x ⅜ x 40 in. (152 x 203 x 4.8 x 1016 mm)
- Key Component – Post Nos. 9-12
  - Type ..... Standard Thrie Beam Posts
  - Shape W6x8.5 (W152x12.6)
- Soil Type ..... Grading B AASHTO M147-65 (1990)
- Vehicle Make /Model ..... GMC C2500 pickup truck
  - Curb ..... 4,564 lb (2,070 kg)
  - Test Inertial ..... 4,472 lb (2,029 kg)
  - Gross Static ..... 4,472 lb (2,029 kg)
- Impact Conditions
  - Speed ..... 62.9 mph (101.3 km/h)
  - Angle ..... 21.7 deg
  - Impact Location ..... centerline of post no. 2
- Exit Conditions
  - Speed ..... NA
  - Angle ..... NA
- Exit Box Criterion ..... Pass
- Vehicle Stability ..... Satisfactory
- Vehicle Stopping Distance ..... 28 ft – 7¾ in. (8.7 m) downstream of impact
  14 ft – 1¾ in. (4.3 m) to the left of impact
- Vehicle Damage ..... Moderate
  - VDS[9] 12-FD-4
  - CDC[10] 12FDEW2
  - Maximum Interior Deformation ..... 1½ in. (38 mm)
- Test Article Damage ..... Severe
- Working Width Envelope ..... 40 ft – 10 in. (12.4 m) longitudinally
  14 ft – 9¾ in. (4.5 m) laterally
- Maximum Angular Displacements
  - Roll ..... -12.61 deg
  - Pitch ..... -5.89 deg
  - Yaw ..... -20.66 deg
- Transducer Data

Evaluation Criteria		Transducer			NCHRP Report No. 350 Limit
		EDR-3	DTS Set 1	DTS Set 2	
OIV ft/s (m/s)	Longitudinal	-28.37 (-8.65)	-28.15 (-8.58)	-28.22 (-8.60)	≤ 39.4 (12)
	Lateral	-0.76 (-0.23)	-0.74 (-0.23)	-0.11 (-0.03)	≤ 39.4 (12)
ORA g's	Longitudinal	-12.50	-15.11	-13.93	≤ 20
	Lateral	-14.92	-17.39	-14.98	≤ 20
THIV – ft/s (m/s)		-	28.48 (8.68)	-	not required
PHD – g's		-	22.19	-	not required
ASI		0.76	0.87	0.78	not required