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U.S.  
Department of  
Transportation

**Federal  
Highway  
Administration**

400 Seventh St., S.W.  
Washington, D.C. 20590

September 11, 2007

In Reply Refer To: HSSD/B-162

Mr. Rick Mauer  
Nucor Steel Marion Inc.  
912 Cheney Avenue  
Marion, Ohio 43302

Dear Mr. Mauer:

In his letter of May 7, 2007, Mr. Dallas James of Armorflex Ltd requested formal Federal Highway Administration (FHWA) acceptance of a new steel strong post (called the Nucor Steel Post) for use in a new 31" (787 mm) high Nucor Strong Post W-beam guardrail system with no blockouts in both roadside and median applications. He also requested formal FHWA acceptance of the Nucor Steel Posts as a substitute for other approved posts in the standard 27" (686 mm) high non-proprietary strong post W-beam guardrail systems with the use of an original plastic blockout. This request was limited to roadside applications only. To support his request, Mr. James also provided a copy of a Holmes Solutions Limited test report dated March 2007, entitled "31 Inch Nucor Strong Post W-Beam Guardrail without Blockouts" and a copy of a Holmes Solutions Limited test report dated March 2007, entitled "27 Inch Nucor Strong Post W-Beam Guardrail with Plastic Blockouts." Mr. James also provided copies of the drawings, test videos, photos, raw data and analysis files and a copy of the correspondence with Mr. Nick Artimovich of my staff concerning the selected test matrix. He also asked us to address the letter of acceptance to you.

#### **Requirements**

Longitudinal barriers should meet the guidelines contained in the NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". FHWA Memorandum "[Action: Identifying Acceptable Highway Safety Features](#)" of July 25, 1997 provides further guidance on crash testing requirements of longitudinal barriers.

#### **Product description**

Nucor Strong Posts are hot rolled high tensile steel fabricated into a U cross section of approximately 2" (50.8 mm) deep and 3-1/2" (88.9 mm) wide. The total weight of the posts is 5 pounds (2.27 kg) per foot. A slot, 3/4" (19.1 mm) wide is located 1" (25.4 mm) down from the top of the posts in the middle of the cross section. The slot has a total length of 7" (178 mm). All posts are 78" (1981 mm) long and hot dip galvanized. Design details for the Nucor Strong Posts are shown in Enclosure 1.

When Nucor posts are used in a new 31" (787 mm) high Nucor Strong Post W-beam guardrail system, the blockouts are not used and round spacer washers are installed between the guardrail and the legs of the U posts. Round spacer washers are manufactured from 1/4" (6.35 mm) mild steel plate with an outside diameter of 3-1/2" (89 mm) and a centrally located hole of 1" (25.4 mm) in diameter. The washers have a hot dip galvanized finish. The washer is captured in place by the 5/8" x 3-1/2" (15.9 mm x 88.9 mm) post bolt and splice nut and is used to provide a backing surface for the guardrail to limit the possibility of the head of the post bolts from pulling through the guardrail. The use of the 1/4" (6.35 mm) washer is a change to the original design implemented after

Test 3-10 was completed. Design details for the Nucor Strong Post W-beam guardrail system in both roadside and median applications are shown in Enclosure 1.

When Nucor posts are used with 27" (686 mm) high non-proprietary W-beam guardrail systems, they are used with the original plastic blockouts, 14" x 3-5/8" (355.6mm x 92.1 mm) which are used to space the guardrail 8" (203 mm) from the face of the U posts. The plastic blockouts are manufactured from a 50 percent blend of new and recycled HDPE (high density polyethylene). Design details for the Nucor Strong Posts as used with 27" (686 mm) high W-beam guardrail systems with blockouts are shown in Enclosure 1.

The rail elements in both applications are standard 12 gauge, BMT (base metal thickness), galvanized W-beam, conforming to AASHTO M180 Class A rail. Both guardrail systems use standard FBB01 5/8 x 1-1/2" (15.9mm x 38.1mm) galvanized splice bolt and nuts. In the 31" (787 mm) high W-beam guardrail systems without blockouts the W-beams are held to the posts using galvanized 5/8 x 3-1/2" (15.9 mm x 88.9 mm) bolts with standard FBB01 splice nuts. In the 27" (686 mm) high W-beam guardrail systems with blockouts the W-beams are held to the posts using galvanized 5/8" x 12" (15.9 mm x 304.8 mm) bolts with standard FBB01 splice nuts.

### Test article installations

In all test article installations the posts were embedded in the AASHTO Designation: M147-65 (1990) "standard" soil and spaced at 75" (1905 mm). Both ends of the installations were terminated with the anchorage detailed from a FLEAT terminal end. The impact heads from the terminal ends were not installed. For the median guardrail installation (test 3-10) the nuts were installed on the opposite face than that impacted by the test vehicle as per the AASHTO SBM04b.

### Testing

The NCHRP Report 350 requires that in order for longitudinal barriers to meet test level 3 (TL-3) criteria they must successfully pass tests 3-10 and 3-11. Since Nucor Strong Posts are proposed to be used in a new 31" (787 mm) high Nucor Strong Post W-beam guardrail system without blockouts in both roadside and median applications and a substitute for other approved posts in the standard 27" (686 mm) high non-proprietary strong post W-beam systems with the use of plastic blockouts in roadside application, you decided to devise an optimal test program which could allow full crash testing of the product while avoiding the duplication of redundant tests. You also intended to test the above systems to the new rewrite of the NCHRP 350 while have them accepted also under the current NCHRP 350.

The resulting test program developed in the consultation with my office included the following tests to evaluate the performance of the new Nucor Strong Post W-beam guardrail system without blockouts in both median and roadside applications:

- Test 3-10 which used a 820C car impacting the system in the median configuration, and
- Test 3-11 which used a 2270P truck impacting the system in the roadside configuration.

To evaluate the performance of Nucor Strong Posts in 27" (686 mm) high W-beam guardrail systems with blockouts in roadside applications you conducted the following test:

- Test 3-11 which used a 2000P truck impacting the system in the roadside configuration.

I agree that the selected program is optimal for a full-crash testing of Nucor Strong Posts with the above W-beam guardrail systems. Test 3-10 on the median barrier configuration of the new Nucor Strong Post W-beam guardrail system is considered to produce the greatest risk to the occupant's safety as it is stiffer than the roadside configuration and has a similar potential for snagging. Further, while the proposed updates to the NCHRP 350 recommend the replacement of the 820C with a 1100 kg passenger car (1100C), test 3-10 using a 820C vehicle would produce higher occupant risk than the 1100C vehicle. Also, I agree that the decision to complete Test 3-11 only on the roadside configuration of Nucor Strong Post W-beam guardrail system is justified as this system is structurally less stiff than the median barrier configuration. Using of the 2270P truck (proposed in the updates to NCHRP 350) in this test as opposed to the currently used 2000P truck is in line with the objective to test structural adequacy of the system.

Similarly, I agree that Test 3-11 which uses a 2000P truck impacting the 27" (686 mm) high W-beam guardrail system in the roadside configuration is sufficient to evaluate the performance of this system. Conducting Test 3-10 would be redundant as the system is similar to the previously approved non-proprietary W-beam systems and is unlikely to cause any concerns in impacts with a small car.

According to the information you provided the test article performed successfully in the above tests. The system redirected impacting vehicles which did not penetrate, underride, or override the installations and remained upright during and after the collision period. There was only minor deformation of the occupant compartment. Occupant risk factors were within the limits specified in the NCHRP 350. Summaries of tests results are presented in Enclosure 2.

In the conducted tests no detached elements, fragments, or other debris showed potential for penetrating the occupant compartment, nor to present an undue hazard to other traffic. However, in test 3-10 one post was broken off at ground level with a large segment of the post coming to rest 6 m behind the barrier approximately 17 m downstream from the point of impact. Test videos show that the broken off part of the post was sliding at ground level before coming to rest and therefore the hazard to other traffic in median application on a level surrounding surface would be minimal. However, the described tendency of the posts to break off should be recognized and should be taken into account when selecting locations for installations. Also, this tendency may be more pronounced when the system is used in the frozen ground or when the surface is paved.

In summary we agree that Nucor Strong Post W-beam guardrail system without blockouts in both roadside and median applications as described above meet the appropriate evaluation criteria for the NCHRP 350 TL-3 devices. Also, the Nucor Strong Posts as described above can be used as a substitute for other approved W-beam posts in the standard 27" (686 mm) high non-proprietary strong post TL-3 W-beam systems with the use of plastic blockouts in the roadside configuration. They should not, however, be used as one-for-one replacements of W6 x 8.5 steel posts in repair/maintenance situations until further testing is conducted.

The above systems may be used at all appropriate locations on the National Highway System (NHS) when selected by the contracting authority, subject to the provisions of Title 23, Code of Federal Regulations, Section 635.411, as they pertain to proprietary products. Please note that this acceptance is only for the use of the posts in the barrier proper. They cannot be used in any of the guardrail terminals that require breakaway posts unless specifically tested for that application. Also, please note also that this acceptance is based on the reported crash performance of your posts and is not meant to address their installation, maintenance or repair characteristics. Your company's 31-inch (787 mm) high guardrail discussed above may be considered crashworthy under both the existing Report 350 guidelines and under the new guidelines when they are formally adopted, assuming that the test matrix currently being proposed by the researchers remains unchanged.

#### **Standard provisions**

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

- This acceptance is limited to the crashworthiness characteristics of the devices and does not

cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

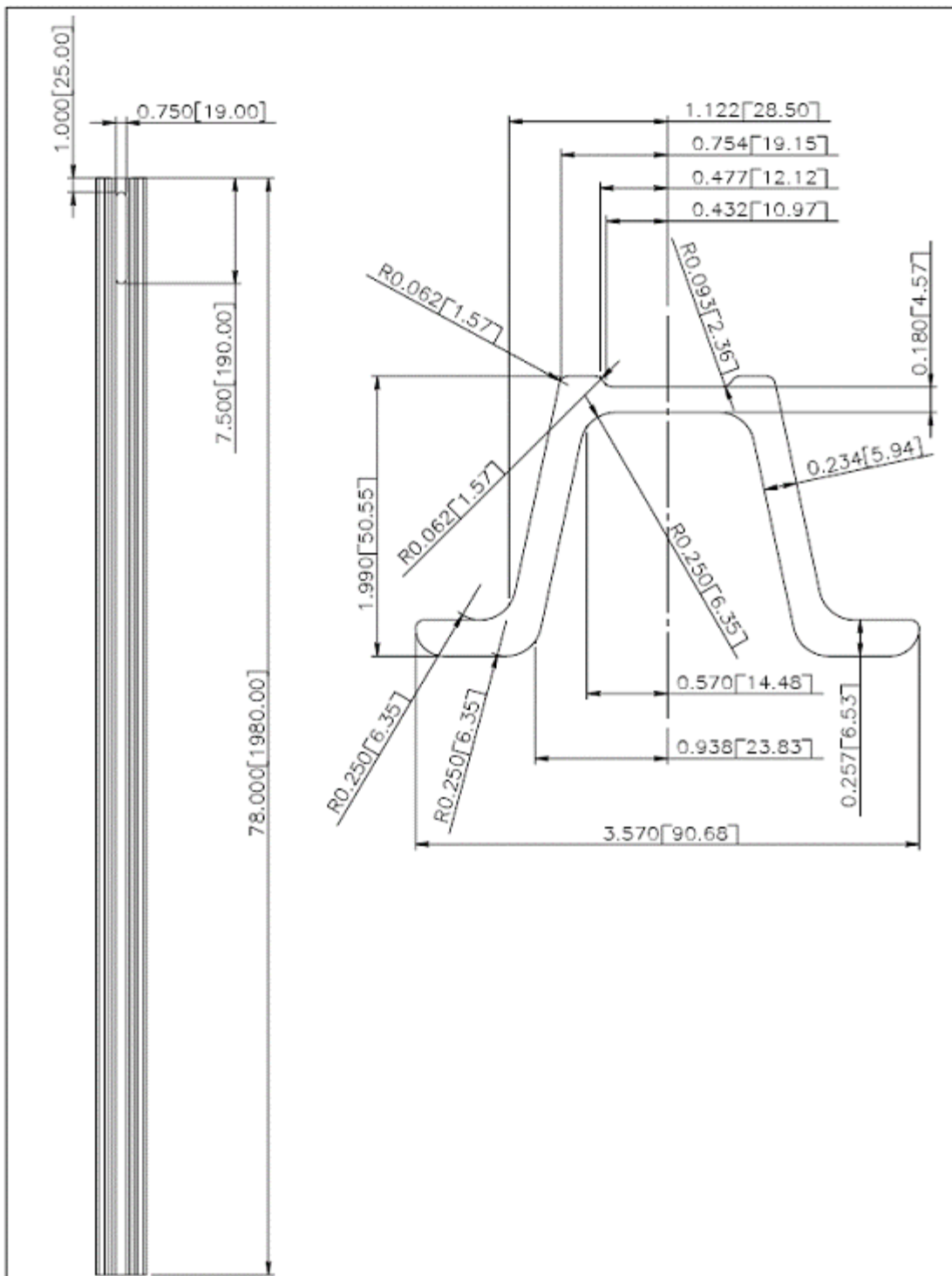
- Any changes that may adversely influence the crashworthiness of the device will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the device being marketed is significantly different from the version that was crash tested, it reserves the right to modify or revoke its 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 they will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance designated as number B-162 shall not be reproduced except in full. This letter and the test documentation upon which this letter is based, is public information. All such letters and documentation may be reviewed at our office upon request.
- The Nucor Strong Post W-beam guardrail system without blockouts and Nucor Strong Posts with blockouts for use in non-proprietary W-beam guardrail systems are patented products and considered proprietary. If proprietary devices are specified by a highway agency for use on Federal-aid projects, except exempt, non-NHS projects, they: (a) 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 device for which the applicant is not the patent holder. The acceptance letter is limited to the crashworthiness characteristics of the candidate device, and 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,

George E. Rice  
Acting Director, Office of Safety Design  
Office of Safety

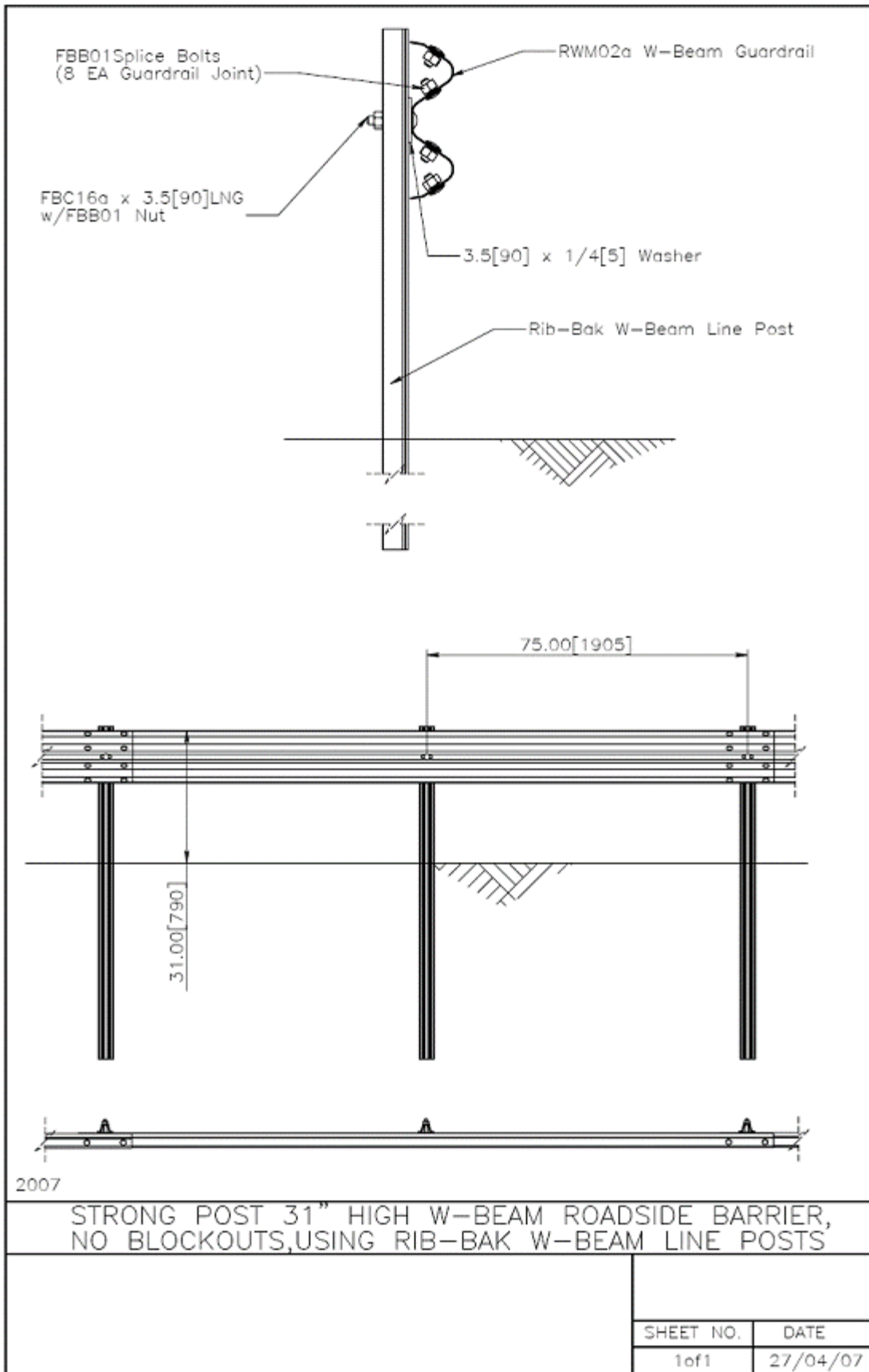
[Enclosures](#)

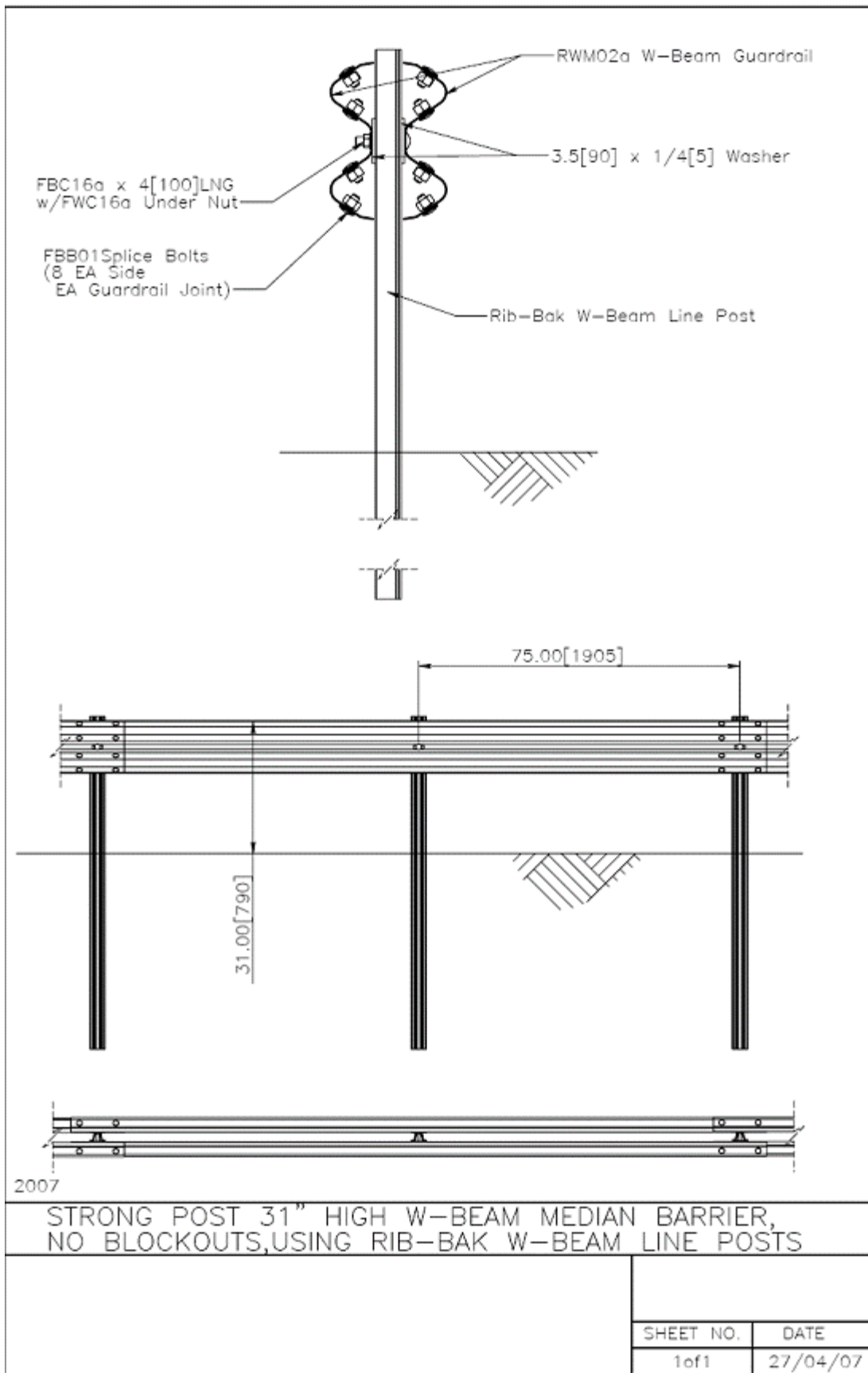


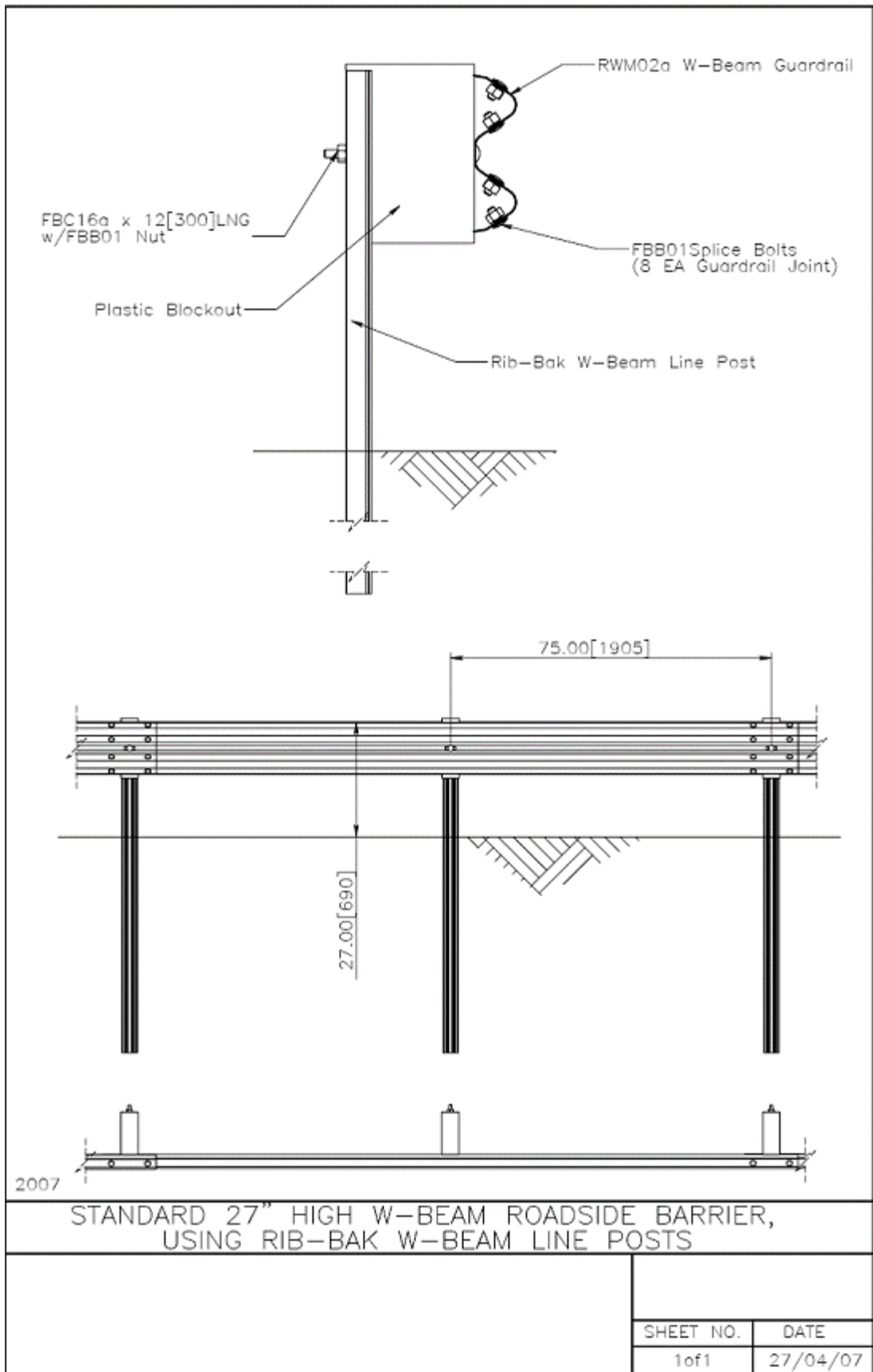
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RIB-BAK W-BEAM LINE POST

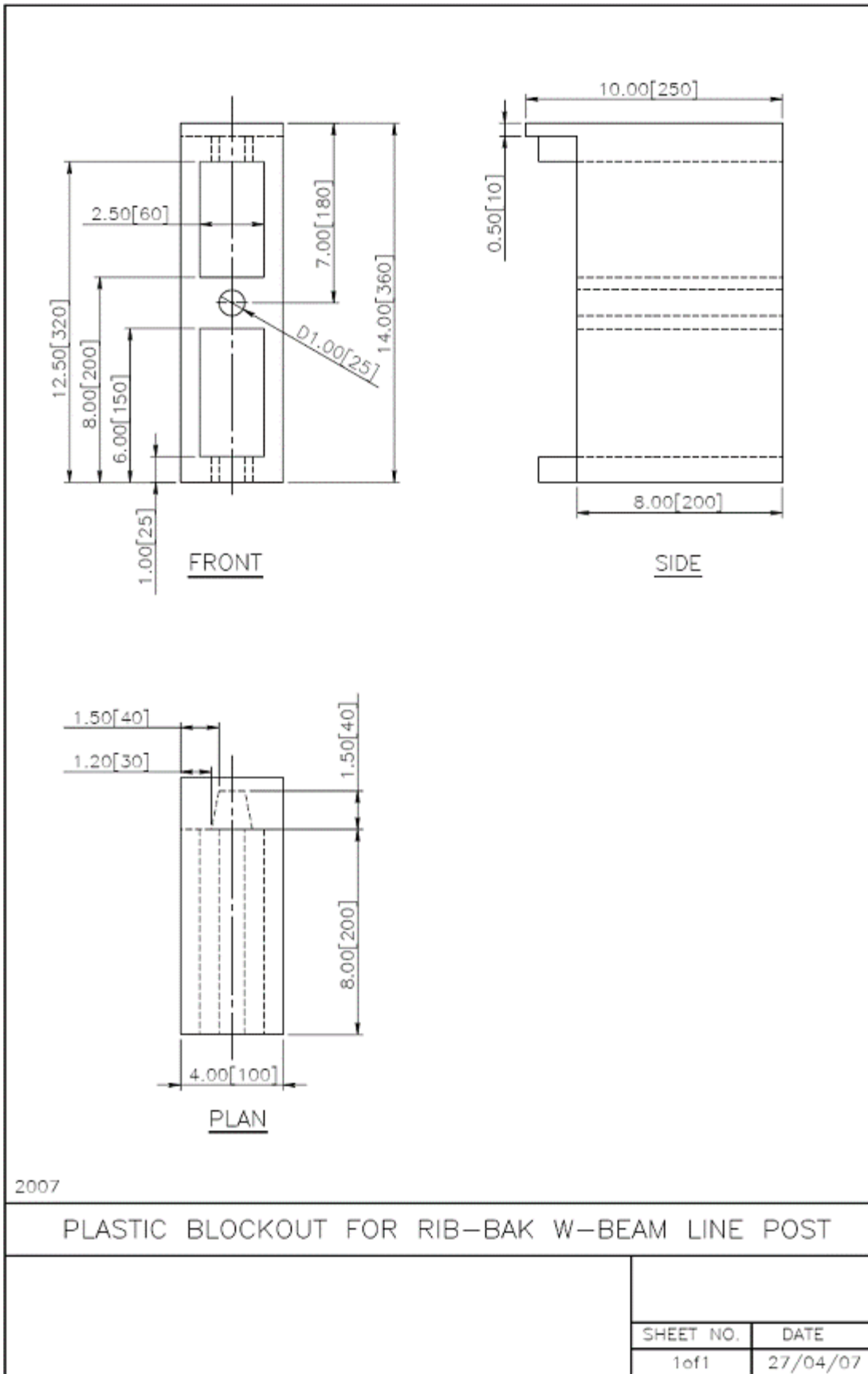
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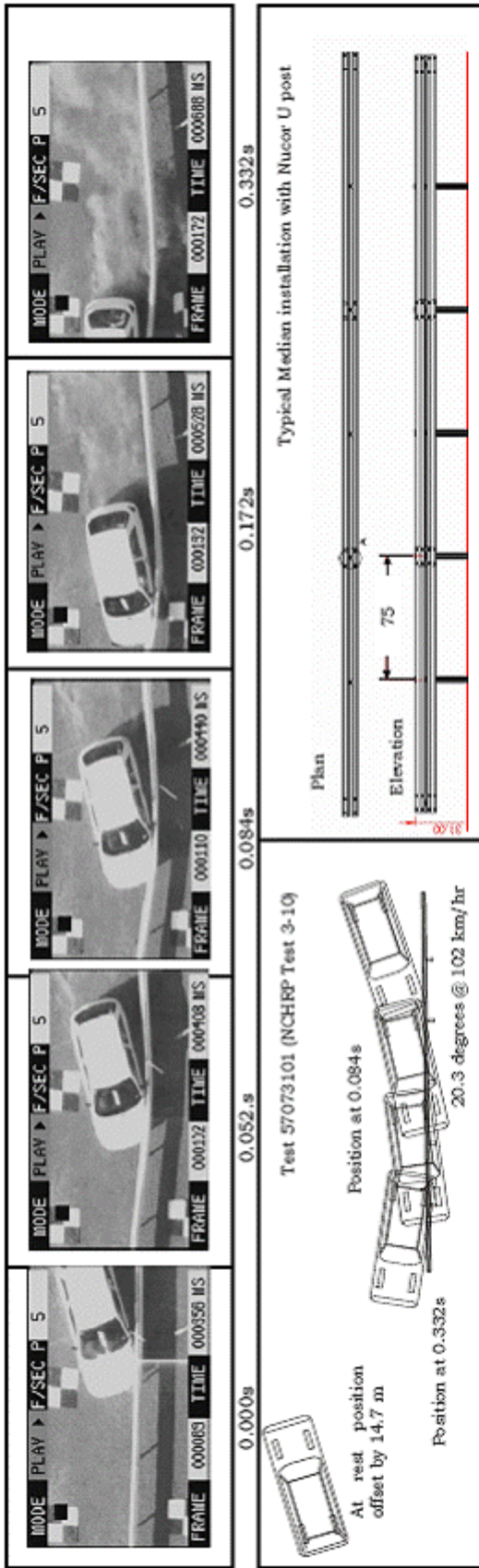












**General Information**  
 Test Agency ..... Holmes Solutions, New Zealand  
 Test Designation ..... NCHRP 350 Test 3-10  
 Test No. .... 57073101  
 Date ..... 5 March, 2007

**Test Article**  
 Type ..... Nucor 31" strong post W-beam median guardrail system  
 Name or Manufacturer... Nucor  
 Installation Length..... 55.4 m  
 Material or Key Elements ..... AASHTO SGROM-a-b Guardrail with 5 pound Nucor U posts  
 Soil Type and Condition..... AASHTO 'standard' soil M147-64

**Test Vehicle**  
 Type ..... Production Model  
 Designation ..... 820C  
 Model ..... 1997 Toyota Starlet  
 Mass (kg) .....  
 Curb ..... 896.5  
 Test Inertial ..... 837.0  
 Dummy ..... 76  
 Gross Static ..... 913.0

**Impact Conditions**  
 Speed (km/h) ..... 102.2  
 Angle (deg) ..... 20.3

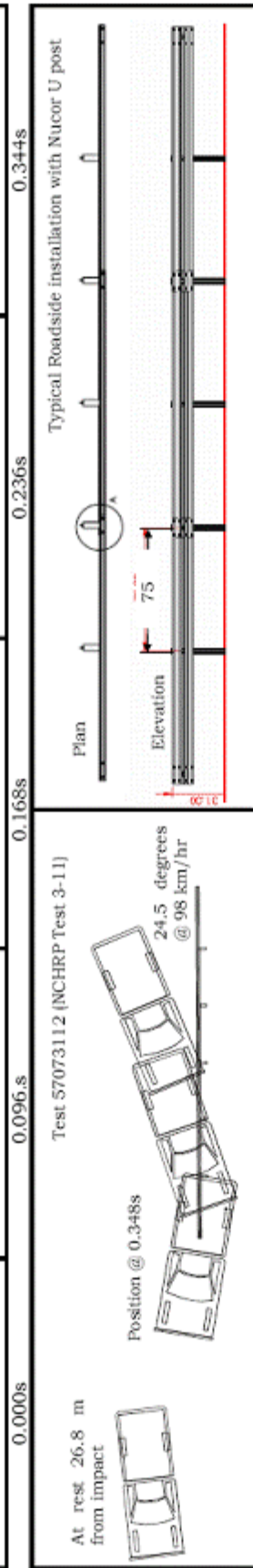
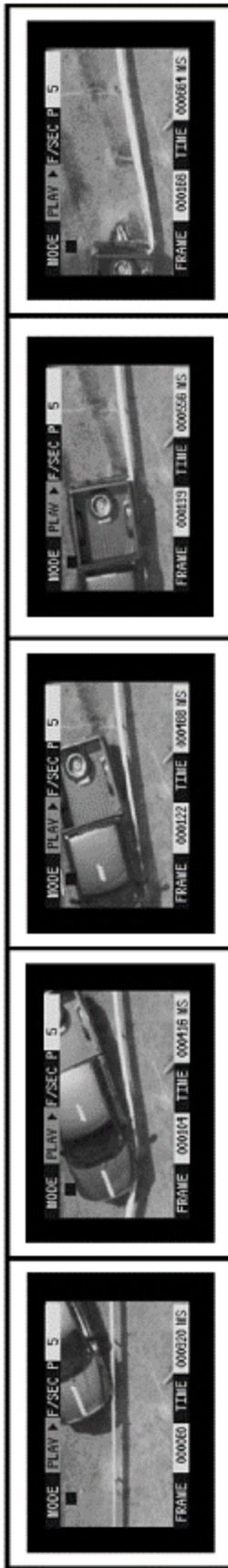
**Exit Conditions**  
 Speed (km/h) ..... 57.1  
 Angle (deg) ..... 5.2

**Occupant Risk Values**  
 Impact Velocity (m/s)  
 x-direction ..... 6.8  
 y-direction ..... -3.5  
 THIV (km/h) ..... 29.6  
 Ridedown Accelerations  
 x-direction (g's) ..... -6.3  
 y-direction (g's) ..... 7.8  
 PHD (g's) ..... 9.4  
 ASI ..... 0.66  
 Max. 0.050-s Average  
 x-direction (g's) ..... -6.5  
 y-direction (g's) ..... 4.8  
 z-direction (g's) ..... 2.5

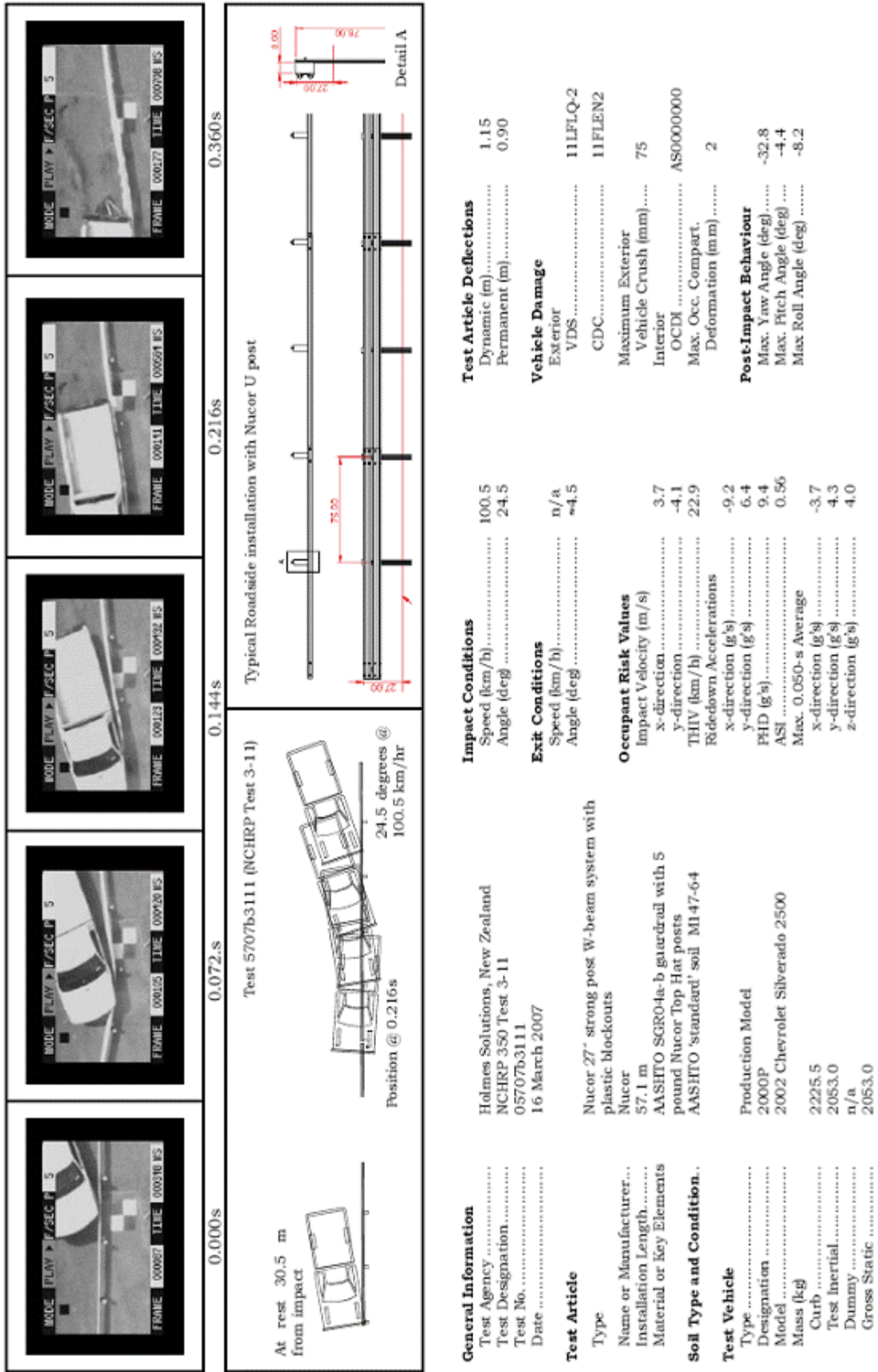
**Test Article Deflections**  
 Dynamic (m) ..... 0.68  
 Permanent (m) ..... 0.29

**Vehicle Damage**  
 Exterior  
 VDS ..... 11LFQ-4  
 CDC ..... 11FLEE2  
 Minimum Exterior Vehicle Crush (mm) ..... 295 mm  
 Interior  
 OCDI ..... AS0000000  
 Max. Occ. Compart. Deformation (mm) ..... 2

**Post-Impact Behaviour**  
 Max. Yaw Angle (deg) ..... -164.7  
 Max. Pitch Angle (deg) ..... 14.5  
 Max Roll Angle (deg) ..... -11.8



<b>General Information</b>	Test Agency ..... Holmes Solutions, New Zealand	<b>Impact Conditions</b>	Speed (km/h)..... 98.0	<b>Test Article Deflections</b>	Dynamic (m)..... 1.05
Test Designation..... NCHRP 350 Test 3-11	Test No. .... 057073112	Angle (deg).....	24.5	Permanent (m).....	0.80
Date ..... 15 March 2007		<b>Exit Conditions</b>	Speed (km/h)..... n/a	<b>Vehicle Damage</b>	
<b>Test Article</b>	Type ..... Nucor 31" strong post W-beam roadside guardrail system	Angle (deg).....	=5.0	Exterior	VDS ..... 11LPQ-2
Name or Manufacturer... Nucor	Installation Length..... 55.4 m			Interior	CDC ..... 11FLEN2
Material or Key Elements	Material or Key Elements			Maximum Exterior	Vehicle Crush (mm)..... 198
<b>Soil Type and Condition..</b>				OCDI.....	AS0000000
				Max. Occ. Compart.	
<b>Test Vehicle</b>				Deformation (mm) .....	1
Type .....	Production Model			<b>Post-Impact Behaviour</b>	
Designation .....	2270P			Max. Yaw Angle (deg) .....	-30.7
Model .....	2003 Dodge Ram			Max. Pitch Angle (deg).....	-8.6
Mass (kg)				Max Roll Angle (deg) .....	-11.8
Curb .....	2220.0				
Test Inertial.....	2232.5				
Dummy.....	n/a				
Gross Static .....	2232.5				



Title 23, Code of Federal Regulations

**§ 635.411 Material or product selection.**

(a) Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project, unless:

(1) Such patented or proprietary item is purchased or obtained through competitive bidding with equally suitable unpatented items; or

(2) The State transportation department certifies either that such patented or proprietary item is essential for synchronization with existing highway facilities, or that no equally suitable alternate exists; or

(3) Such patented or proprietary item is used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes.

(b) When there is available for purchase more than one nonpatented, nonproprietary material, semifinished or finished article or product that will fulfill the requirements for an item of work of a project and these available materials or products are judged to be of satisfactory quality and equally acceptable on the basis of engineering analysis and the anticipated prices for the related item(s) of work are estimated to be approximately the same, the PS&E for the project shall either contain or include by reference the specifications for each such material or product that is considered acceptable for incorporation in the work. If the State transportation department wishes to substitute some other acceptable material or product for the material or product designated by the successful bidder or bid as the lowest alternate, and such substitution results in an increase in costs, there will not be Federal-aid participation in any increase in costs.

(c) A State transportation department may require a specific material or product when there are other acceptable materials and products, when such specific choice is approved by the Division Administrator as being in the public interest. When the Division Administrator's approval is not obtained, the item will be nonparticipating unless bidding procedures are used that establish the unit price of each acceptable alternative. In this case Federal-aid participation will be based on the lowest price so established.

(d) Appendix A sets forth the FHWA requirements regarding (1) the specification of alternative types of culvert pipes, and (2) the number and types of such alternatives which must be set forth in the specifications for various types of drainage installations.

(e) Reference in specifications and on plans to single trade name materials will not be approved on Federal-aid contracts.

(f) In the case of a design-build project, the following requirements apply: Federal funds shall not participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the Request for Proposals document unless the conditions of paragraph (a) of this section are applicable.

[41 FR 36204, Aug. 27, 1976, as amended at 67 FR 75926, Dec. 10, 2002]



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