Texas A&M Transportation Institute
Proving Ground

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Test Report Date: September 2018

MASH TL-5 Evaluation of PennDOT PA Bridge Barrier

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16. Abstract

TTI evaluated the performance of the PennDOT PA Bridge Barrier in accordance with criteria specified in the American Association of State Highway and Transportation Officials (AASHTO), *Manual for Assessing Safety Hardware* (*MASH, Second Edition, 2016*). *MASH* Tests 5-10, 5-11, and 5-12 were performed on the bridge rail. The tests involved an 1100C and a 2270P vehicle, each impacting the PennDOT PA Bridge Barrier at a target impact speed and impact angle of 62 mi/h and 25°, respectively, and a 36000V vehicle impacting the PennDOT PA Bridge Barrier at a target impact speed and impact angle of 50 mi/h and 15°, respectively.

Assessment of the tests based on the applicable safety evaluation criteria for longitudinal barriers showed that the PennDOT PA Bridge Barrier performed acceptably for *MASH* Tests 5-10, 5-11, and 5-12.

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Chapter 1. INTRODUCTION

The purpose of the tests reported herein was to assess the performance of the PennDOT PA Bridge Barrier according to the safety-performance evaluation guidelines included in the American Association of State Highway and Transportation Officials (AASHTO), *Manual for Assessing Safety Hardware* (*MASH*) (*1*). The crash testing was performed in accordance with *MASH* Tests 5-10, 5-11, and 5-12, which involve an 1100C and a 2270P vehicle impacting the PennDOT PA Bridge Barrier at a target impact speed and impact angle of 62 mi/h and 25°, respectively, and a 36000V vehicle impacting the PennDOT PA Bridge Barrier at a target impact speed and impact angle of 50 mi/h and 15°, respectively.

This report provides details of the PennDOT PA Bridge Barrier, detailed documentation of the crash test results, and an assessment of the performance of the PennDOT PA Bridge Barrier for *MASH* Tests 5-10, 5-11, and 5-12 evaluation criteria.

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Chapter 2. SYSTEM DETAILS

2.1. TEST ARTICLE AND INSTALLATION DETAILS

The test installation was comprised of a steel reinforced cantilevered concrete bridge deck, 11 inches thick, supporting a 24-inch tall × 18-inch thick steel reinforced concrete barrier. The test installation was constructed with three ½-inch wide joints, two extended through the parapet wall only, and the third through the wall and deck.

There were 20 posts attached to the top of the parapet using cast in place anchor bolts. The posts were spaced on 90–inch centers, beginning 44-inches from each end of the concrete deck and parapet, for a total installation length of 149 ft-10 inches. Two rectangular HSS 5×4×⅜ rails were attached to each post, with the tops of the rails located 37 inches and 50 inches above grade, respectively.

Figure 2. presents overall information on the PennDOT PA Bridge Barrier, and Figure 2.2 provides photographs of the installation. Appendix A provides further details of the PennDOT PA Bridge Barrier.

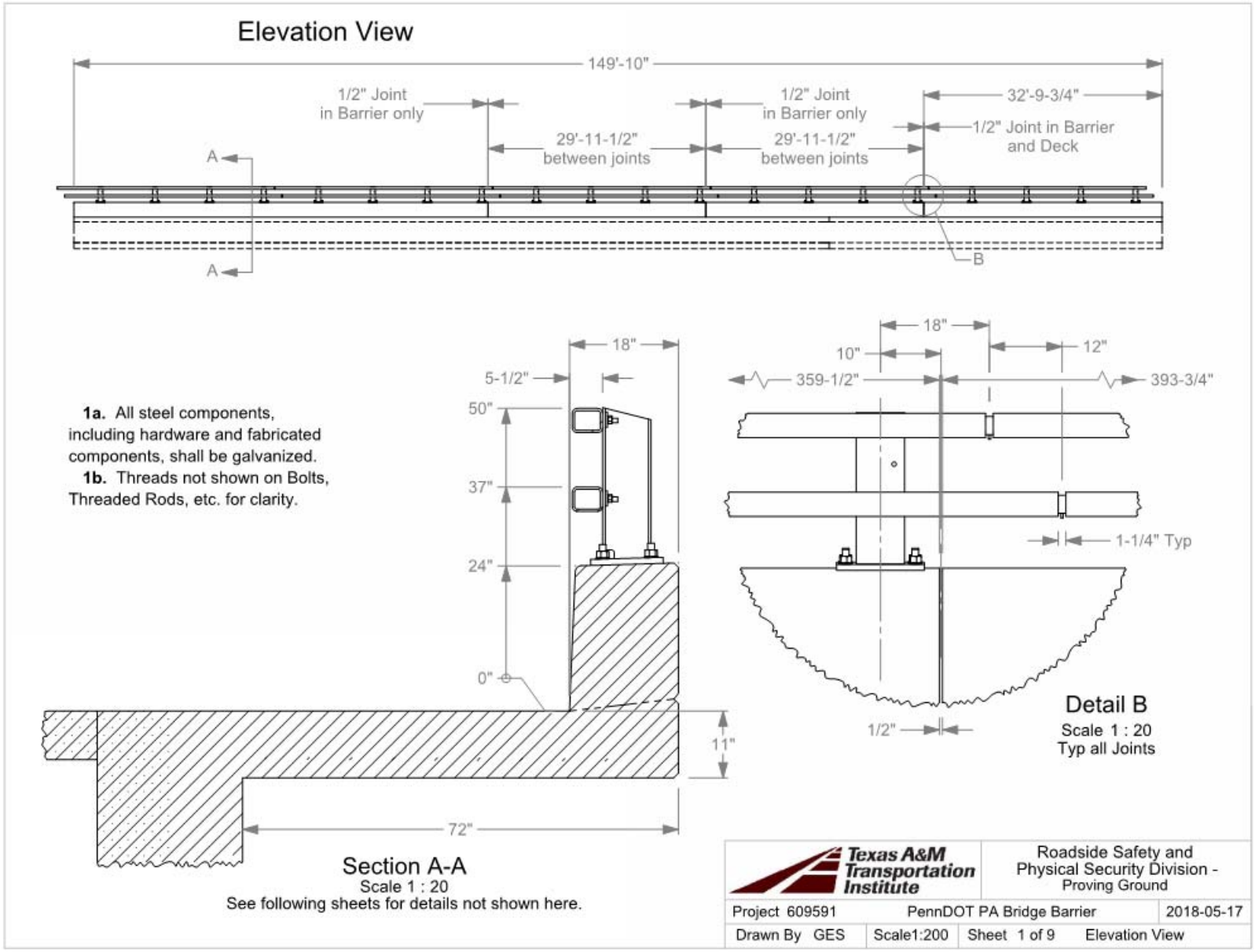

Figure 2.1. Details of the PennDOT PA Bridge Barrier.

Figure 2.2. PennDOT PA Bridge Barrier prior to Testing.

2.2. MATERIAL SPECIFICATIONS

Appendix B provides material certification documents for the materials used to install/construct the PennDOT PA Bridge Barrier.

The specified minimum unconfined compressive strength of the concrete for the support wall, bridge deck and moment slab (moment slab was poured along with bridge deck batches) was 4,000 psi, the working slab was 3,000 psi, and the barrier was 3,500 psi. The average unconfined compressive strengths of the batches of concrete used in the construction of the test installation were as follows with locations of the different batches shown in the following illustration Figure 2.3

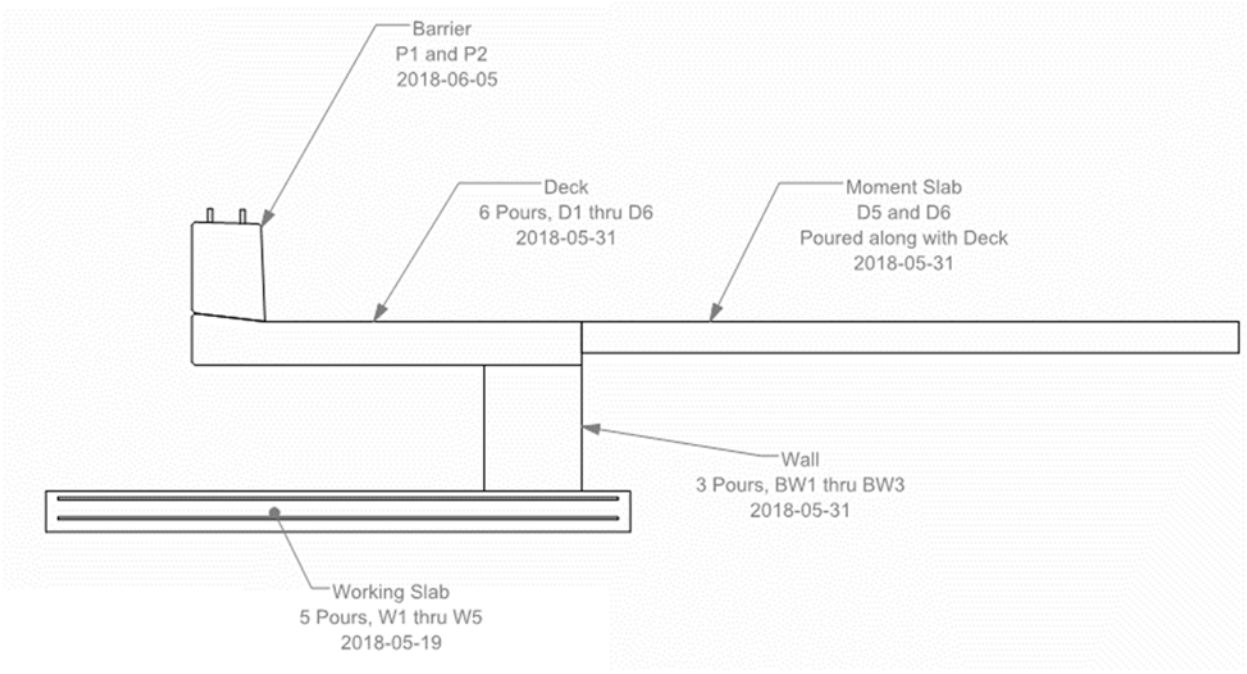

Figure 2.3. Concrete Map Overview of the of the PennDOT PA Bridge Barrier

Working Slab: 3,895 psi (over 5 batches) on 2018-05-19, 37 days from pour date.

Wall: 6,225 psi (over 3 batches) on 2018-05-31, 26 days from pour date.

Deck (moment slab): 5,815 psi (over 6 batches) on 2018-05-31, 26 days from pour date.

Barrier: 4,981 psi (over 2 batches) on 2018-06-05, 20 days from pour date.

Steel reinforcement of the bridge deck and wall was comprised of epoxy coated ASTM A615 Grade 60 rebar with specified minimum yield strength of 60 ksi.

Chapter 3. TEST REQUIREMENTS AND EVALUATION CRITERIA

3.1. CRASH TEST PERFORMED / MATRIX

Table 3.1 shows the test conditions and evaluation criteria for *MASH* TL-5 for longitudinal barriers. *MASH* Test 5-10 involves an 1100C vehicle, weighing 2420 lb ±55 lb, impacting the critical impact point (CIP) of the barrier at an impact speed of 62 mi/h ±2.5 mi/h and an angle of 25° ±1.5°. *MASH* Test 5-11 involves a 2270P vehicle, weighing 5000 lb ±110 lb, impacting the CIP of the barrier at an impact speed of 62 mi/h ±2.5 mi/h and an angle of 25° ±1.5°. *MASH* Test 5-12 involves a 36000V vehicle weighing 79,300 lb ±1100 lb, impacting the CIP of the barrier at an impact speed of 50 mi/h ±2.5 mi/h and an angle of 15° ±1.5°.

The target CIPs were determined using the information provided in *MASH* Section 2.2.1 and Section 2.3.2, and Tables 2-7 and 2-8. The target CIP for *MASH* Test 5-11 on the PennDOT PA Bridge Barrier was 4.3 ft ±1 ft upstream of post 9 edge with lower rail splice. The target CIP for *MASH* Test 5-10 was 3.6 ft ±1 ft upstream of post 13 edge with lower rail splice. The target CIP for *MASH* Test 5-12 was 1 ft ±1 ft, downstream of post 5 edge with lower rail splice.

Table 3.1. Test Conditions and Evaluation Criteria Specified for *MASH* TL-5 Longitudinal Barriers.

Test Article	Test Designation	Test Vehicle	Impact Conditions		Evaluation Criteria
			Speed	Angle	
Longitudinal Barrier	5-10	1100C	62 mi/h	25°	A, D, F, H, I
	5-11	2270P	62 mi/h	25°	A, D, F, H, I
	5-12	36000V	50 mi/h	15°	A, D,G

The crash tests and data analysis procedures were in accordance with guidelines presented in *MASH*. Chapter 4 presents brief descriptions of these procedures.

3.2. EVALUATION CRITERIA

The appropriate safety evaluation criteria from Tables 2-2A and 5-1 of *MASH* were used to evaluate the crash tests reported herein. The test conditions and evaluation criteria required for *MASH* Tests 5-10, 5-11, and 5-12 are listed in Table 3.1, and the substance of the evaluation criteria in Table 3.2. An evaluation of the crash test results is presented in detail under the section Assessment of Test Results.

Table 3.2. Evaluation Criteria Required for *MASH* TL-5 Longitudinal Barriers.

Evaluation Factors	Evaluation Criteria	*MASH* Test
Structural Adequacy	*A. Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.*	5-10, 5-11, 5-12
Occupant Risk	*D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present undue hazard to other traffic, pedestrians, or personnel in a work zone.* *Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.*	5-10, 5-11, 5-12
	F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	5-10, 5-11
	G. It is preferable, although not essential, that the vehicle remain upright during and after the collision.	5-12
	H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	5-10, 5-11
	I. The occupant ridedown accelerations should satisfy the following: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	5-10, 5-11

Chapter 4. TEST CONDITIONS

4.1. TEST FACILITY

The full-scale crash tests reported herein were performed at Texas A&M Transportation Institute (TTI) Proving Ground, an International Standards Organization (ISO)/International Electrotechnical Commission (IEC) 17025-accredited laboratory with American Association for Laboratory Accreditation (A2LA) Mechanical Testing Certificate 2821.01. The full-scale crash tests were performed according to TTI Proving Ground quality procedures, and according to the *MASH* guidelines and standards.

The test facilities of the TTI Proving Ground are located on the Texas A&M University RELLIS Campus, which consists of a 2000-acre complex of research and training facilities situated 10 miles northwest of the flagship campus of Texas A&M University. The site, formerly a United States Army Air Corps base, has large expanses of concrete runways and parking aprons well suited for experimental research and testing in the areas of vehicle performance and handling, vehicle-roadway interaction, durability and efficacy of highway pavements, and evaluation of roadside safety hardware and perimeter protective devices. The site selected for construction and testing of the PennDOT PA Bridge Barrier was at the end of an out-of-service runway. The runway consists of an unreinforced jointed-concrete pavement in 12.5-ft × 15-ft blocks nominally 6 inches deep. The runway was built in 1942, and the joints have some displacement, but are otherwise flat and level.

4.2 VEHICLE TOW AND GUIDANCE SYSTEM

For the 5-10 and 5-11 tests, the vehicle was towed into the test installation using a steel cable guidance and reverse tow system. A steel cable for guiding the test vehicle was tensioned along the path, anchored at each end, and threaded through an attachment to the front wheel of the test vehicle. An additional steel cable was connected to the test vehicle, passed around a pulley near the impact point, through a pulley on the tow vehicle, and then anchored to the ground such that the tow vehicle moved away from the test site. A 2:1 speed ratio between the test and tow vehicle existed with this system. Just prior to impact with the installation, the test vehicle was released and ran unrestrained. The vehicle remained freewheeling (i.e., no steering or braking inputs) until it cleared the immediate area of the test site (no sooner than 2 s after impact), after which the brakes were activated, if needed, to bring the test vehicle to a safe and controlled stop.

For the 5-12 test the vehicle was placed in 9th gear for the 5-12 test. With the vehicle idling the clutch was remotely engaged, to allow the truck to be pushed to speed. Once at speed, within the power band of the gear, the clutch was remotely released.. The accelerator was then remotely depressed and the vehicle accelerated under its own power to the required speed. A steel cable for guiding the test vehicle was tensioned along the path, anchored at each end, and threaded through an attachment to the front wheel of the test vehicle. The vehicle was released and ran unrestrained just prior to impact with the installation. The vehicle remained freewheeling (i.e., no steering or braking inputs) until it cleared the immediate area of the test site (no sooner than 2 s after impact), after which the brakes were activated, if needed, to bring the test vehicle to a safe and controlled stop.

4.3 DATA ACQUISITION SYSTEMS

4.3.1 Vehicle Instrumentation and Data Processing

Each test vehicle was instrumented with a self-contained, on-board data acquisition system. The signal conditioning and acquisition system is a 16-channel, Tiny Data Acquisition System (TDAS) Pro produced by Diversified Technical Systems, Inc. The accelerometers, which measure the x, y, and z axis of vehicle acceleration, are strain gauge type with linear millivolt output proportional to acceleration. Angular rate sensors, measuring vehicle roll, pitch, and yaw rates, are ultra-small, solid state units designed for crash test service. The TDAS Pro hardware and software conform to the latest SAE J211, Instrumentation for Impact Test. Each of the 16 channels is capable of providing precision amplification, scaling, and filtering based on transducer specifications and calibrations. During the test, data are recorded from each channel at a rate of 10,000 values per second with a resolution of one part in 65,536. Once data are recorded, internal batteries back these up inside the unit should the primary battery cable be severed. Initial contact of the pressure switch on the vehicle bumper provides a time zero mark as well as initiates the recording process. After each test, the data are downloaded from the TDAS Pro unit into a laptop computer at the test site. The Test Risk Assessment Program (TRAP) software then processes the raw data to produce detailed reports of the test results.

Each of the TDAS Pro units is returned to the factory annually for complete recalibration and all instrumentation used in the vehicle conforms to all specifications outlined by SAE J211. All accelerometers are calibrated annually by means of an ENDEVCO® 2901, precision primary vibration standard. This standard and its support instruments are checked annually and receive a National Institute of Standards Technology (NIST) traceable calibration. The rate transducers used in the data acquisition system receive a calibration via a Genisco Rate-of-Turn table. The subsystems of each data channel are also evaluated annually, using instruments with current NIST traceability, and the results are factored into the accuracy of the total data channel, per SAE J211. Calibrations and evaluations are also made any time data are suspect. Acceleration data is measured with an expanded uncertainty of ±1.7 percent at a confidence factor of 95 percent (k=2).

TRAP uses the data from the TDAS Pro to compute occupant/compartment impact velocities, time of occupant/compartment impact after vehicle impact, and the highest 10-millisecond (ms) average ridedown acceleration. TRAP calculates change in vehicle velocity at the end of a given impulse period. In addition, maximum average accelerations over 50-ms intervals in each of the three directions are computed. For reporting purposes, the data from the vehicle-mounted accelerometers are filtered with a 60-Hz low-pass digital filter, and acceleration versus time curves for the longitudinal, lateral, and vertical directions are plotted using TRAP.

TRAP uses the data from the yaw, pitch, and roll rate transducers to compute angular displacement in degrees at 0.0001-s intervals, then plots yaw, pitch, and roll versus time. These displacements are in reference to the vehicle-fixed coordinate system with the initial position and orientation of the vehicle-fixed coordinate systems being initial impact. Rate of rotation data is measured with an expanded uncertainty of ±0.7 percent at a confidence factor of 95 percent (k=2).

Placement of the electronic instrumentation in the *MASH* Test 5-12 is shown in Appendix E1, Figure E.1 and described below.

(A) The front accelerometers were placed on the tractor frame rail 14.0 inches forward of the front axle, 20.0 inches left of the longitudinal centerline, and at height of 33.0 inches above ground surface.
(B) Accelerometers and rate transducers were placed on the tractor frame just ahead of the fifth wheel, 105 inches rearward of the front axle, at the longitudinal centerline, and at a height of 32 inches above ground surface.
(C) The rear accelerometers were placed on the trailer frame, between the two rear trailer axles, 677 inches rearward of the front axle, at the longitudinal centerline, and 49.5 inches above ground surface.

4.3.2 Anthropomorphic Dummy Instrumentation

An Alderson Research Laboratories Hybrid II, 50th percentile male anthropomorphic dummy, restrained with lap and shoulder belts, was placed in the front seat on the impact side of the 1100C vehicle. The dummy was not instrumented.

According to *MASH*, use of a dummy in the 2270P vehicle is optional, however, it is recommended a dummy be used when testing "any longitudinal barrier with a height greater than or equal to 33 inches." Use of the dummy in the 2270P vehicle is recommended for tall rails to evaluate the "potential for an occupant to extend out of the vehicle and come into direct contact with the test article." Although this information is reported, it is not part of the impact performance evaluation. Since the rail height of the PennDOT PA Bridge Barrier was 50 inches above grade, a dummy was placed in the front seat of the 2270P vehicle on the impact side and restrained with lap and shoulder belts.

MASH does not recommend or require use of a dummy in the 36000V vehicle.

4.3.3 Photographic Instrumentation Data Processing

Photographic coverage of each test included three digital high-speed cameras:

- One overhead with a field of view perpendicular to the ground and directly over the impact point;
- One placed upstream of the impact point on the traffic side of the barrier; and
- A third placed to have a field of view parallel to and aligned with the installation at the downstream end.

A flashbulb on the impacting vehicle was activated by a pressure-sensitive tape switch to indicate the instant of contact with the PennDOT PA Bridge Barrier. The flashbulb was visible from each camera. The video files from these digital high-speed cameras were analyzed to observe phenomena occurring during the collision and to obtain time-event, displacement, and angular data. A digital camera recorded and documented conditions of each test vehicle and the installation before and after the test.

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Chapter 5. *MASH* TEST 5-11 (CRASH TEST NO. 609591-03-1)

5.1 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 5-11 involves a 2270P vehicle, weighing 5000 lb ±110 lb, impacting the CIP of the bridge rail at an impact speed of 62 mi/h ±2.5 mi/h and an angle of 25° ±1.5°. The target CIP for *MASH* Test 5-11 on the PennDOT PA Bridge Barrier was 4.3 ft ±1 ft upstream of post 9 edge with lower rail splice. The 2013 RAM 1500 pickup used in the test weighed 5004 lb, and the actual impact speed and angle were 63.2 mi/h and 24.8°, respectively. The actual impact point was 4.3 ft upstream of the upstream edge of post 9. Minimum target impact severity (IS) was 106 kip-ft, and actual IS was 121 kip-ft.

5.2 WEATHER CONDITIONS

The test was performed on the morning of June 28, 2018. Weather conditions at the time of testing were as follows: wind speed: 8 mi/h; wind direction: 228° (vehicle was traveling in a southerly direction); temperature: 86°F; relative humidity: 73 percent.

5.3 TEST VEHICLE

Figures 5.1 and 5.2 show the 2013 RAM 1500 pickup used for the crash test. The vehicle's test inertia weight was 5004 lb, and its gross static weight was 5169 lb. The height to the lower edge of the vehicle bumper was 11.8 inches, and height to the upper edge of the bumper was 27.0 inches. The height to the vehicle's center of gravity was 29.0 inches. Tables C.1 and C.2 in Appendix C1 give additional dimensions and information on the vehicle. The vehicle was directed into the installation using the cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.

Figure 5.1. PennDOT PA Bridge Barrier/Test Vehicle Geometrics for Test No. 609591-03-1.

Figure 5.2. Test Vehicle before Test No. 609591-03-1.

5.4 TEST DESCRIPTION

The 2013 RAM 1500 was traveling at an impact speed of 61.7 mi/h when it contacted the PennDOT PA Bridge Barrier 4.3 ft upstream of post 9 at an impact angle of 24.825.3°. Table 5.1 lists events that occurred during Test No. 609591-03-1. Figures C.1 and C.2 in Appendix C2 present sequential photographs during the test.

Table 5.1. Events during Test No. 609591-03-1.

TIME (s)	EVENTS
0.000	Vehicle makes contact with bridge rail
0.023	Vehicle begins to redirect
0.051	Right front bumper shears off of vehicle when contacting post 9
0.082	Dummy head begins to break through passenger side window
0.182	Vehicle becomes parallel with bridge rail
0.188	Rear right side of truck contacts bridge rail
0.192	Left front tire lifts off of pavement
0.214	Left rear tire lands back on pavement
0.255	Left front tire lands back on pavement
0.299	Vehicle loses contact with bridge rail while traveling at 50.8 mi/h

For longitudinal barriers, it is desirable that the vehicle redirects and exits the barrier within the exit box criteria (not less than 32.8 ft downstream from loss of contact for cars and pickups). The test vehicle exited within the exit box criteria defined in *MASH*. After loss of contact with the barrier, the vehicle came to rest 212 ft downstream of the impact and 12 ft toward traffic lanes.

5.5 DAMAGE TO TEST INSTALLATION

Figure 5.3 shows the damage to the PennDOT PA Bridge Barrier. There was slight concrete damage to the concrete barrier edges near impact and at joint, along with some surface

scuffing of the traffic face of the rail and concrete wall. Working width was 18.0 inches at a height of 24.0 inches. Maximum dynamic deflection during the test was 0.7 inches, and there was no measureable permanent deformation.

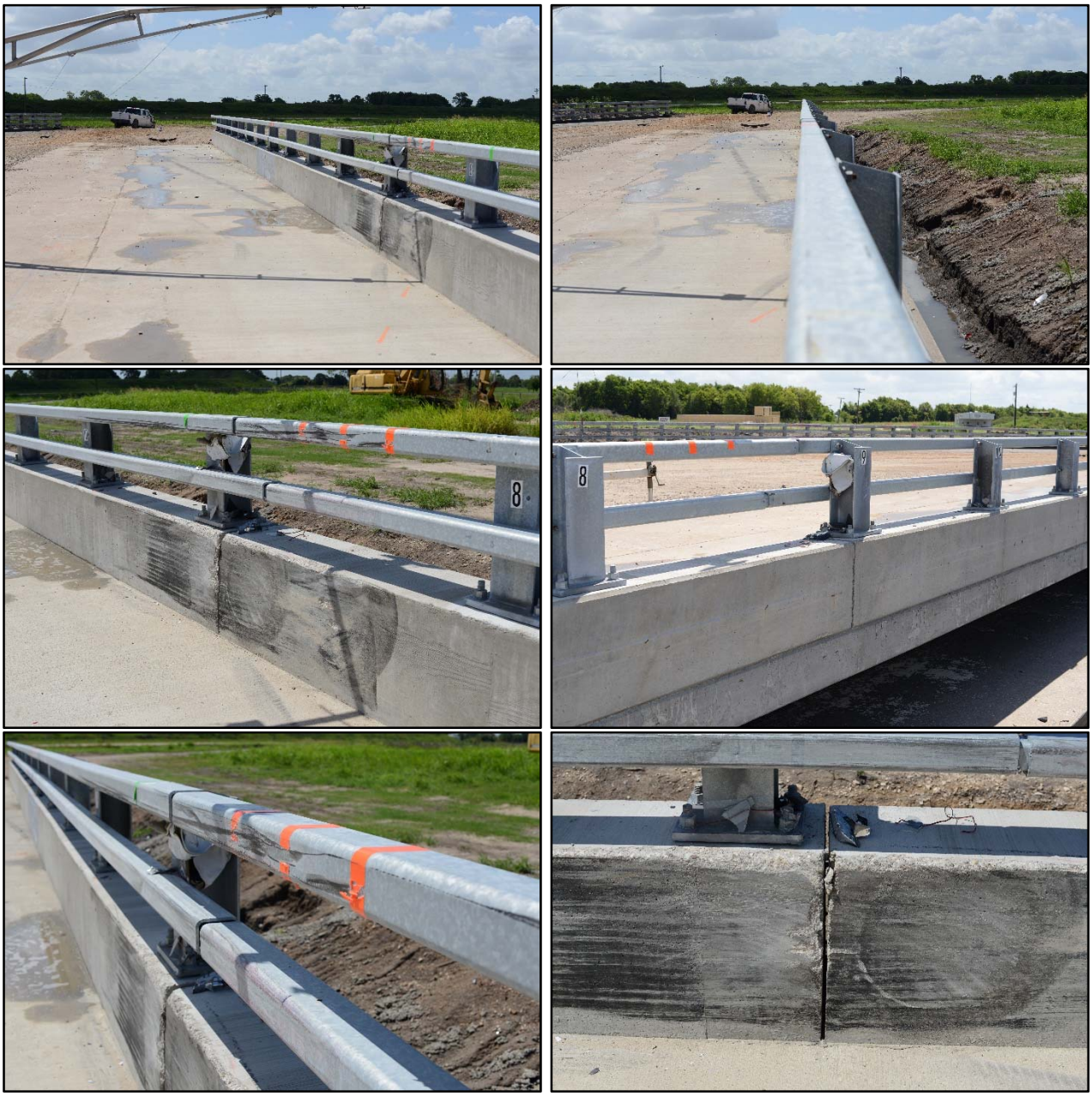


Figure 5.3. PennDOT PA Bridge Barrier after Test No. 609591-03-1.

5.6 VEHICLE DAMAGE

Figure 5.4 shows the damage sustained by the vehicle. The front bumper, hood, grill, radiator and support, right front fender, right head light, right A-post, right front tire and rim,

right front corner of roof, right front and rear doors and glass, right rear fender, right rear tail light, rear bumper and tailgate were damaged. The windshield sustained a crack starting at the bottom and radiating upward. Maximum exterior crush to the vehicle was 11.0 inches in the side plane at the right corner at bumper height. Maximum occupant compartment deformation was 3.0 inches on the right side from the firewall to the passenger seat, and vertically on the passenger side from the floorboard to the roof at the passenger seat location. Figure 5.5 shows the interior of the vehicle. Tables C.3 and C.4 in Appendix C1 provide exterior crush and occupant compartment measurements.

Figure 5.4. Test Vehicle after Test No. 609591-03-1.

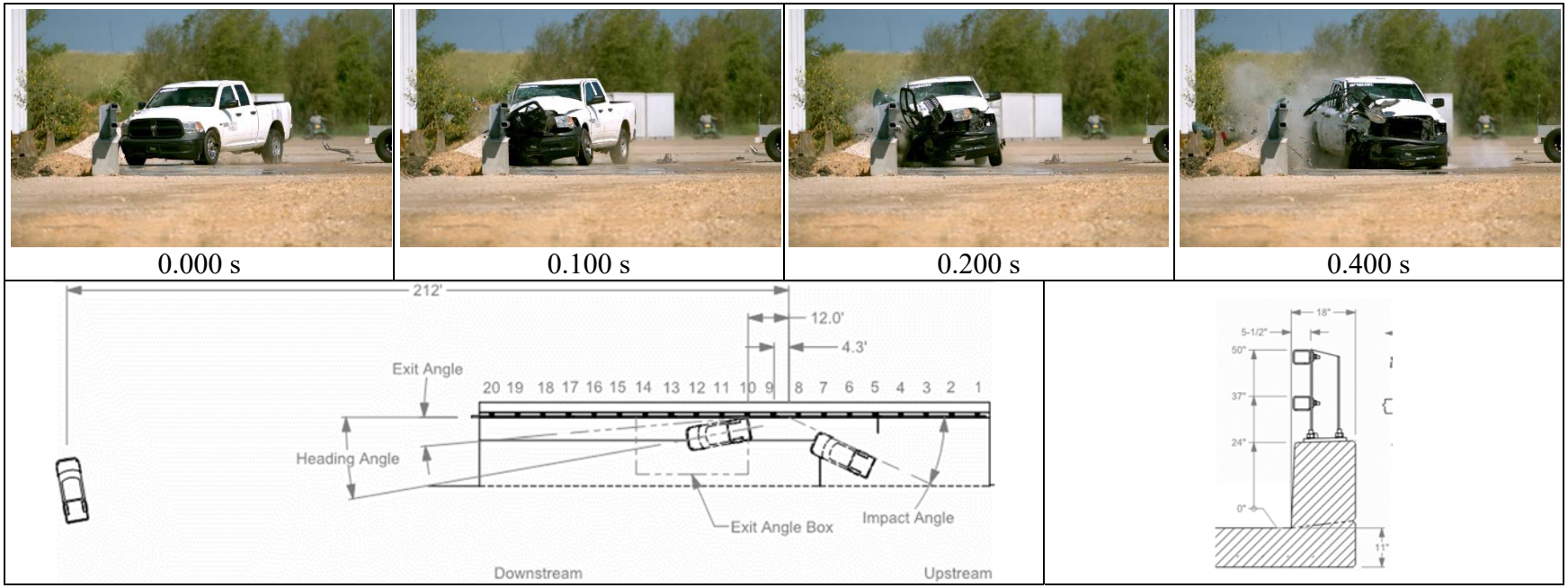
Figure 5.5. Interior of Test Vehicle for Test No. 609591-03-1.

5.7 OCCUPANT RISK FACTORS

Data from the accelerometer, located at the vehicle center of gravity, were digitized for evaluation of occupant risk and are shown in Table 5.2. Figure 5.6 summarizes these data and other pertinent information from the test. Figure C.3 in Appendix C3 shows the vehicle angular displacements, and Figures C.4 through C.9 in Appendix C4 show accelerations versus time traces.

Table 5.2. Occupant Risk Factors for Test No. 609591-03-1.

Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)	ft/s	at 0.0918 seconds on right side of interior
Longitudinal	**19.4**	
Lateral	**28.2**	
Occupant Ridedown Accelerations (G's)		
Longitudinal	**-3.2**	(0.1038 - 0.1138 seconds)
Lateral	**-6.7**	(0.2152 - 0.2252 seconds)
Theoretical Head Impact Velocity (THIV)	km/h	at 0.0895 seconds on right side of interior
	38.1	
	m/s	
	10.6	
Post Head Deceleration (PHD) (G's)	**7.1**	(0.2152 - 0.2252 seconds)
Acceleration Severity Index (ASI)	**2.06**	(0.0574 - 0.1074 seconds)
Maximum 50-ms Moving Average (G's)		
Longitudinal	**-9.4**	(0.0318 - 0.0818 seconds)
Lateral	**-15.9**	(0.0328 - 0.0828 seconds)
Vertical	**-2.3**	(0.0013 - 0.0513 seconds)
Maximum Roll, Pitch, and Yaw Angles	**Degrees**	
Roll	**4**	(0.4838 seconds)
Pitch	**4**	(0.0623 seconds)
Yaw	**34**	(0.5737 seconds)



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- TTI Test No. 609591-03-1
- Test Date 2018-06-28

Test Article
- Type ..... Longitudinal Barrier - Bridge Rail
- Name ..... PennDOT PA Bridge Barrier
- Installation Length ..... 149 ft-10 inches
- Material or Key Elements .... 24-inch tall × 18-inch thick reinforced concrete parapet with two HSS 5×4×⅜ rails at 37 inches and 50 inches

Soil Type and Condition ..... Concrete bridge deck, damp

Test Vehicle
- Type/Designation 2270P
- Make and Model ..... 2013 RAM 1500 Pickup
- Curb ..... 4952 lb
- Test Inertial ..... 5004 lb
- Dummy ..... 165 lb
- Gross Static ..... 5169 lb

Impact Conditions
- Speed ..... 63.2 mi/h
- Angle ..... 24.8°
- Location/Orientation ..... 4.3 ft upstream of post 9

Impact Severity ..... 121 kip-ft

Exit Conditions
- Speed ..... 50.7 mi/h
- Exit Traj./Heading Angle ..... 4.4°/5.7°

Occupant Risk Values
- Longitudinal OIV ..... 19.4 ft/s
- Lateral OIV ..... 28.2 ft/s
- Longitudinal Ridedown ..... 3.2 g
- Lateral Ridedown ..... 6.7 g
- THIV ..... 34.8 ft/s
- PHD ..... 7.1 g
- ASI 2.06

Max. 0.050-s Average
- Longitudinal ..... -9.4 g
- Lateral ..... 15.9 g
- Vertical ..... -2.3 g

Post-Impact Trajectory
- Stopping Distance ..... 212 ft downstream 12 ft toward traffic

Vehicle Stability
- Maximum Yaw Angle ..... 34°
- Maximum Pitch Angle ..... 4°
- Maximum Roll Angle ..... 4°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 0.7 inches
- Permanent ..... None
- Working Width ..... 18.0 inches
- Working Width Height ..... 24.0 inches

Vehicle Damage
- VDS 10-RFQ-5
- CDC 10FREW3
- Max. Exterior Deformation ..... 11.0 inches
- OCDI RF0122110
- Max. Occupant Compartment Deformation ..... 3.0 inches

Figure 5.6. Summary of Results for *MASH* Test 5-11 on PennDOT PA Bridge Barrier.

Chapter 6. *MASH* TEST 5-10 (CRASH TEST NO. 609591-03-2)

6.1 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 5-10 involves an 1100C vehicle, weighing 2420 lb ±55 lb, impacting the CIP of the bridge rail at an impact speed of 62 mi/h ±2.5 mi/h and an angle of 25° ±1.5°. The target CIP for *MASH* Test 5-10 on the PennDOT PA Bridge Barrier was 3.6 ft ±1 ft upstream of post 13 edge with lower rail splice.

The 2011 Kia Rio* used in the test weighed 2427 lb, and the actual impact speed and angle were 61.7 mi/h and 25.3°, respectively. The actual impact point was 4.1 ft upstream of the upstream edge of post 13. Minimum target IS was 51 kip-ft, and actual IS was 60 kip-ft.

6.2 WEATHER CONDITIONS

The test was performed on the morning of June 26, 2018. Weather conditions at the time of testing were as follows: wind speed: 9 mi/h; wind direction: 182° (vehicle was traveling in a southerly direction); temperature: 88°F; relative humidity: 69 percent.

6.3 TEST VEHICLE

Figures 6.1 and 6.2 show the 2011 Kia Rio used for the crash test. The vehicle's test inertia weight was 2427 lb, and its gross static weight was 2592 lb. The height to the lower edge of the vehicle bumper was 7.8 inches, and height to the upper edge of the bumper was 21.5 inches. Table D.1 in Appendix D1 gives additional dimensions and information on the vehicle. The vehicle was directed into the installation using a cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.

* An older model vehicle was used, based upon availability. An older model vehicle is permitted by AASHTO as long as it is otherwise *MASH* compliant. This vehicle meets the *MASH* dimensional specifications.

Figure 6.1. PennDOT PA Bridge Barrier/Test Vehicle Geometrics for Test No. 609591-03-2.

Figure 6.2. Test Vehicle before Test No. 609591-03-2.

6.4 TEST DESCRIPTION

The 2011 Kia Rio was traveling at an impact speed of 61.7 mi/h when it contacted the PennDOT PA Bridge Barrier was 4.1 ft upstream of the upstream edge of post 13 at an impact angle of 25.3°. Table 6.1 lists events that occurred during Test No. 609591-03-2. Figures D.1 and D.2 in Appendix D2 present sequential photographs during the test.

Table 6.1. Events during Test No. 609591-03-2.

TIME (s)	EVENTS
0.000	Vehicle makes contact with bridge rail
0.034	Vehicle begins to redirect
0.059	Right front panel and hood of vehicle contact post # 13
0.084	Left front and rear tire lift off of pavement
0.129	Dummy head at maximum extension outside of window but did not contact bridge rail.
0.162	Vehicle becomes parallel with bridge rail
0.184	Right rear of vehicle contacts bridge rail

0.293	Vehicle loses contact with bridge rail while traveling at 46.2 mi/h
0.326	Front left tire lands back on pavement
0.398	Rear left tire lands back on pavement

For longitudinal barriers, it is desirable that the vehicle redirects and exits the barrier within the exit box criteria (not less than 32.8 ft downstream from loss of contact for cars and pickups). The test vehicle exited within the exit box criteria defined in *MASH*. After loss of contact with the barrier, the vehicle came to rest 169 ft downstream of the impact and 2 ft toward traffic lanes.

6.5 DAMAGE TO TEST INSTALLATION

Figure 6.3 shows the damage to the PennDOT PA Bridge Barrier. There was only superficial damage to the traffic face of the concrete and some light scrapping on the railing. Working width was 18.0 inches at a height of 24 inches from the ground. There was no dynamic deflection and no permanent deformation in the PennDOT PA Bridge Barrier.

Figure 6.3. PennDOT PA Bridge Barrier after Test No. 609591-03-2.

6.6 VEHICLE DAMAGE

Figure 6.4 shows the damage sustained by the vehicle. The front bumper, hood, radiator and support, right strut, right front fender, right head light, right front door and glass, right rear door, right rear quarter panel, right rear tail light, and rear bumper were damaged. The windshield sustained stress cracks starting at the bottom right side and radiating upward. Maximum exterior crush to the vehicle was 6.0 inches in the horizontal plane at the front bumper at bumper height. Maximum occupant compartment deformation was 3.0 inches at the floor

panel to lower instrument panel on the passenger side. Figure 6.5 shows the interior of the vehicle. Tables D.2 and D.3 in Appendix D1 provide exterior crush and occupant compartment measurements.

Figure 6.4. Test Vehicle after Test No. 609591-03-2.

Figure 6.5. Interior of Test Vehicle for Test No. 609591-03-2.

6.7 OCCUPANT RISK FACTORS

Data from the accelerometer, located at the vehicle center of gravity, were digitized for evaluation of occupant risk and are shown in Table 6.2. Figure 6.6 summarizes these data and other pertinent information from the test. Figure C.3 in Appendix C3 shows the vehicle angular displacements, and Figures C.4 through C.9 in Appendix C4 show accelerations versus time traces.

Table 6.2. Occupant Risk Factors for Test No. 609591-03-2.

Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)	ft/s	at 0.0702 seconds on right side of interior
Longitudinal	**22.3**	
Lateral	**34.1**	
Occupant Ridedown Accelerations (G's)		
Longitudinal	**-7.9**	(0.2732 - 0.2832 seconds)
Lateral	**-9.7**	(0.1938 - 0.2038 seconds)
Theoretical Head Impact Velocity (THIV)	km/h	at 0.0696 seconds on right side of interior
	44.5	
	m/s	
	12.4	
Post Head Deceleration (PHD) (G's)	**10.2**	(0.2780 - 0.2880 seconds)
Acceleration Severity Index (ASI)	**2.93**	(0.0439 - 0.0939 seconds)
Maximum 50-ms Moving Average (G's)		
Longitudinal	**-12.6**	(0.0229 - 0.0729 seconds)
Lateral	**-20.9**	(0.0117 - 0.0617 seconds)
Vertical	**6.7**	(0.0158 - 0.0658 seconds)
Maximum Roll, Pitch, and Yaw Angles	**Degrees**	
Roll	**8**	(0.1345 seconds)
Pitch	**12**	(0.8042 seconds)
Yaw	**33**	(0.6349 seconds)

General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... MASH Test 5-10
- TTI Test No. 609591-03-2
- Test Date 2018-06-26

Test Article
- Type ..... Longitudinal Barrier - Bridge Rail
- Name ..... PennDOT Bridge Deck
- Installation Length ..... 149 ft-10 inches
- Material or Key Elements .... 24-inch tall × 18-inch thick reinforced concrete wall with two HSS 5×4×⅜ rails at 37 inches and 50 inches
- **Soil Type and Condition** ..... Concrete bridge deck, damp

Test Vehicle
- Type/Designation 1100C
- Make and Model ..... 2011 KIA RIO
- Curb ..... 2457 lb
- Test Inertial ..... 2427 lb
- Dummy ..... 165 lb
- Gross Static ..... 2592 lb

Impact Conditions
- Speed ..... 61.7 mi/hr
- Angle ..... 25.3°
- Location/Orientation ..... 49.2 inches upstream of Post 13

Impact Severity ..... 60 kip-ft

Exit Conditions
- Speed ..... 46.3 mi/h
- Exit Traj./Heading Angle ..... 3.4°/10.3°

Occupant Risk Values
- Longitudinal OIV ..... 22.3 ft/s
- Lateral OIV ..... 34.1 ft/s
- Longitudinal Ridedown ..... 7.9 g
- Lateral Ridedown ..... 9.7 g
- THIV ..... 40.7 ft/s
- PHD 10.2g
- ASI 2.9

Max. 0.050-s Average
- Longitudinal ..... -12.6 g
- Lateral ..... -20.9 g
- Vertical ..... 6.7 g

Post-Impact Trajectory
- Stopping Distance ..... 169 ft downstream 2 ft toward traffic

Vehicle Stability
- Maximum Yaw Angle ..... 33°
- Maximum Pitch Angle ..... 12°
- Maximum Roll Angle ..... 8°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... None
- Permanent ..... None
- Working Width ..... 18 inches
- Working Width Height ..... 24 inches

Vehicle Damage
- VDS 10-RFQ-5
- CDC 10FREW3
- Max. Exterior Deformation ..... 6.0 inches
- OCDI RF0114100
- Max. Occupant Compartment Deformation ..... 3.0 inches

Figure 6.6. Summary of Results for *MASH* Test 5-10 on PennDOT PA Bridge Barrier.

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Chapter 7. *MASH* TEST 5-12 (CRASH TEST NO. 609591-03-3)

7.1 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 5-12 involves a 36000V vehicle, weighing 79,300 lb ± 1100 lb, impacting the CIP of the bridge rail at an impact speed of 50 mi/h ±2.5 mi/h and an angle of 15° ±1.5°. The target CIP for *MASH* Test 5-12 on the PennDOT PA Bridge Barrier was 1 ft ±1 ft downstream of the edge of post 5.

The 2008 Freightliner CL120 Tractor & 53ft 2002 Utility Trailer used in the test weighed 79,280 lb, and the actual impact speed and angle were 49.9 mi/h and 14.8°, respectively. The actual impact point was 1.9 ft downstream of the edge of post 15 with the lower rail splice. Minimum target IS was 404 kip-ft, and actual IS was 430.6 kip-ft.

7.2 WEATHER CONDITIONS

The test was performed on the morning of July 3, 2018. Weather conditions at the time of testing were as follows: wind speed: 7 mi/h; wind direction: 195° (vehicle was traveling in a southerly direction); temperature: 86°F; relative humidity: 71 percent.

7.3 TEST VEHICLE

Figures 7.1 and 7.2 show the 2008 Freightliner CL120 Tractor & 2002 Utility 53ft Trailer used for the crash test. The vehicle's test inertia weight was 79,280 lb. The height to the lower edge of the vehicle bumper was 15 inches, and height to the upper edge of the bumper was 34.5 inches. The height to the ballast's center of gravity was 72.5 inches. Tables E.1 and Figure E.1 in Appendix E1 give additional dimensions and information on the vehicle. The vehicle was directed into the installation using a cable guidance system under self-power, and was released to be freewheeling and unrestrained just prior to impact.

Figure 7.1. PennDOT PA Bridge Barrier/Test Vehicle Geometrics for Test No. 609591-03-3.

Figure 7.2. Test Vehicle before Test No. 609591-03-3.

7.4 TEST DESCRIPTION

The 2008 Freightliner CL120 Tractor & 2002 Utility 53ft Trailer was traveling at an impact speed of 61.7 mi/h when it contacted the PennDOT PA Bridge Barrier 1.9 ft downstream of the edge of Post 15 with the lower rail splice at an impact angle of 25.3°. Table 7.1 lists events that occurred during Test No. 609591-03-3. Figures E.2 and E.3 in Appendix E2 present sequential photographs during the test.

Table 7.1. Events during Test No. 609591-03-3.

TIME (s)	EVENTS
0.000	Tractor contacts bridge rail
0.101	Tractor begins to redirect
0.148	Front left tire of tractor lifts off of pavement
0.165	Trailer front right corner contacts rail
0.283	Tractor becomes parallel with bridge rail
0.347	Left front tire lands back on pavement
0.735	Trailer right rear corner contacts rail
0.766	Trailer becomes parallel with bridge rail
0.970	Trailer right rear corner makes furthest penetration to field side
0.973	Left turn indicator comes on and begins blinking
1.258	Tractor Trailer loses contact with bridge rail while traveling at 44.0 mi/h

For longitudinal barriers, it is desirable that the vehicle redirects and exits the barrier within the exit box criteria (not less than 65.6 ft downstream from loss of contact for vehicles other than cars and pickups). The test vehicle exited within the exit box criteria defined in *MASH*. After loss of contact with the barrier, the vehicle came to rest 270 ft downstream of the impact and 8 ft toward traffic lanes.

7.5 DAMAGE TO TEST INSTALLATION

Figure 7.3 shows the damage to the PennDOT PA Bridge Barrier. Both top and bottom rails were deformed upstream of post 5 to post 7. The concrete at posts 4 through 7 was broken completely through. Working width was 51.9 inches at a height of 130.8 inches. Maximum dynamic deflection during the test was estimated (all views partially or fully obscured) to be 20 inches, and maximum permanent deformation was 6.5 inches, 43 inches downstream of center of post 5.

Figure 7.3. PennDOT PA Bridge Barrier after Test No. 609591-03-3.

7.6 VEHICLE DAMAGE

Figure 7.4 shows the damage sustained by the vehicle. The vehicle sustained damage to the front bumper, hood, front axle, right front U-bolts and springs, right head light, front right tire and rim, right door, right fuel tank, right front outer tire and rim on tractor, and right side of trailer. Maximum exterior crush to the vehicle was 18 inches in the horizontal plane at bumper height. Maximum occupant compartment deformation was 2.5 inches. Figure 7.5 shows the interior of the vehicle. Table C.3 and Figure C.41 in Appendix C11 provide exterior crush and occupant compartment measurements.

Figure 7.4. Test Vehicle after Test No. 609591-03-3.

Figure 7.5. Interior of Test Vehicle for Test No. 609591-03-3.

7.7 OCCUPANT RISK FACTORS

Data from the accelerometer, located near the 5th wheel of the Tractor, were digitized for informational purposes only. The results are shown in Table 7.2. Figure 7.6 summarizes these data and other pertinent information from the test. Figure E.4 in Appendix E3 shows the vehicle angular displacements, and Figures E.5 through E.13 in Appendix E4 show accelerations versus time traces.

Table 7.2. Occupant Risk Factors for Test No. 609591-03-3. Measure from 5th wheel Accelerometers

Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)	ft/s	at 0.1980 seconds on right side of interior
Longitudinal	**3.0**	
Lateral	**13.5**	
Occupant Ridedown Accelerations (G's)		
Longitudinal	**-8.9**	(0.2158 - 0.2258 seconds)
Lateral	**20.5**	(0.2394 - 0.2494 seconds)
Theoretical Head Impact Velocity (THIV)	km/h	at 0.1978 seconds on right side of interior
	15.1	
	m/s	
	4.2	
Post Head Deceleration (PHD) (G's)	**21.2**	(0.2393 - 0.2493 seconds)
Acceleration Severity Index (ASI)	**1.35**	(0.2214 - 0.2714 seconds)
Maximum 50-ms Moving Average (G's)		
Longitudinal	**-2.4**	(0.1760 - 0.2260 seconds)
Lateral	**-6.9**	(0.2569 - 0.3069 seconds)
Vertical	**12.8**	(0.2009 - 0.2509 seconds)
Maximum Roll, Pitch, and Yaw Angles	**Degrees**	
Roll	**22**	(1.3763 seconds)
Pitch	**35**	(1.9979 seconds)
Yaw	**25**	(1.9666 seconds)

General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... MASH Test 5-12
- TTI Test No. 609591-03-3
- Test Date 2018-07-03

Test Article
- Type ..... Longitudinal Barrier - Bridge Rail
- Name ..... PennDOT PA Bridge Barrier
- Installation Length ..... 149 ft-10 inches
- Material or Key Elements .... 24-inch tall × 18-inch thick reinforced concrete wall with two HSS 5×4×⅜ rails at 37 inches and 50 inches

Soil Type and Condition ..... Concrete bridge deck, damp

Test Vehicle
- Type/Designation 36000V
- Make and Model ..... 2008 Freightliner CL120 & 2002 Utility 53ft
- Curb ..... 28,750 lb
- Test Inertial ..... 79.280 lb
- Dummy ..... None
- Gross Static ..... 79,280 lb

Impact Conditions
- Speed ..... 49.9 mi/h
- Angle ..... 14.8°
- Location/Orientation ..... 23 inches dwnstrm of post 5

Impact Severity .....

Exit Conditions
- Speed ..... 44.0 mi/h
- Exit Traj./Heading Angle ..... 4.2°/0.8°

Occupant Risk Values
- Longitudinal OIV ..... 3.0 ft/s
- Lateral OIV ..... 13.5 ft/s
- Longitudinal Ridedown ..... 8.9 g
- Lateral Ridedown ..... 20.5 g
- THIV ..... 13.8 ft/s
- PHD ..... 21.2 g
- ASI 1.4

Max. 0.050-s Average
- Longitudinal ..... -2.4 g
- Lateral ..... -6.9 g
- Vertical ..... 12.8 g

Post-Impact Trajectory
- Stopping Distance ..... 270 ft downstream 8 ft toward traffic

Vehicle Stability
- Maximum Yaw Angle ..... 25°
- Maximum Pitch Angle ..... 35°
- Maximum Roll Angle ..... 22°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic (View Partially Obscured) ..... 20 inches
- Permanent ..... 7.0 inches
- Working Width ..... 51.9 inches
- Working Width Height ..... 130.8 inches

Vehicle Damage
- VDS ..... NA
- CDC ..... NA
- Max. Exterior Deformation ..... 18 inches
- OCDI ..... NA
- Max. Occupant Compartment Deformation ..... 2.5 inches

Figure 7.6. Summary of Results for *MASH* Test 5-12 on PennDOT PA Bridge Barrier.

Chapter 8. SUMMARY AND CONCLUSIONS

8.1 ASSESSMENT OF TEST RESULTS

The crash testing reported herein was performed in accordance with *MASH* Tests 5-10, 5-11, and 5-12, which involves an 1100C and 2270P vehicle impacting the PennDOT PA Bridge Barrier at a target impact speed and impact angle of 62 mi/h and 25°, respectively, and a 36000V vehicle impacting the PennDOT PA Bridge Barrier at target impact speed and impact angle of 50 mi/h and 15°, respectively. An assessment of the tests based on the applicable safety evaluation criteria for *MASH* Tests 5-10, 5-11, and 5-12 for longitudinal barriers are provided in Table 8.1, 8.2, and 8.3.

8.2 CONCLUSIONS

The PennDOT PA Bridge Barrier performed acceptably for *MASH* Tests 5-10, 5-11, and 5-12 for longitudinal barriers.

Table 8.1. Performance Evaluation Summary for *MASH* Test 5-11 on PennDOT PA Bridge Barrier.

Test Agency: Texas A&M Transportation Institute Test No.: 609591-03-1 Test Date: 2018-06-28

MASH Test 5-10 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.	The PennDOT PA Bridge Barrier contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. The dynamic deflection of the bridge rail during the test was 0.7 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 3.0 inches on the passenger side at the floor pan to roof, and wheel/foot well and toe pan area measurements.	Pass
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 2270P vehicle remained upright during and after the collision event. Roll and pitch angles were 4° and 4°, respectively.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 19.4 ft/s, and lateral OIV was 28.2 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 3.2 g, and lateral occupant ridedown acceleration was 6.7 g.	Pass

Table 8.2. Performance Evaluation Summary for *MASH* Test 5-10 on PennDOT PA Bridge Barrier.

Test Agency: Texas A&M Transportation Institute Test No.: 609591-03-2 Test Date: 2018-06-26

MASH Test 5-10 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.	The PennDOT PA Bridge Barrier contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. There was no observable dynamic deflection or residual permanent deformation of the bridge rail.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 3.0 inches in the passenger side foot well area.	Pass
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 8° and 12°, respectively.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 22.3 ft/s, and lateral OIV was 34.1 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 7.9 g, and lateral occupant ridedown acceleration was 9.7 g.	Pass

Table 8.3. Performance Evaluation Summary for *MASH* Test 5-12 on PennDOT PA Bridge Barrier.

Test Agency: Texas A&M Transportation Institute Test No.: 609591-03-3 Test Date: year-mo-da

***MASH* Test 5-12 Evaluation Criteria**	**Test Results**	**Assessment**
Structural Adequacy		
A. Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.	The PennDOT PA Bridge Barrier contained and redirected the 36000V vehicle. The vehicle did not penetrate, underride, or override the installation. The dynamic deflection of the bridge rail during the test was 7.0 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 2.5 inches.	Pass
G. It is preferable, although not essential, that the vehicle remain upright during and after collision.	The 36000V vehicle remained upright during and after the collision.	Pass

Table 8.4. Assessment Summary for *MASH* TL-5 Tests on PennDOT PA Bridge Barrier.

Evaluation Factors	Evaluation Criteria	Test No. 609591-03-2	Test No. 609591-03-1	Test No. 609591-03-3
Structural Adequacy	A	S	S	S
Occupant Risk	D	S	S	S
	F	S	S	N/A
	G	N/A	N/A	S
	H	S	S	N/A
	I	S	S	N/A
Test No.		***MASH* Test 5-10**	***MASH* Test 5-11**	***MASH* Test 5-12**
Pass/Fail		Pass	Pass	Pass

S = Satisfactory
U = Unsatisfactory
N/A = Not Applicable

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REFERENCES

1. AASHTO. *Manual for Assessing Roadside Safety Hardware, Second Edition.* 2016, American Association of State Highway and Transportation Officials: Washington, D.C.

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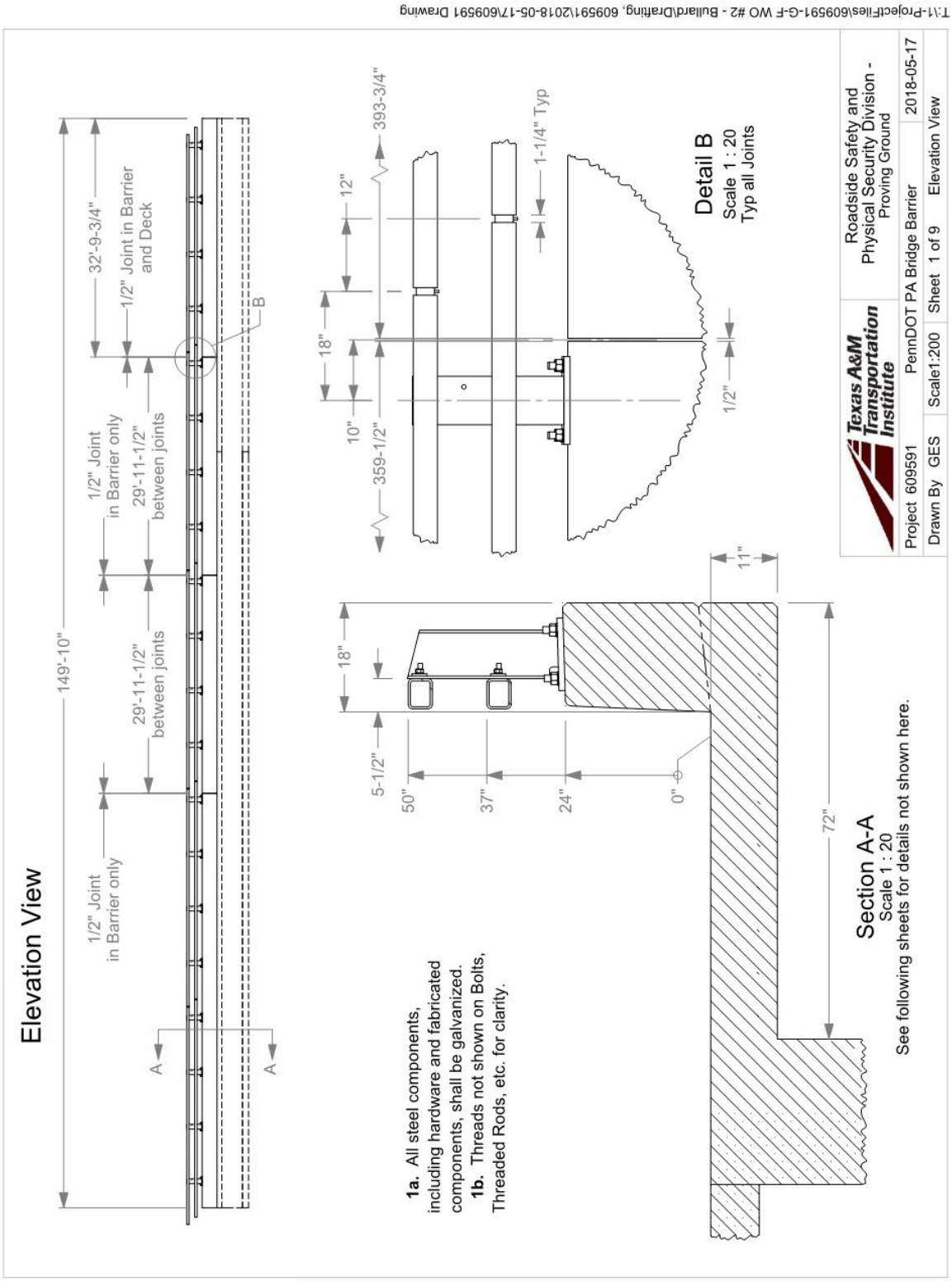
APPENDIX A. DETAILS OF THE BRIDGE RAIL



Plan View
149'-10"
142'-6"
44"
C
90" Typ
13'-6"
Existing Concrete
New Concrete
± 104'-0"
± 45'-10"
Nut, 3/4 heavy hex
ASTM A563
Nut, 1-1/8 heavy hex
ASTM A563 Grade DH
Washer, 1-1/8 clipped, 3/16" thick, 2-1/4" OD
ASTM F436
Washer, 3/4 Lock
3/16" thick
ASTM F436
Rail Splice
Detail C
Scale 1 : 10
Plate Washer
2 1/2" x 2 1/2" x 3/8"
ASTM A709 Grade 36 KSI
with Ø13/16" hole @ center
12" Typ
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project 609591
PennDOT PA Bridge Barrier
2018-07-20
Drawn By GES
Scale1:200
Sheet 2 of 9
Plan View
T:\1-ProjectFiles\609591-G-F WO 2 - Bullard\Drafting, 609591\2018-05-17\609591 Drawing

3a. Mill to Bear is defined as follows: A minimum of 25% of the Post web and compression flange end area must fit within 1/32" of the Base Plate, with no gap more than 0.040" for the remaining 75% of the end area.

3b. Galvanize all components after fabrication is complete.

3c. All welding must be performed by certified welders using industry standard practices.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 609591	PennDOT PA Bridge Barrier	2018-05-17
Drawn By GES	Scale 1:10	Sheet 3 of 9 Post Details

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Rail Details
Top Rail
29'-10-3/4"
24'-1-5/8"
23'-9-1/8"
16'-7-5/8"
16'-3-1/8"
9'-1-5/8"
8'-9-1/8"
19-5/8"
15-1/8"
0"
E
E
Bottom Rail
29'-10-3/4"
25'-1-5/8"
24'-9-1/8"
17'-7-5/8"
17'-3-1/8"
10'-1-5/8"
9'-9-1/8"
31-5/8"
27-1/8"
0"
E
E
F
F
Rail Splice
HSS 4" x 3" x 5/16" x 25 1/4"
ASTM A500 Grade B
Section F-F
Scale 1 : 5
Ø3/8" x 3/4" smooth stud
ASTM A108
3/16
HSS 5" x 4" x 3/8"
ASTM A500 Grade B
Ø3/4" x 2 1/2" Threaded Anchor Stud
ASTM A 108
3/16
Section E-E
Scale 1 : 10
4a. All welding must be performed by certified welders using industry standard practices.
4b. Galvanize all components after fabrication is complete.
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project 609591
PennDOT PA Bridge Barrier
2018-05-17
Drawn By GES
Scale 1:40
Sheet 4 of 9
Rail Details
T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\2018-05-17\609591 Drawing

New Concrete Cross Section

5a. Note 1/2" slope at top of Barrier and 1" slope on traffic face.

5b. R1" Fillet at front edge of Barrier. Chamfer 3/4" each way at back of Deck and Barrier, four places total.

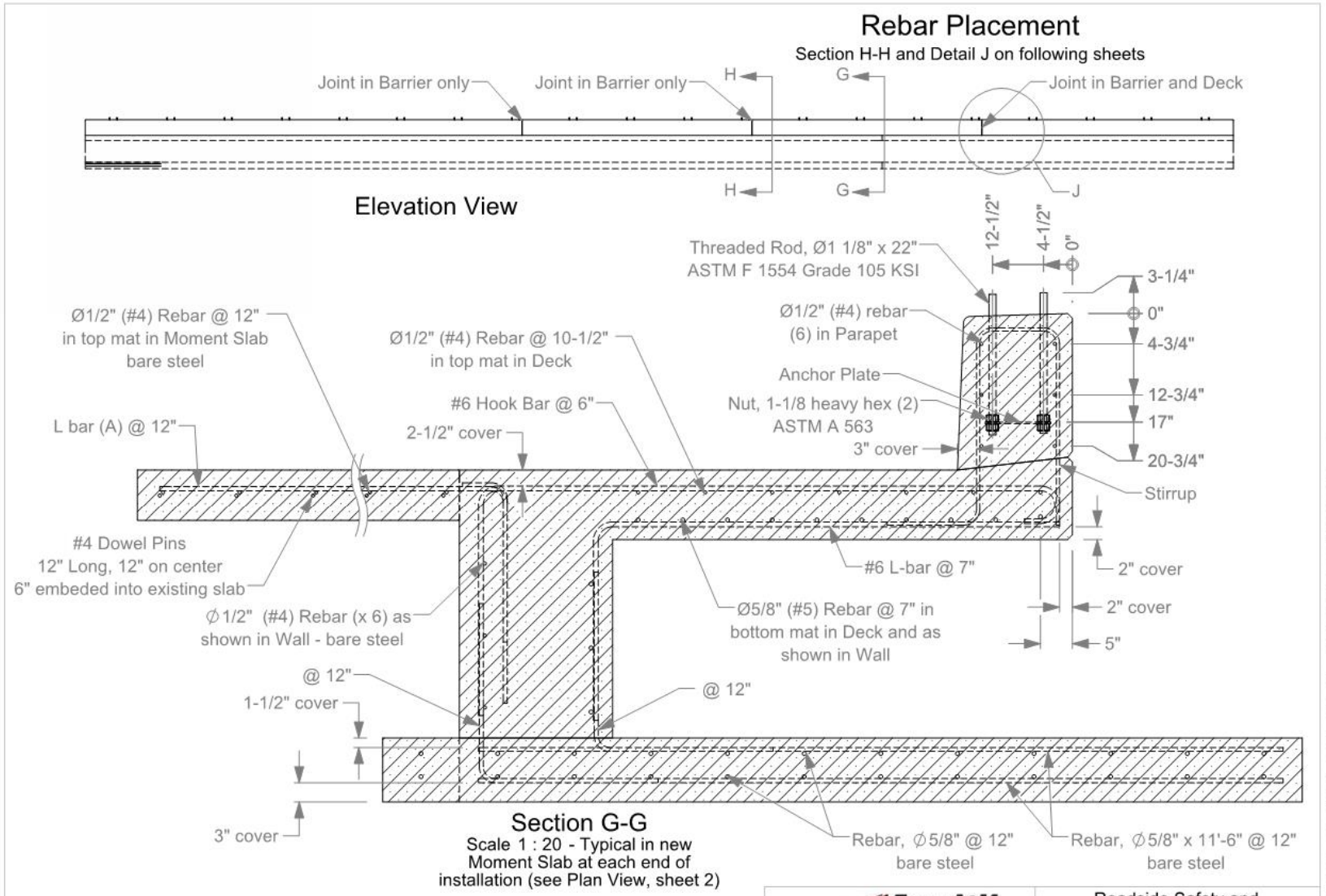
5c. Rake finish construction joint between Barrier and Deck.

5d. The concrete strength shall be as follows: Working Slab and Moment Slab: minimum 3000 psi. Wall and Deck: 4000 psi. Barrier 3500 psi.

5e. Working Slab 12" overhang on the traffic side of the Wall is only at the new Moment Slab sections.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 609591	PennDOT PA Bridge Barrier		2018-05-17
Drawn By GES	Scale 1:20	Sheet 5 of 9	New Concrete Cross Section

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\2018-05-17\609591 Drawing



6a. Minimum rebar lap is 31" for #5 bars, 35" for #4 bars in the Barrier, and 25" for all other #4 bars.

6b. All rebar is grade 60, and epoxy coated unless otherwise indicated.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 609591	PennDOT PA Bridge Barrier		2018-05-17
Drawn By GES	Scale1:200	Sheet 6 of 9	Rebar Placement

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\2018-05-17\609591 Drawing

Section H-H
See 7a

7a. Section H-H is typical at existing Moment Slab. Details not shown are same as Section G-G (previous sheet).

7b. Minimum rebar lap is 31" for #5 bars, 35" for #4 bars in the Barrier, and 25" for all other #4 bars.

7c. All rebar is grade 60, and epoxy coated unless otherwise indicated.

7d. The Anchor Bars weld to existing rebar (not shown here) protruding from the runway. Minimum 3" weld, bars at maximum 18" spacing.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 609591	PennDOT PA Bridge Barrier	2018-05-17
Drawn By GES	Scale 1:20	Sheet 7 of 9 Section H-H

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Draffting, 609591\2018-05-17\609591 Drawing

Detail J
Scale 1 : 15
Stirrup and Anchor Bolt spacing typical all Joints.

8a. Place Stirrup at center of each Post location, with additional Stirrup @ 9" each way (except at Joints, as shown). Space Stirrups @ 18" between Posts.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project 609591	PennDOT PA Bridge Barrier	2018-05-17
Drawn By GES	Scale 1:20	Sheet 8 of 9 Detail J

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\2018-05-17\609591 Drawing

9a. All rebar is grade 60, and epoxy coated unless otherwise indicated.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project 609591	PennDOT PA Bridge Barrier		2018-05-17
Drawn By GES	Scale 1:10	Sheet 9 of 9	Rebar Bends

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\2018-05-17\609591 Drawing

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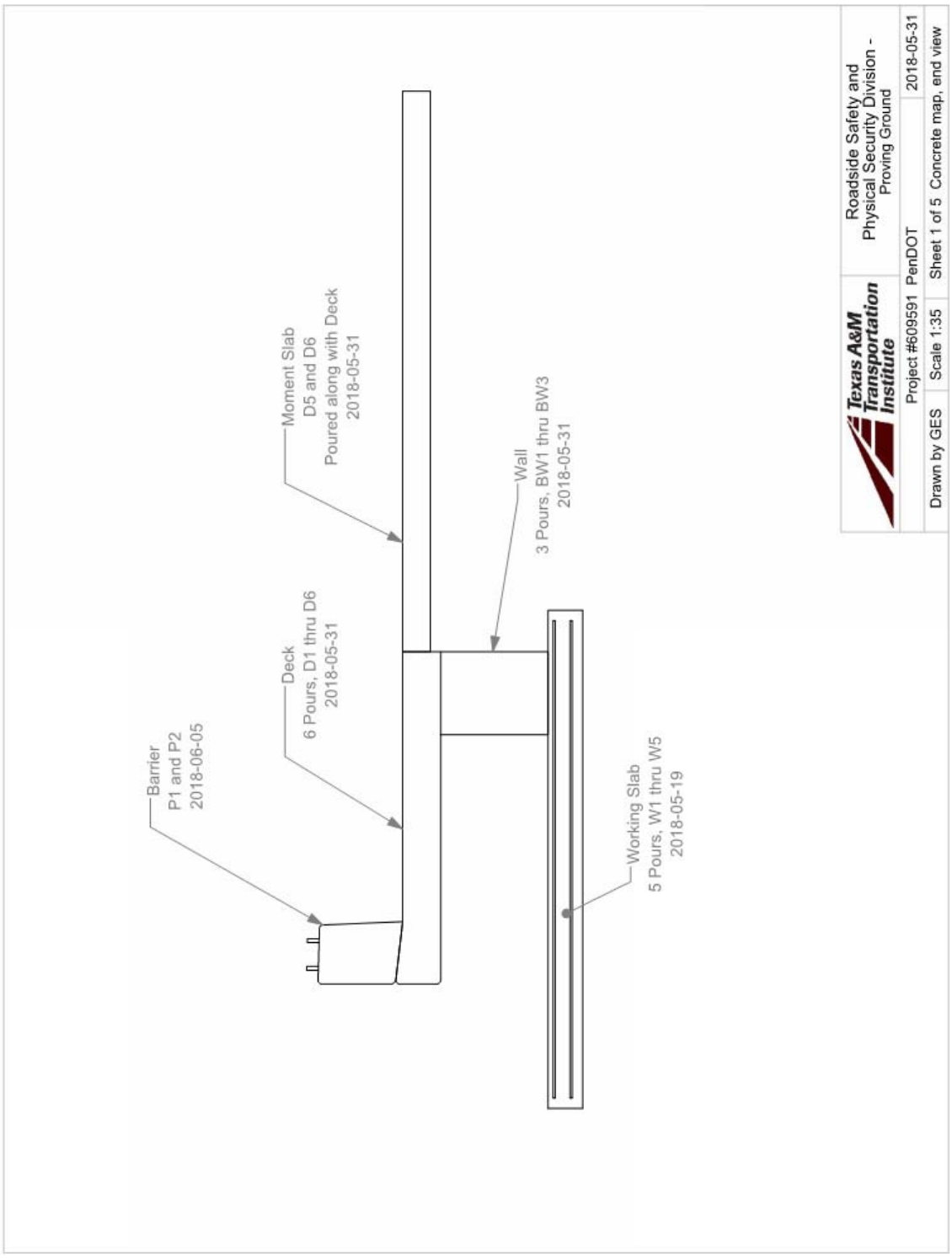
APPENDIX B. SUPPORTING CERTIFICATION DOCUMENTS



Section A-A

Texas A&M Transportation Institute

Roadside Safety and Physical Security Division - Proving Ground

Project #609591 PenDOT 2018-05-31

Drawn by GES

Sheet 2 of 4 Concrete Map, working slab

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\609591 Concrete Map

Texas A&M Transportation Institute Proving Ground, 3100 SH 47, Bldg 7091, Bryan, TX 77807 Texas A&M University, College Station, TX 77843, Phone 979-845-6375	5.7.2 Concrete Sampling	Doc. No. QPF 5.7.2	Revision Date: 2018-04-17
Quality Policy Form	Revised by: B. L. Griffith Approved by: D. Kuhn	Revision: 6	Page: 1 of 1

Project No: 609591 **Casting Date:** 2018-05-19 **Mix Design (psi):** 3000

Printed Name of Technician taking Sample: Matt Robinson

Printed Name of Technician breaking Sample: Matt Robinson

Signed Name of Technician taking Sample:

Signed Name of Technician breaking Sample:

Load No.	Truck No.	Ticket No.	Location (from concrete map)
W1/T1	390127	0042224	Right Side Working Slab ≈30'
W2/T2	390144	0042225	Next to 1st Pour ≈30'
W3/T3	390119	0042228	Next to 2nd Pour ≈30'

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
W1/T1	2018-06-25	37 days	3395	96000	
W1/T1	"	"	3891	110000	3548
W1/T1	"	"	3360	95000	
W2/T2	2081-06-25	37 days	3714	105000	
W2/T2	"	"	3926	111000	3855
W2/T2	"	"	3926	111000	
W3/T3	2018-06-25	37 days	4209	119000	
W3/T3	"	"	4669	132000	4220
W3/T3	"	"	3784	107000	

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	5.7.2 Concrete Sampling	Doc. No. QPF 5.7.2	Revision Date: 2018-04-17
Quality Policy Form	Revised by: B. L. Griffith Approved by: D. Kuhn	Revision: 6	Page: 1 of 1

Project No: 609591 **Casting Date:** 2018-05-19 **Mix Design (psi):** 3000

Printed Name of Technician taking Sample: Matt Robinson

Printed Name of Technician breaking Sample: Matt Robinson

Signed Name of Technician taking Sample:

Signed Name of Technician breaking Sample:

Load No.	Truck No.	Ticket No.	Location (from concrete map)
W4/T4	390107	0042230	Next to Pour #3, ≈30'
W5/T5	390150	0042231	Final Pour on Left, ≈30'

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
W4/T4	2018-06-25	37 days	3745	106000	
W4/T4	"	"	4067	115000	3961
W4/T4	"	"	4067	115000	
W5/T5	2018-06-25	37 days	3961	112000	
W5/T5	"	"	3997	113000	3890
W5/T5	"	"	3714	105000	

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042224

Bryan Plant #6

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
RT 21 LF 47 RT RIVERSIDE CAMPUS
GO STRAIGHT TO THE BACK TO JOB

Disp Order#: 2002

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
7:50:07	CLALS	10.00	50.00		EDDIE SWE	390127	
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/19/18	TTITENRAI	1	10.00			5.00in	6141567

WARNING
IRRITATING TO THE SKIN AND EYES
Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

CONCRETE is a PERISHABLE COMMODITY and BECOMES THE PROPERTY of the PURCHASER UPON LEAVING the PLANT. ANY CHANGES or CANCELLATION of ORIGINAL INSTRUCTIONS MUST be TELEPHONED to the OFFICE BEFORE **LOADING** starts.
The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.
All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.
Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.
A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.
Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)
Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration, the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.
SIGNED:
X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:
_____GAL X_____
WEIGHMASTER
Thank you for your business
NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.
LOAD RECEIVED BY
X _____

QUANTITY	CODE	DESCRIPTION	UNIT PRICE	EXTENDED PRICE
10.00CY	CLALS	CLASS A 3000 PSI		

OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	ARRIVED JOB	START UNLOADING	SLUMP	CONCRETE TEMP.	
8:07					
TOTAL ROUND TRIP	TOTAL AT JOB	UNLOADING TIME	AIR	CYLINDERS	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1 _____
ADDITIONAL CHARGE 2 _____
GRAND TOTAL ▶

Truck 390127 | Driver 548949 | User user | Disp Ticket Num 6141567 | Ticket ID 50017 | Time 7:50 | Date 19 | **B** 0042224
Load Size 10.00 CYDS | Mix Code CLALS | Returned | Qty | Mix Age | Seq D | Load ID 45

Material	Design Qty	Required	Batched	% Var	Moisture	Actual Wat
SAND	1385 lb	14473 lb	14380 lb	-0.64%	4.50% M	74 gl
MSTN1"	1400 lb	14105 lb	14000 lb	-0.74%	0.75% M	12 gl
GRAVEL3/8"	470 lb	4771 lb	4790 lb	0.41%	1.50% M	8 gl
CEMENT	315.0 lb	3150.0 lb	3128.0 lb	-0.70%		
FLYASH	105.0 lb	1050.0 lb	1048.0 lb	-0.19%		
WATER	30.2 gl	186.3 gl	186.7 gl	0.22%		186.7 gl
ADZZ80	19.00 oz	190.00 oz	190.00 oz	0.00%		

Actual Num Batches: 1 Manual 7:50:07
Load Total: 38916 lb Design W/C: 0.600 Water/Cement: 0.604 T Design Water: 302.0 gl Actual Water: 281.9 gl To Add: 20.1 gl
Slump: 5.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl/ Load Trim Water: -2.0 gl/ CYDS

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042231

Bryan Plant #6

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

#5

Disp Order#: 2002

TTI TEN RAIL
RT 21 LF 47 RT RIVERSIDE CAMPUS
WAIT AT THE FRONT ENTRANCE THEY
WILL PICK YOU UP AND TAKE YOU T
HE JOB

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
8:42:04	CLALS	10.00	50.00		ROBERT WI	390150	
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/19/18	TTITENRAI	5	50.00			5.00in	6141574

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

CONCRETE is a PERISHABLE COMMODITY and BECOMES THE PROPERTY of the PURCHASER UPON LEAVING the PLANT. ANY CHANGES or CANCELLATION of ORIGINAL INSTRUCTIONS MUST be TELEPHONED to the OFFICE BEFORE **LOADING** starts.

The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.

All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.

Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.

A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration, the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00CY	CLALS	CLASS A 3000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
851	901				
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL ▶

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390150	455351	user	6141574	50024	8:42	5/19/2018

B 0042231

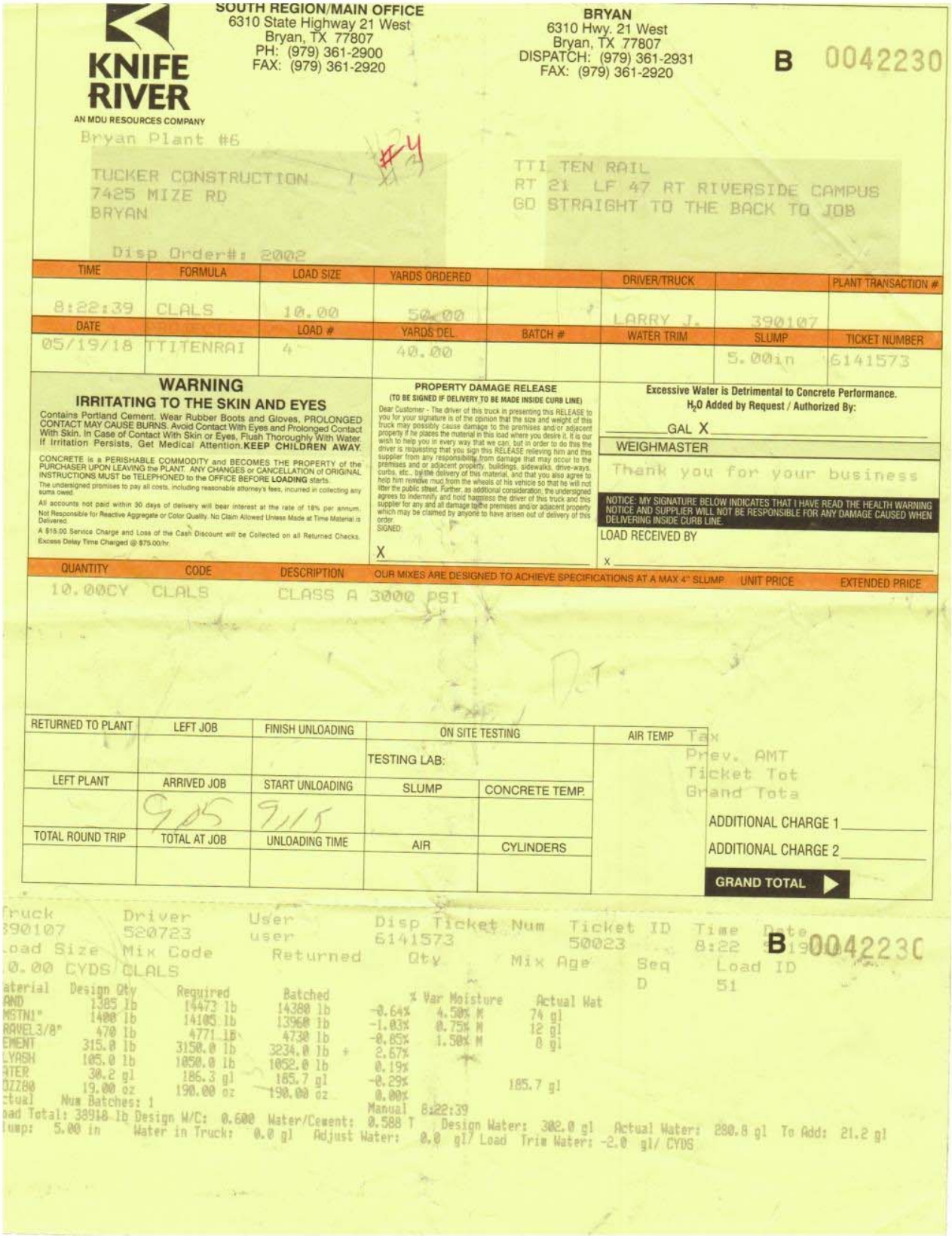
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLALS				D	52

Material	Design Qty	Required	Batched		% Var	Moisture	Actual Wat
SAND	1385 lb	14473 lb	14410 lb		-0.44%	4.50% M	74 gl
#57STN1"	1400 lb	14105 lb	14070 lb		-0.25%	0.75% M	13 gl
GRAVEL3/8"	470 lb	4771 lb	4780 lb		0.20%	1.50% M	8 gl
CEMENT	315.0 lb	3150.0 lb	3230.0 lb	+	2.54%		
FLYASH	105.0 lb	1050.0 lb	1050.0 lb		0.00%		
WATER	30.2 gl	186.3 gl	185.7 gl		-0.29%		185.7 gl
AZZ80	19.00 oz	190.00 oz	190.00 oz		0.00%		

Actual Num Batches: 1 Manual 8:42:04

Load Total: 39102 lb Design W/C: 0.600 Water/Cement: 0.589 T Design Water: 302.0 gl Actual Water: 281.1 gl To Add: 20.9 gl

Slump: 5.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl/ Load Trim Water: -2.0 gl/ CYDS



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042230

Bryan Plant #6

#4

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

Disp Order#: 2002

TTI TEN RAIL
RT 21 LF 47 RT RIVERSIDE CAMPUS
GO STRAIGHT TO THE BACK TO JOB

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
8:22:39	CLALS	10.00	50.00		LARRY J.	390107	
DATE		LOAD #	YARDS DEL	BATCH #	WATER TRIM	SLUMP	TICKET NUMBER
05/19/18	TTITENRAI	4	40.00			5.00in	6141573

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration, the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00CY	CLALS	CLASS A 3000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	ARRIVED JOB	START UNLOADING	SLUMP	CONCRETE TEMP.	
	9:05	9:15			
TOTAL ROUND TRIP	TOTAL AT JOB	UNLOADING TIME	AIR	CYLINDERS	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1

ADDITIONAL CHARGE 2

GRAND TOTAL

Truck 390107 | Driver 520723 | User user | Disp Ticket Num 6141573 | Ticket ID 50023 | Time 8:22 | Date 5/19/18

B 0042230

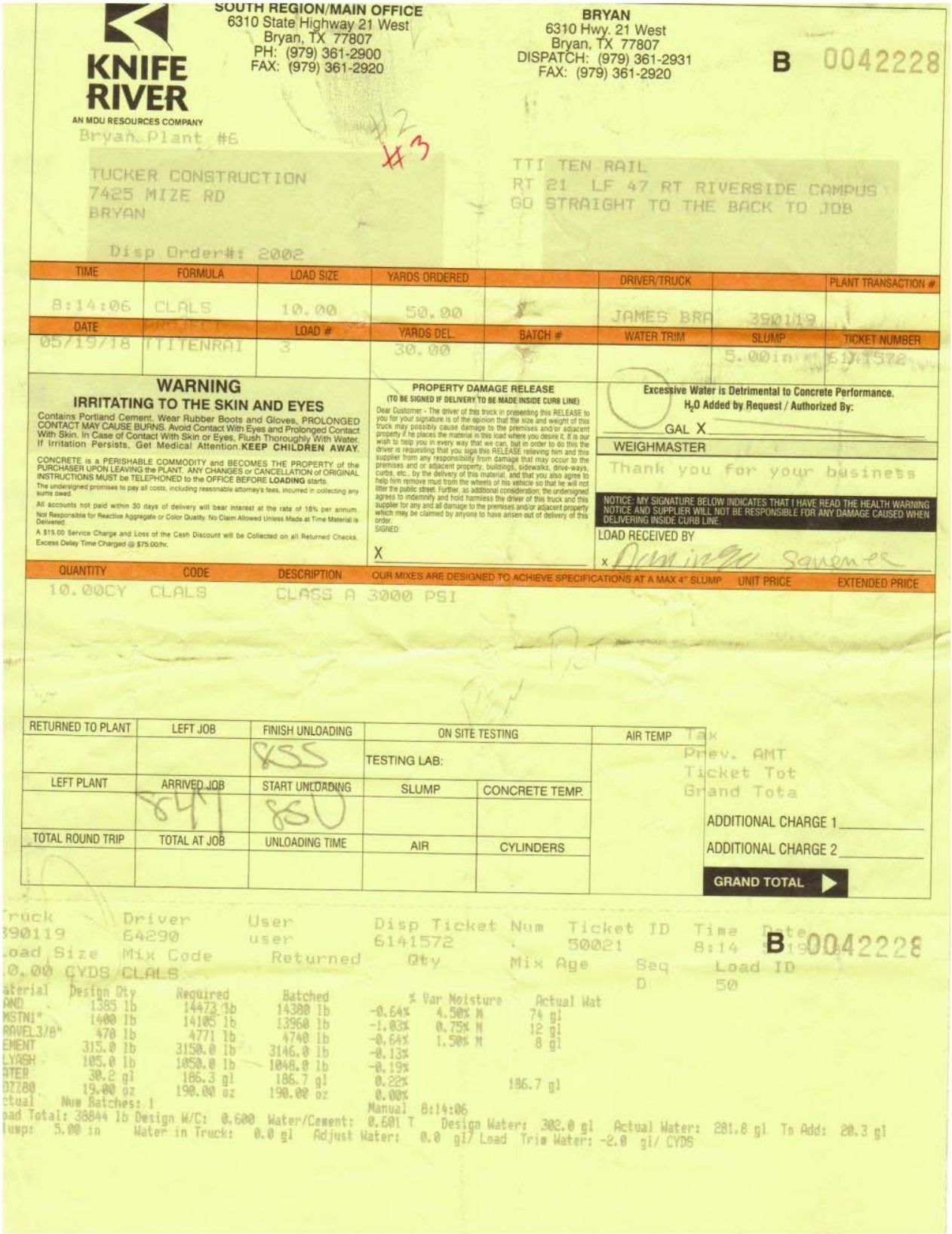
Load Size 10.00 CYDS | Mix Code CLALS | Returned | Qty | Mix Age | Seq D | Load ID 51

Material	Design Qty	Required	Batched	% Var	Moisture	Actual Wat
SAND	1385 lb	14473 lb	14380 lb	-0.64%	4.50% M	74 gl
MSTN1"	1400 lb	14105 lb	13960 lb	-1.03%	0.75% M	12 gl
GRAVEL3/8"	470 lb	4771 lb	4730 lb	-0.85%	1.50% M	0 gl
CEMENT	315.0 lb	3150.0 lb	3234.0 lb	2.67%		
FLYASH	105.0 lb	1050.0 lb	1052.0 lb	0.19%		
WATER	30.2 gl	186.3 gl	185.7 gl	-0.29%		
ADMIX00	19.00 oz	190.00 oz	190.00 oz	0.00%		185.7 gl

Actual Num Batches: 1 Manual 8:22:39

Load Total: 38918 lb Design W/C: 0.600 Water/Cement: 0.588 Design Water: 302.0 gl Actual Water: 280.8 gl To Add: 21.2 gl

Slump: 5.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl/ Load Trim Water: -2.0 gl/ CYDS



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042228

Bryan Plant #6

#2
#3

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
RT 21 LF 47 RT RIVERSIDE CAMPUS
GO STRAIGHT TO THE BACK TO JOB

Disp Order#: 2002

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
8:14:06	CLALS	10.00	50.00		JAMES BRA	390119	
DATE	[illegible]	LOAD #	YARDS DEL.	BATCH #	WATER TRIM	SLUMP	TICKET NUMBER
05/19/18	TTITENRAI	3	30.00			5.00in	6141572

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves. PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.

All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.

Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.

A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration, the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

x Dominga Saveres

QUANTITY	CODE	DESCRIPTION	UNIT PRICE	EXTENDED PRICE
10.00CY	CLALS	CLASS A 3000 PSI OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP		

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
		855	TESTING LAB:		
LEFT PLANT	ARRIVED JOB	START UNLOADING	SLUMP	CONCRETE TEMP.	
	847	850			
TOTAL ROUND TRIP	TOTAL AT JOB	UNLOADING TIME	AIR	CYLINDERS	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL ▶

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390119	64290	user	6141572	50021	8:14	5/19/18

B 0042228

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLALS				D	50

Material	Design Qty	Required	Batched	% Var	Moisture	Actual Wat
SAND	1385 lb	14473 lb	14380 lb	-0.64%	4.50% M	74 gl
#57STN1"	1400 lb	14105 lb	13960 lb	-1.03%	0.75% M	12 gl
GRAVEL3/8"	470 lb	4771 lb	4740 lb	-0.64%	1.50% M	8 gl
CEMENT	315.0 lb	3150.0 lb	3146.0 lb	-0.13%		
FLYASH	105.0 lb	1050.0 lb	1048.0 lb	-0.19%		
WATER	30.2 gl	186.3 gl	186.7 gl	0.22%		186.7 gl
DAZ80	19.00 oz	190.00 oz	190.00 oz	0.00%		

Actual Num Batches: 1 Manual 8:14:06

Load Total: 38844 lb Design W/C: 0.600 Water/Cement: 0.601 T Design Water: 302.0 gl Actual Water: 281.8 gl To Add: 20.3 gl
Slump: 5.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl/ Load Trim Water: -2.0 gl/ CYDS

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042225

Bryan Plant #6

#2

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

Disp Order#: 2002

TTI TEN RAIL
RT 21 LF 47 RT RIVERSIDE CAMPUS
GO STRAIGHT TO THE BACK TO JOB

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
8:01:35	CLALS	10.00	50.00		RAY ALWEL	390144	
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/19/18	TTITENRAI	2	20.00			5.00in	6141568

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

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SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

x

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00CY	CLALS	CLASS A 3000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
B11	B30				
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL

Truck 390144 | Driver 554014 | User user | Disp Ticket Num 6141568 | Ticket ID 50018 | Time 8:01 | Date 5/19/18 | **B 0042225**

Load Size | Mix Code | Returned | Qty | Mix Age | Seq | Load ID
10.00 CYDS CLALS | D | 46

Material	Design Qty	Required	Batched	% Var	Moisture	Actual Wat
SAND	1385 lb	14473 lb	14370 lb	-0.71%	4.50% M	74 gl
#57NI*	1400 lb	14105 lb	14010 lb	-0.67%	0.75% M	12 gl
GRAVEL3/8"	470 lb	4771 lb	4790 lb	0.41%	1.50% M	8 gl
CEMENT	315.0 lb	3150.0 lb	3140.0 lb	-0.32%		
FLYASH	105.0 lb	1050.0 lb	1050.0 lb	0.00%		
WATER	30.2 gl	186.3 gl	186.5 gl	0.09%		186.5 gl
ADMIX80	19.00 oz	190.00 oz	190.00 oz	0.00%		

Actual Num Batches: 1 | Manual 8:01:35
Load Total: 38928 lb | Design W/C: 0.600 | Water/Cement: 0.602 T | Design Water: 302.0 gl | Actual Water: 281.6 gl | To Add: 20.4 gl
Slump: 5.00 in | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl/ Load | Trim Water: -2.0 gl/ CYDS

Elevation view of Wall

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #609591 PenDOT		2018-05-31
Drawn by GES	Scale 1:200	Sheet 3 of 4 Concrete map, Wall

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\609591 Concrete Map

Texas A&M Transportation Institute Proving Ground, 3100 SH 47, Bldg 7091, Bryan, TX 77807 Texas A&M University, College Station, TX 77843, Phone 979-845-6375	5.7.2 Concrete Sampling	Doc. No. QPF 5.7.2	Revision Date: 2018-04-17
Quality Policy Form	Revised by: B. L. Griffith Approved by: D. Kuhn	Revision: 6	Page: 1 of 1

Project No: 609591 **Casting Date:** 2018-05-31 **Mix Design (psi):** 4000

Printed Name of Technician taking Sample: GREG FRITZ

Printed Name of Technician breaking Sample: Matt Robinson

Signed Name of Technician taking Sample:

Signed Name of Technician breaking Sample:

Load No.	Truck No.	Ticket No.	Location (from concrete map)
BW1/T1	39RENTAL2	0021446	Bottom Half Wall ≈ 110'
BW2/T2	39Rental2	0021447	Top Half South C Post Wall / Bottom Half ≈ 45'
BW3/T3	39rental1	0021448	Top Half Wall from South C Post to 15' from end

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
BW1/T1	2018-06-25	26 days	5655	160000	
BW1/T1	"	"	5655	160000	5655
BW1/T1	"	"	5655	160000	
BW2/T2	2018-06-25	26days	6720	190000	
BW2/T2	"	"	6685	189000	6685
BW2/T2			6650	188000	
BW3/T3	2018-06-25	26day	6508	184000	
BW3/T3	"	"	6013	170000	6331
BW3/T3			6423	183000	

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021448

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 2008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED	P.O.#	DRIVER/TRUCK		PLANT TRANSACTION #
5:04:17	CLSLS	10.00	120.00		B'S TRANS 39RENTAL1		
DATE	**PROJECT**	**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	TTITENRAI	3	30.00			5.00 in	20012566

WARNING
IRRITATING TO THE SKIN AND EYES
Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

_____GAL X_____

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X _____

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00 yd	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1 _____
ADDITIONAL CHARGE 2 _____
GRAND TOTAL

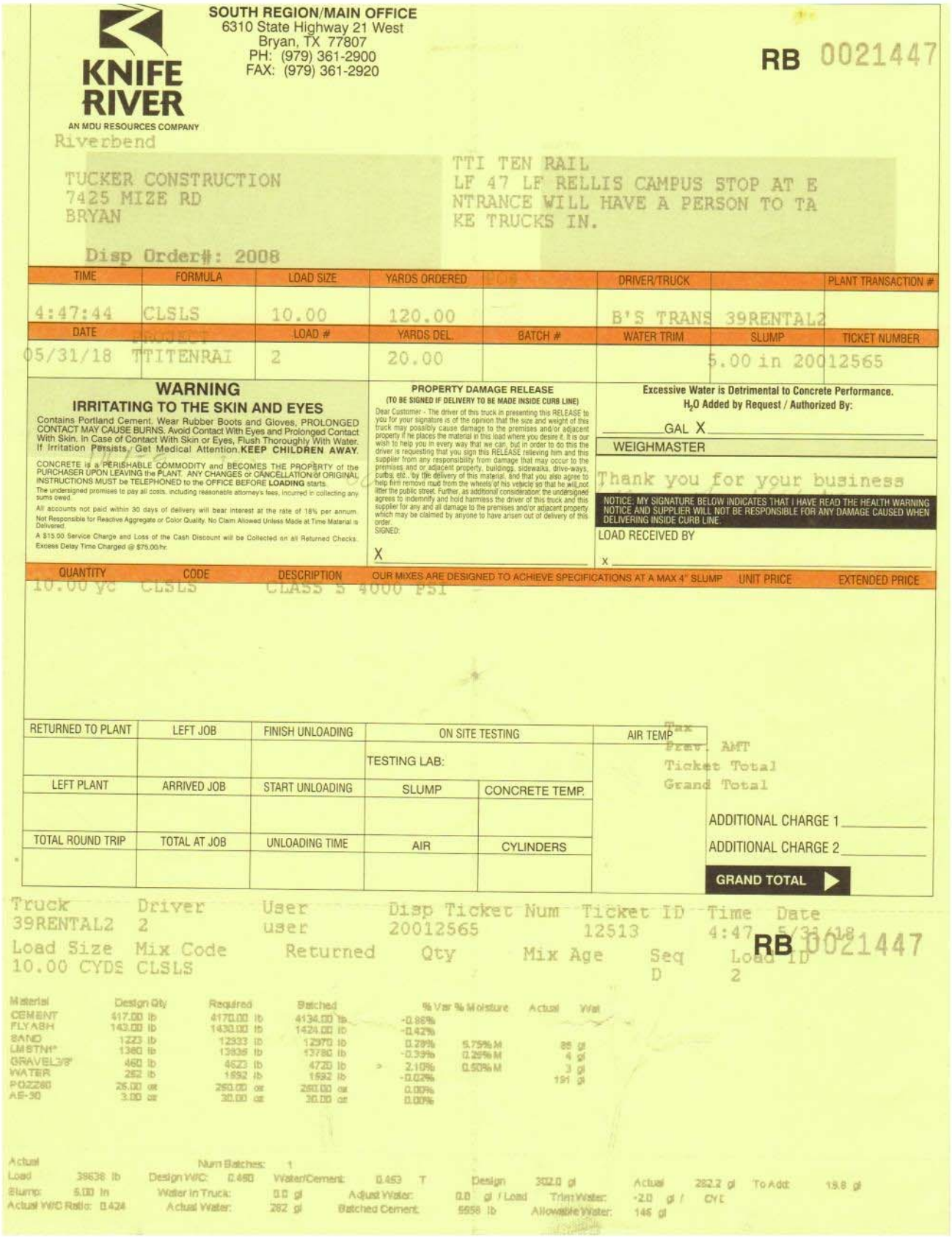
Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
39RENTAL1	1	user	20012566	12514	5:04	5/31/18

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	3

RB 0021448

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual	Wst
CEMENT	417.00 lb	4170.00 lb	4164.00 lb	-0.14%			
FLYASH	143.00 lb	1430.00 lb	1416.00 lb	-0.98%			
SAND	1223 lb	12933 lb	13000 lb	0.52%	5.79% M	69 gl	
LMSTNM*	1380 lb	13639 lb	13920 lb	0.62%	0.28% M	4 gl	
GRAVEL3/8"	460 lb	4623 lb	4980 lb	7.72%	0.50% M	3 gl	
WATER	252 lb	1692 lb	1591 lb	-0.09%		191 gl	
POZZ80	25.00 oz	250.00 oz	250.00 oz	0.00%			
AE-90	3.00 oz	30.00 oz	30.00 oz	0.00%			

Actual		Num Batches:	1						
Load:	39089 lb	Design W/C:	0.460	Water/Cement:	0.452	T	Design	302.0 gl	Actual	282.5 gl	To Add:	19.5 gl
Slump:	5.00 in	Water In Truck:	0.0 gl	Adjust Water:	0.0 gl / Load		Trim Water:	-2.0 gl / CYD				
Actual W/C Ratio:	0.423	Actual Water:	282 gl	Batched Cement:	5550 lb		Allowable Water:	153 gl				



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021447

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 2008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
4:47:44	CLSLS	10.00	120.00		B'S TRANS	39RENTAL2	
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	TTITENRAI	2	20.00			5.00 in	20012565

WARNING
IRRITATING TO THE SKIN AND EYES
Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention.**KEEP CHILDREN AWAY.**

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Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.
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Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)
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SIGNED:
X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:
GAL X
WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.
LOAD RECEIVED BY
X

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00 yd	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Total
Grand Total
ADDITIONAL CHARGE 1
ADDITIONAL CHARGE 2
GRAND TOTAL

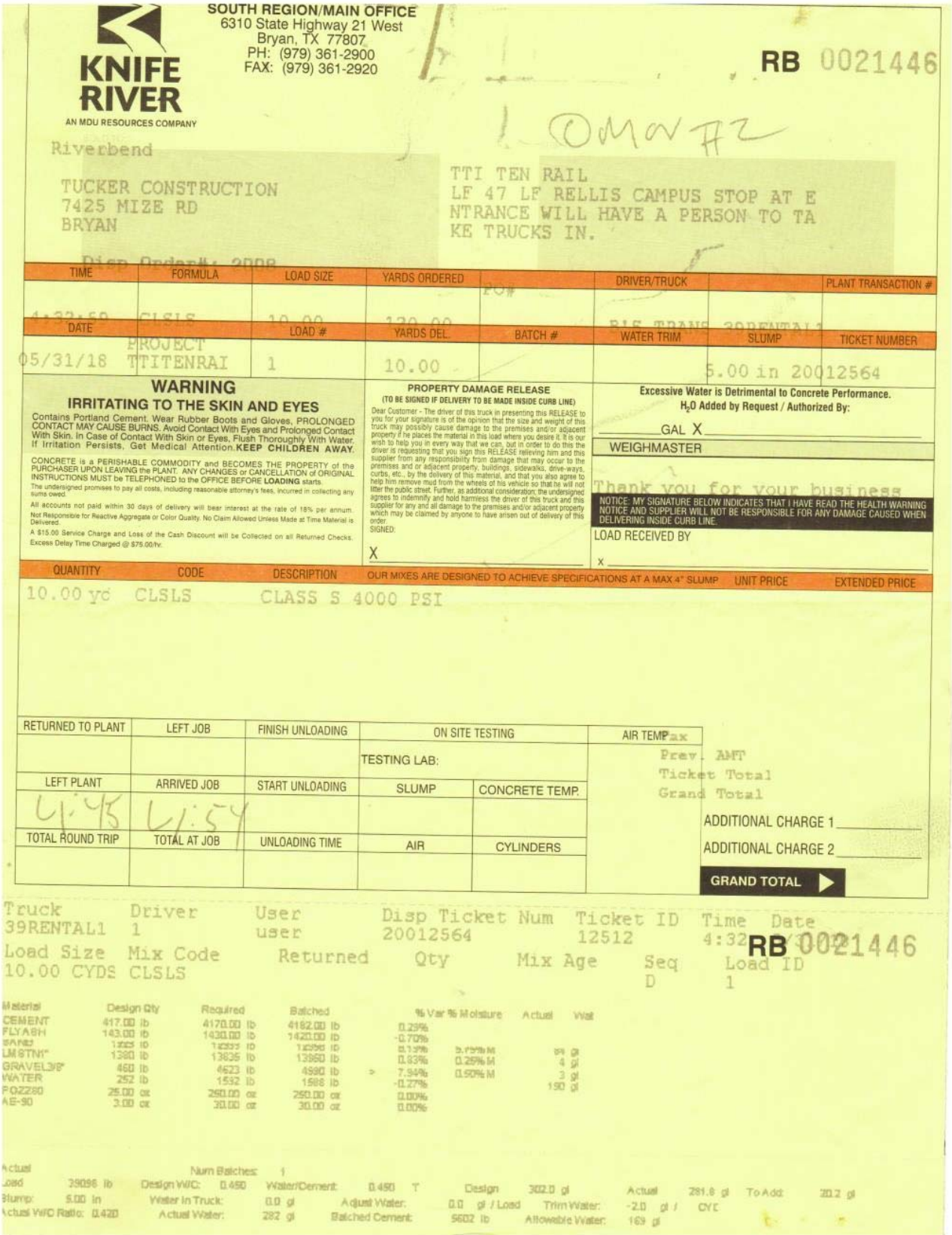
Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
39RENTAL2	2	user	20012565	12513	4:47	5/31/18

RB 0021447

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	2

Material	Design Qty	Required	Batched		% Var	% Moisture	Actual	Wat
CEMENT	417.00 lb	4170.00 lb	4134.00 lb		-0.86%			
FLYASH	143.00 lb	1430.00 lb	1424.00 lb		-0.42%			
SAND	1223 lb	12333 lb	12370 lb		0.29%	5.75% M	88 gl	
LMSTN#*	1360 lb	13836 lb	13780 lb		-0.39%	0.25% M	4 gl	
GRAVEL3/8"	460 lb	4620 lb	4720 lb	>	2.10%	0.50% M	3 gl	
WATER	262 lb	1892 lb	1692 lb		-0.02%		191 gl	
PO2280	26.00 oz	260.00 oz	260.00 oz		0.00%			
AE-30	3.00 oz	30.00 oz	30.00 oz		0.00%			

Actual
Load 39638 lb | Num Batches: 1
Slump: 5.00 in | Design W/C: 0.460 | Water/Cement: 0.453 T | Design 302.0 gl | Actual 282.2 gl | To Add: 19.8 gl
Actual W/C Ratio: 0.424 | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl / Load | Trim Water: -2.0 gl / CYL
Actual Water: 282 gl | Batched Cement: 5958 lb | Allowable Water: 146 gl



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021446

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 20008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED	PO#	DRIVER/TRUCK		PLANT TRANSACTION #
4:32:59	CLSLS	10.00	120.00		BIG TRANS 39RENTAL1		
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	PROJECT TTITENRAI	1	10.00			5.00 in	20012564

WARNING
IRRITATING TO THE SKIN AND EYES

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SIGNED:

X _____

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

_____GAL X _____

WEIGHMASTER

Thank you for your business

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LOAD RECEIVED BY

x _____

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00 yd	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
4:45	4:54				
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
39RENTAL1	1	user	20012564	12512	4:32	

RB 0021446

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	1

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual	Wat
CEMENT	417.00 lb	4170.00 lb	4182.00 lb	0.29%			
FLYASH	143.00 lb	1430.00 lb	1420.00 lb	-0.70%			
SAND	1355 lb	13553 lb	13556 lb	0.03%	3.75% M	51 gl	
LMSTN1"	1380 lb	13636 lb	13960 lb	0.83%	0.25% M	4 gl	
GRAVEL3/8"	460 lb	4623 lb	4990 lb	> 7.94%	0.50% M	3 gl	
WATER	252 lb	1532 lb	1566 lb	-0.27%		190 gl	
POZZ80	25.00 oz	250.00 oz	250.00 oz	0.00%			
AE-90	3.00 oz	30.00 oz	30.00 oz	0.00%			

Actual				Num Batches:	1								
Load	39096 lb	Design W/C:	0.450	Water/Cement:	0.490	T	Design	302.0 gl		Actual	281.8 gl	To Add:	20.2 gl
Slump:	5.00 in	Water In Truck:	0.0 gl	Adjust Water:	0.0 gl / Load		Trim Water:	-2.0 gl / CYD					
Actual W/C Ratio:	0.420	Actual Water:	282 gl	Batched Cement:	5602 lb		Allowable Water:	169 gl					

Plan view of Deck and Moment Slab

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #609591 PenDOT		2018-05-31
Drawn by GES	Scale 1:200	Sheet 4 of 4 Concrete Map, Deck and MS

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\609591 Concrete Map

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	5.7.2 Concrete Sampling	Doc. No. QPF 5.7.2	Revision Date: 2018-04-17
Quality Policy Form	Revised by: B. L. Griffith Approved by: D. Kuhn	Revision: 6	Page: 1 of 1

Project No: 609591 **Casting Date:** 2018-05-31 **Mix Design (psi):** 4000

Printed Name of Technician taking Sample: GREG FRITZ

Printed Name of Technician breaking Sample: Matt Robinson

Signed Name of Technician taking Sample:

Signed Name of Technician breaking Sample:

Load No.	Truck No.	Ticket No.	Location (from concrete map)
D1 ~~D4~~/T4	390143	0021445	Final 15' of Top Wall, SouthEnd Deck to Post #3
~~D2 T5~~/T5	390128	0042464	Start @ Post #3 on South Deck to Post #10
~~D3 T6~~/T6	390133	0021450	Start @ Post #10 from South Deck to Post #15

BE 2018-06-25

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
D1/T4	2018-06-25	26 days	6225	176000	
D1/T4	"	"	5518	156000	6060
D1/T4	"	"	6437	182000	
D2/T5	2018-06-25	26 days	5942	168000	
D2/T5	"	"	6190	175000	6115
D2/T5	"	"	6225	176000	
D3/T6	2018-06-25	26 days	5836	165000	
D3/T6	"	"	5655	161000	5694
D3/T6	"	"	5553	157000	

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	5.7.2 Concrete Sampling	Doc. No. QPF 5.7.2	Revision Date: 2018-04-17
Quality Policy Form	Revised by: B. L. Griffith Approved by: D. Kuhn	Revision: 6	Page: 1 of 1

Project No: 609591 **Casting Date:** 2018-05-31 **Mix Design (psi):** 4000

Printed Name of Technician taking Sample: Greg Fritz

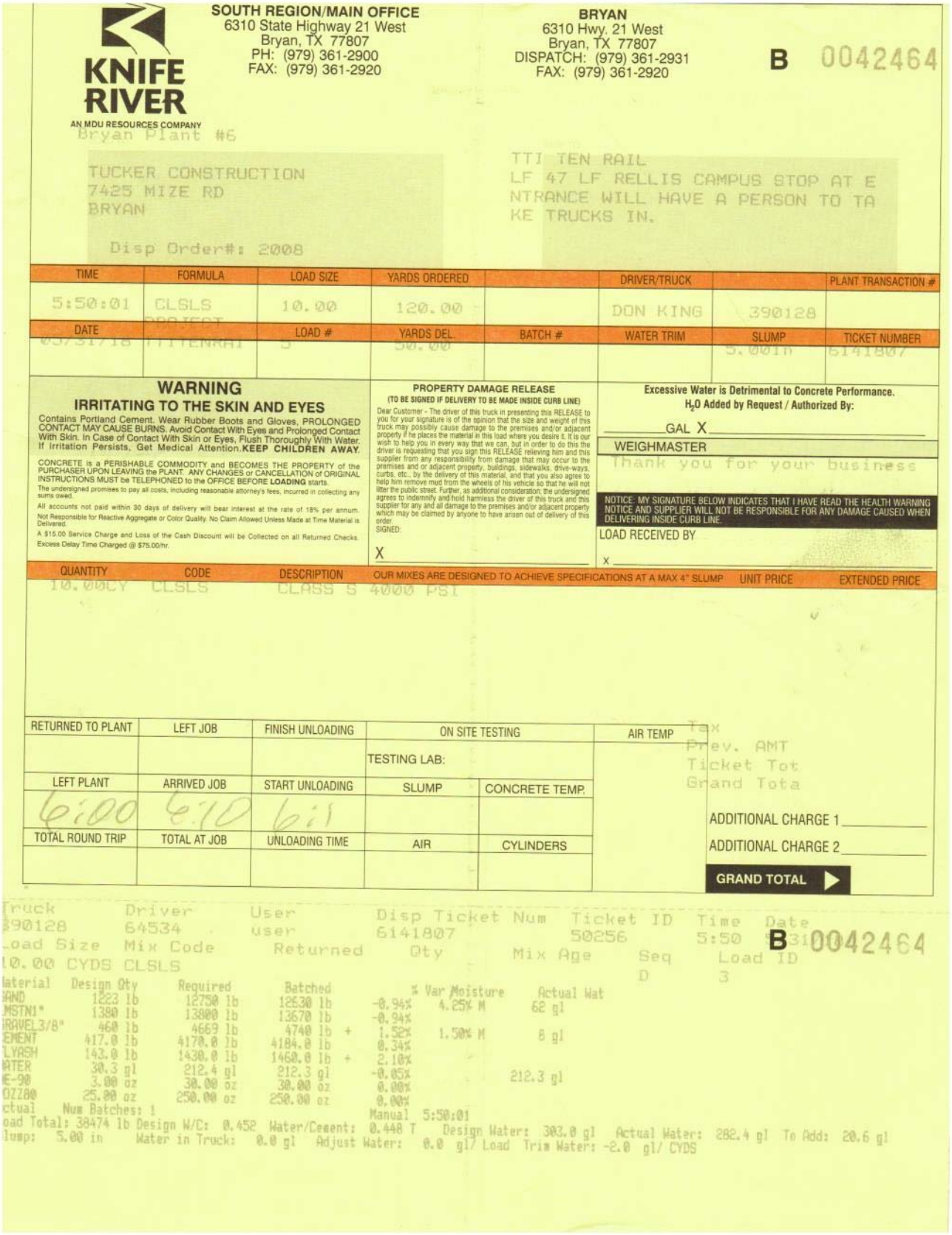
Printed Name of Technician breaking Sample: Matt Robinson

Signed Name of Technician taking Sample:

Signed Name of Technician breaking Sample:

Load No.	Truck No.	Ticket No.	Location (from concrete map)
D4/T7	390108	0021452	Post #15 from South Side to Post #18 W/MS
D5/T8	350126	0021454	Post #18 W/MS to End of Deck
D6/T9	39Rental2	0042475	10'x15' section of Mount Slab NE corner

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
D4/T7	2018-06-25	26 days	5164	146000	
D4/T7	"	"	5164	146000	5140
D4/T7	"	"	5093	144000	
D5/T8	2018-06-25	26 days	5552	157000	
D5/T8	"	"	5129	145000	5423
D5/T8	"	"	5588	158000	
D6/T9	2018-06-25	26 days	6473	183000	
D6/T9	"	"	6614	187000	6445
D6/T9	"	"	6261	177000	



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042464

Bryan Plant #6

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

Disp Order#: 2008

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
5:50:01	CLSLS	10.00	120.00		DON KING	390128	
DATE	**LOAD #**	**YARDS DEL.**	**BATCH #**		**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	3	50.00				5.00in	6141807

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

CONCRETE is a PERISHABLE COMMODITY and BECOMES THE PROPERTY of the PURCHASER UPON LEAVING the PLANT. ANY CHANGES or CANCELLATION of ORIGINAL INSTRUCTIONS MUST be TELEPHONED to the OFFICE BEFORE **LOADING** starts.

The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.

All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.

Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.

A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration; the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X _____

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

_____GAL X _____

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X _____

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00CY	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
6:00	6:10	6:1			
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL ▶

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390128	64534	user	6141807	50256	5:50	05/31/18

B 0042464

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	3

Material	Design Qty	Required	Batched		% Var	Moisture	Actual Wat
SAND	1223 lb	12750 lb	12630 lb		-0.94%	4.25% M	62 gl
#MSTN1*	1390 lb	13800 lb	13670 lb		-0.94%		
GRAVEL3/8"	460 lb	4669 lb	4740 lb	+	1.52%	1.50% M	8 gl
CEMENT	417.0 lb	4170.0 lb	4184.0 lb		0.34%		
FLYASH	143.0 lb	1430.0 lb	1460.0 lb	+	2.10%		
WATER	30.3 gl	212.4 gl	212.3 gl		-0.05%		212.3 gl
HE-90	3.00 oz	30.00 oz	30.00 oz		0.00%		
DZZ80	25.00 oz	250.00 oz	250.00 oz		0.00%		

Actual Num Batches: 1 Manual 5:50:01

Load Total: 38474 lb Design W/C: 0.452 Water/Cement: 0.448 T Design Water: 303.0 gl Actual Water: 282.4 gl To Add: 20.6 gl

Slump: 5.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl/ Load Trim Water: -2.0 gl/ CYDS

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021449

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 2008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED	PO#	DRIVER/TRUCK		PLANT TRANSACTION #
5:19:05	CLSLS	10.00	120.00		ROY DAVIS	390143	
DATE	**PROJECT**	**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	TTITENRAI	4	40.00			5.00 in	20012567

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

CONCRETE is a PERISHABLE COMMODITY and BECOMES THE PROPERTY of the PURCHASER UPON LEAVING the PLANT. ANY CHANGES or CANCELLATION of ORIGINAL INSTRUCTIONS MUST be TELEPHONED to the OFFICE BEFORE **LOADING** starts.

The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.

All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.

Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.

A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration; the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X _____

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

_____GAL X _____

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

x _____

QUANTITY	CODE	DESCRIPTION	UNIT PRICE	EXTENDED PRICE
10.00 yd	CLSLS	CLASS S 4000 PSI OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP		

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
5:35	5:49	6:22			
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL ▶

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390143	554626	user	20012567	12515	5:19	5/31/18

RB 0021449

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	4

Material	Design Qty	Required	Batched		% Var	% Moisture	Actual	Wsl
CEMENT	417.00 lb	4170.00 lb	4150.00 lb		-0.48%			
FLYASH	143.00 lb	1430.00 lb	1432.00 lb		0.14%			
SAND	1223 lb	12842 lb	12360 lb		0.84%	5.00% M	74 gl	
LMSTN1"	1360 lb	13835 lb	13980 lb		1.06%	0.25% M	4 gl	
GRAVEL3/8"	460 lb	4623 lb	4910 lb	>	6.21%	0.50% M	3 gl	
WATER	252 lb	1684 lb	1683 lb		-0.07%		202 gl	
PQZ290	25.00 oz	250.00 oz	250.00 oz		0.00%			
AE-90	3.00 oz	30.00 oz	30.00 oz		0.00%			

Actual
Load 39123 lb | Num Batches: 1
Slump: 5.00 in | Design W/C: 0.460 | Water/Cement: 0.452 T | Design 302.0 gl | Actual 292.7 gl | To Add: 19.3 gl
Actual W/C Ratio: 0.423 | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl / Load | Trim Water: -2.0 gl / CYt
Actual Water: 283 gl | Batched Cement: 5592 lb | Allowable Water: 152 gl

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021450

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LE 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 2008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
6:03:46	CLSLS	10.00	120.00		LLOYD JON	390133	
DATE	**PROJECT**	**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	TTITENRAI	6	60.00			5.00 in	20012569

WARNING
IRRITATING TO THE SKIN AND EYES
Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.
All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.
Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.
A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.
Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)
Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration; the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.
SIGNED:
X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:
GAL X
WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.
LOAD RECEIVED BY
X

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00 yd	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
10:19	6:36				
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Tax
Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1
ADDITIONAL CHARGE 2
GRAND TOTAL

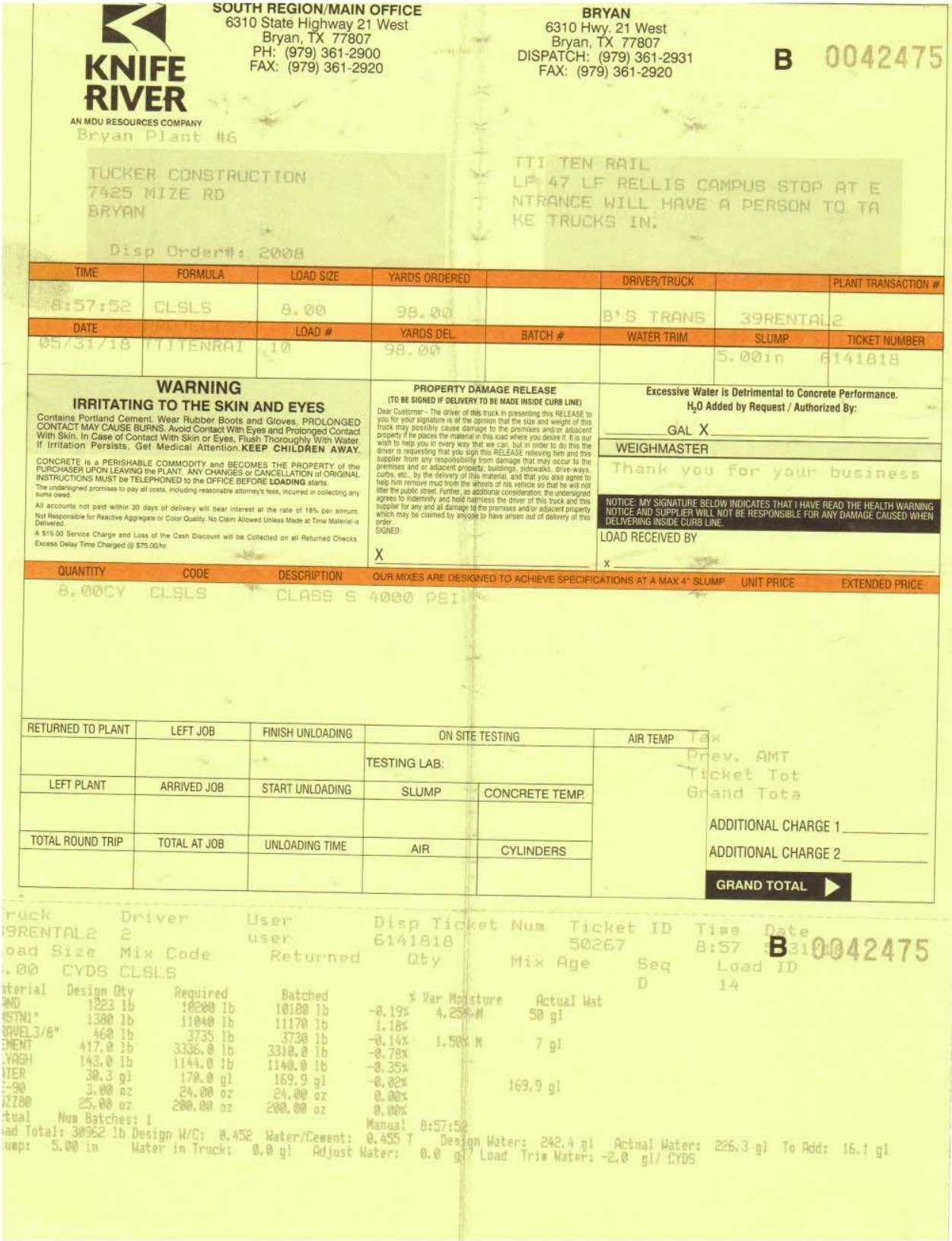
Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390133	490896	user	20012569	12516	6:03	5/31/18

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	5

RB 0021450

Material	Design Qty	Required	Batched		% Var	% Moisture	Actual	Wat
CEMENT	417.00 lb	417.00 lb	418.00 lb		0.24%			
FLYASH	143.00 lb	143.00 lb	144.00 lb		1.26%			
SAND	1333 lb	12942 lb	12980 lb		0.32%	5.00% M	74 gl	
LMSTN#*	1390 lb	13838 lb	13900 lb		0.19%	0.25% M	4 gl	
GRAVEL3/8"	460 lb	4623 lb	5010 lb	>	8.37%	0.50% M	3 gl	
WATER	252 lb	1694 lb	1683 lb		-0.07%		202 gl	
POZZ80	25.00 oz	250.00 oz	250.00 oz		0.00%			
AE-90	3.00 oz	30.00 oz	30.00 oz		0.00%			

Actual Num Batches: 1
Load 39163 lb Design W/C: 0.460 Water/Cement: 0.447 T Design 302.0 gl Actual 282.8 gl To Add: 19.2 gl
Slump: 5.00 in Water In Truck: 0.0 gl Adjust Water: 0.0 gl / Load Trim Water: -2.0 gl / CYL
Actual W/C Ratio: 0.419 Actual Water: 283 gl Batched Cement: 5632 lb Allowable Water: 174 gl



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

BRYAN
6310 Hwy. 21 West
Bryan, TX 77807
DISPATCH: (979) 361-2931
FAX: (979) 361-2920

B 0042475

Bryan Plant #6

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

Disp Order#: 2008

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
8:57:52	CLSLS	8.00	98.00		B'S TRANS	39RENTAL2	
DATE	**[illegible]**	**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	TTITENRAI	10	98.00			5.00in	6141818

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration; the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

x

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
8.00CY	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	ARRIVED JOB	START UNLOADING	SLUMP	CONCRETE TEMP.	
TOTAL ROUND TRIP	TOTAL AT JOB	UNLOADING TIME	AIR	CYLINDERS	

Tax
Prev. AMT
Ticket Tot
Grand Tota

ADDITIONAL CHARGE 1

ADDITIONAL CHARGE 2

GRAND TOTAL

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
39RENTAL2	2	user	6141818	50267	8:57	5/31/2018

B 0042475

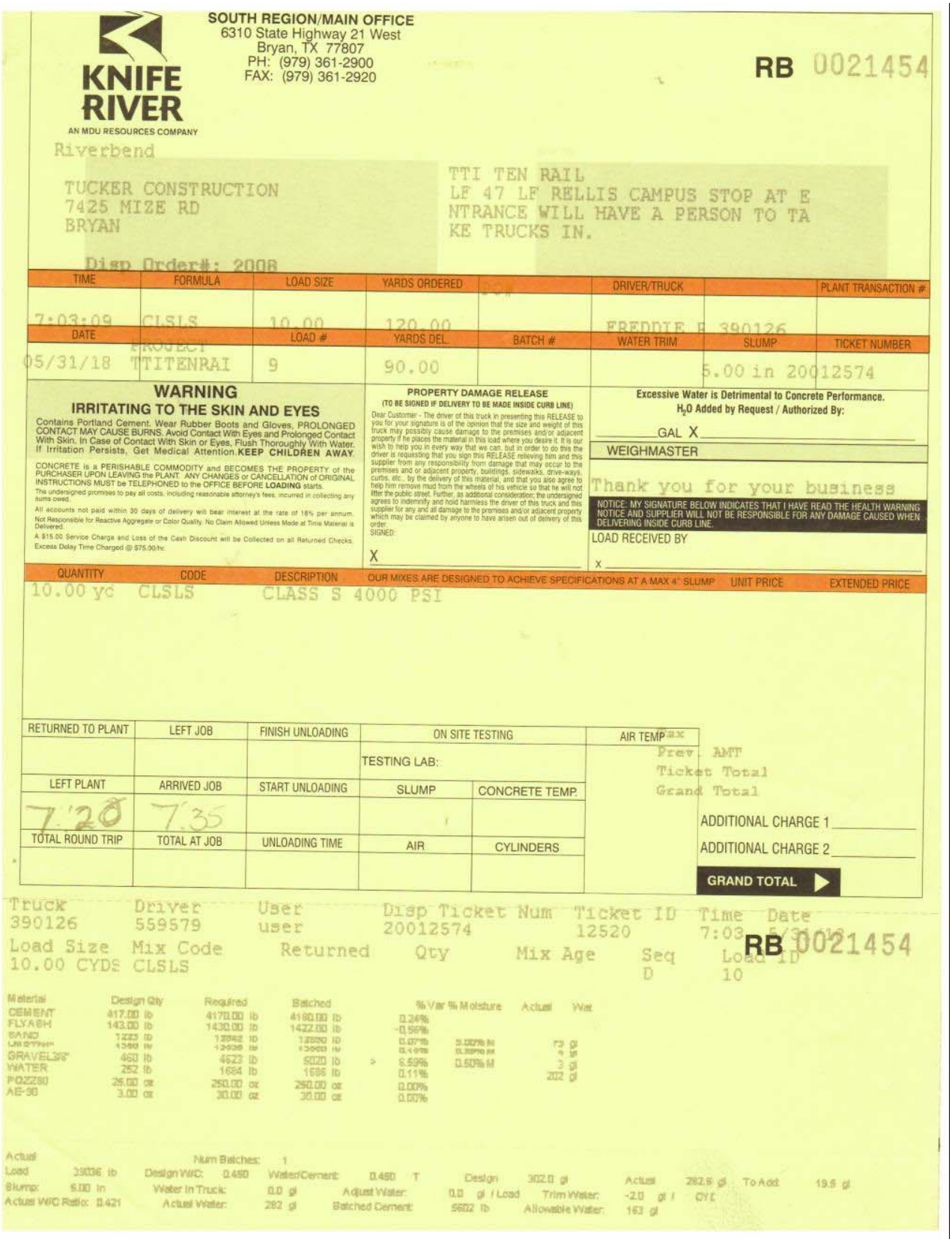
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
8.00	CYDS CLSLS				D	14

Material	Design Qty	Required	Batched	% Var	Moisture	Actual Wat
GND	1823 lb	18200 lb	10100 lb	-0.19%	4.25% M	50 gl
#STN1"	1380 lb	11040 lb	11170 lb	1.18%		
GRAVEL3/8"	460 lb	3735 lb	3730 lb	-0.14%	1.50% M	7 gl
CEMENT	417.0 lb	3336.0 lb	3310.0 lb	-0.78%		
FLYASH	143.0 lb	1144.0 lb	1140.0 lb	-0.35%		
WATER	30.3 gl	170.0 gl	169.9 gl	-0.02%		169.9 gl
ADMIX-90	3.00 oz	24.00 oz	24.00 oz	0.00%		
ADMIX7280	25.00 oz	200.00 oz	200.00 oz	0.00%		

Actual Num Batches: 1 Manual 8:57:52

Load Total: 30962 lb Design W/C: 0.452 Water/Cement: 0.455 T Design Water: 242.4 gl Actual Water: 226.3 gl To Add: 16.1 gl

Slump: 5.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl Load Trim Water: -2.0 gl/ CYDS



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021454

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 2008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
7:03:09	CLSLS	10.00	120.00		FREDDIE F 390126		
DATE		LOAD #	YARDS DEL.	BATCH #	WATER TRIM	SLUMP	TICKET NUMBER
05/31/18	PROJECT TTITENRAI	9	90.00			5.00 in	20012574

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

CONCRETE is a PERISHABLE COMMODITY and BECOMES THE PROPERTY of the PURCHASER UPON LEAVING the PLANT. ANY CHANGES or CANCELLATION of ORIGINAL INSTRUCTIONS MUST be TELEPHONED to the OFFICE BEFORE **LOADING** starts.

The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.

All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.

Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.

A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration; the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X

QUANTITY	CODE	DESCRIPTION	UNIT PRICE	EXTENDED PRICE
10.00 yc	CLSLS	CLASS S 4000 PSI		

OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	ARRIVED JOB	START UNLOADING	SLUMP	CONCRETE TEMP.	
7:20	7:35				
TOTAL ROUND TRIP	TOTAL AT JOB	UNLOADING TIME	AIR	CYLINDERS	

Tax
Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1

ADDITIONAL CHARGE 2

GRAND TOTAL

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390126	559579	user	20012574	12520	7:03	5/31/18

RB 0021454

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	10

Material	Design Qty	Required	Batched	%Var	%Moisture	Actual	Wat
CEMENT	417.00 lb	417.00 lb	416.00 lb	0.24%			
FLYASH	143.00 lb	143.00 lb	142.00 lb	-0.56%			
SAND	1223 lb	1223 lb	1220 lb	0.07%	0.00% N	73 gl	
LIMESTONE	1360 lb	1360 lb	1360 lb	0.00%	0.00% M	0 lb	
GRAVEL3/8"	460 lb	460 lb	460 lb	0.00%	0.00% M	0 gl	
WATER	252 lb	252 lb	252 lb	0.00%		30 gl	
POZZ80	25.00 oz	25.00 oz	25.00 oz	0.00%		202 gl	
AE-90	3.00 oz	3.00 oz	3.00 oz	0.00%			

Actual Load	20036 lb	Num Batches: 1							
Slump:	5.00 in	Design W/C: 0.460	Water/Cement: 0.460	T	Design	302.0 gl	Actual	282.8 gl	To Add: 19.5 gl
Actual W/C Ratio:	0.421	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load		Trim Water:	-2.0 gl / CYL			
		Actual Water: 282 gl	Batched Cement: 9602 lb		Allowable Water:	163 gl			

KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021452

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT E
NTRANCE WILL HAVE A PERSON TO TA
KE TRUCKS IN.

Disp Order#: 2008

TIME	FORMULA	LOAD SIZE	YARDS ORDERED	PO#	DRIVER/TRUCK		PLANT TRANSACTION #
6:37:49	CLSLS	10.00	120.00		MELVIN MA 390108		
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
05/31/18	PROJECT TTITENRAI	8	80.00			5.00 in	20012572

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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The undersigned promises to pay all costs, including reasonable attorney's fees, incurred in collecting any sums owed.

All accounts not paid within 30 days of delivery will bear interest at the rate of 18% per annum.

Not Responsible for Reactive Aggregate or Color Quality. No Claim Allowed Unless Made at Time Material is Delivered.

A $15.00 Service Charge and Loss of the Cash Discount will be Collected on all Returned Checks.

Excess Delay Time Charged @ $75.00/hr.

PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

Dear Customer - The driver of this truck in presenting this RELEASE to you for your signature is of the opinion that the size and weight of this truck may possibly cause damage to the premises and/or adjacent property if he places the material in this load where you desire it. It is our wish to help you in every way that we can, but in order to do this the driver is requesting that you sign this RELEASE relieving him and this supplier from any responsibility from damage that may occur to the premises and or adjacent property, buildings, sidewalks, drive-ways, curbs, etc., by the delivery of this material, and that you also agree to help him remove mud from the wheels of his vehicle so that he will not litter the public street. Further, as additional consideration; the undersigned agrees to indemnify and hold harmless the driver of this truck and this supplier for any and all damage to the premises and/or adjacent property which may be claimed by anyone to have arisen out of delivery of this order.

SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

_____GAL X_____

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00 yc	CLSLS	CLASS S 4000 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
6:50	7:00				
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1 _____

ADDITIONAL CHARGE 2 _____

GRAND TOTAL

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390108	569696	user	20012572	12518	6:37	5/31/18

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLSLS				D	8

RB 0021452

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual	Wat
CEMENT	417.00 lb	4170.00 lb	4164.00 lb	-0.14%			
FLYASH	143.00 lb	1430.00 lb	1426.00 lb	-0.29%			
SAND	1223 lb	12232 lb	12393 lb	1.09%	0.00% M	74 gl	
[illegible]	1398 lb	13980 lb	13960 lb	0.35%	0.20% M	4 gl	
GRAVEL3/8"	460 lb	4623 lb	5080 lb	> 9.89%	0.50% M	3 gl	
WATER	252 lb	1684 lb	1683 lb	-0.07%		202 gl	
POZZ80	25.00 oz	250.00 oz	250.00 oz	0.00%			
AE-90	3.00 oz	30.00 oz	30.00 oz	0.00%			

Actual Load: 39231 lb | Num Batches: 1
Slump: 5.00 in | Design W/C: 0.460 | Water/Cement: 0.461 T | Design: 302.0 gl | Actual: 282.9 gl | To Add: 19.1 gl
Actual W/C Ratio: 0.422 | Water in Truck: 0.0 gl | Adjust Water: 0.0 gl / Load | Trim Water: -2.0 gl / CYD
Actual Water: 283 gl | Batched Cement: 5590 lb | Allowable Water: 154 gl

Texas A&M Transportation Institute

Roadside Safety and Physical Security Division - Proving Ground

Project #609591 PenDOT			2018-05-31
Drawn by GES	Scale 1:200	Sheet 5 of 5 Concrete Map, Parapet	

T:\1-ProjectFiles\609591-G-F WO #2 - Bullard\Drafting, 609591\609591 Concrete Map

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	5.7.2 Concrete Sampling	Doc. No. QPF 5.7.2	Revision Date: 2018-04-17
Quality Policy Form	Revised by: B. L. Griffith Approved by: D. Kuhn	Revision: 6	Page: 1 of 1

Project No: 609591 **Casting Date:** 2018-06-05 **Mix Design (psi):** 3600

Printed Name of Technician taking Sample: GREG FRITZ

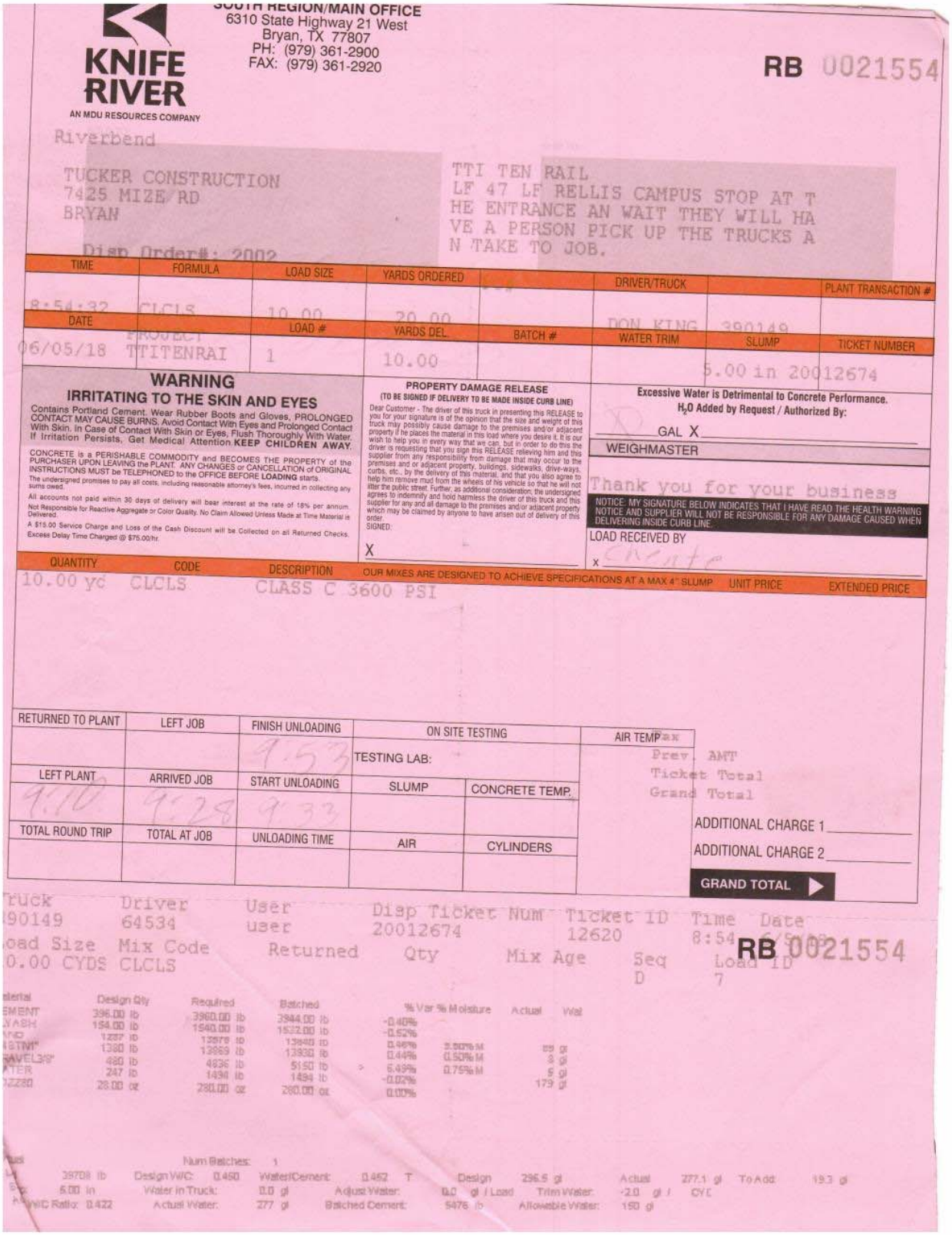
Printed Name of Technician breaking Sample: Matt Robinson

Signed Name of Technician taking Sample:

Signed Name of Technician breaking Sample:

Load No.	Truck No.	Ticket No.	Location (from concrete map)
P1/T1	390149	0021554	South 2/3rds of Parapet
P2/T2	350141	0021556	North 1/3rd of Parapet

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
P1/T1	2018-06-25	20 days	4,421	125,000	
P1/T1	"	"	47,40	134,000	4,680
P1/T1	"	"	4,881	138,000	
P2/T2	2018-06-25	20 days	5305	150000	
P2/T2	"	"	5199	147000	5281
P2/T2	"	"	5341	151000	



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021554

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

Disp Order#: 2002

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT T
HE ENTRANCE AN WAIT THEY WILL HA
VE A PERSON PICK UP THE TRUCKS A
N TAKE TO JOB.

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
8:54:32	CLCLS	10.00	20.00		DON KING	390149	
DATE	**LOAD #**	**YARDS DEL.**	**BATCH #**		**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
06/05/18	PROJECT TTITENRAI 1	10.00				5.00 in	20012674

WARNING
IRRITATING TO THE SKIN AND EYES
Contains Portland Cement. Wear Rubber Boots and Gloves, PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

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SIGNED:
X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:
GAL X
WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY
x Route

QUANTITY	CODE	DESCRIPTION	UNIT PRICE	EXTENDED PRICE
10.00 yd	CLCLS	CLASS C 3600 PSI OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP		

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
		9:53	TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
9:10	9:28	9:33			
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Prev. AMT
Ticket Total
Grand Total
ADDITIONAL CHARGE 1
ADDITIONAL CHARGE 2
GRAND TOTAL

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390149	64534	user	20012674	12620	8:54	6/5/18

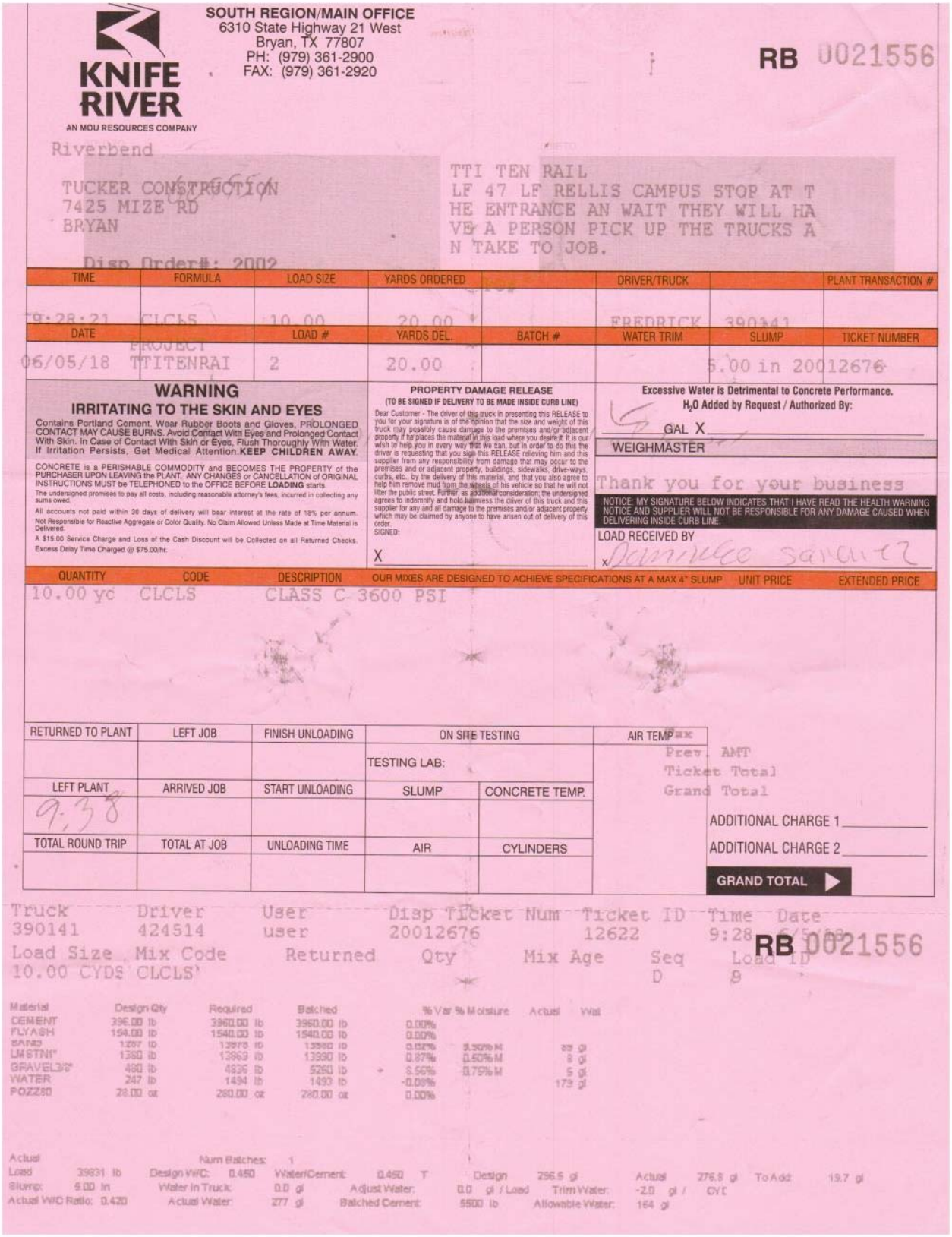
Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLCLS				D	7

RB 0021554

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual	Wat
CEMENT	396.00 lb	3960.00 lb	3944.00 lb	-0.40%			
FLYASH	154.00 lb	1540.00 lb	1522.00 lb	-0.52%			
SAND	1237 lb	12379 lb	12640 lb	0.46%	5.00% M	89 gl	
#8STNT	1390 lb	13869 lb	13930 lb	0.44%	0.50% M	8 gl	
GRAVEL3/8"	480 lb	4836 lb	5150 lb	6.49%	0.75% M	5 gl	
WATER	247 lb	1494 lb	1494 lb	-0.02%		179 gl	
AZZ80	28.00 oz	280.00 oz	280.00 oz	0.00%			

Num Batches: 1

Load	39708 lb	Design W/C:	0.460	Water/Cement:	0.462	T	Design	296.5 gl	Actual	277.1 gl	To Add: 19.3 gl
Slump	5.00 in	Water in Truck:	0.0 gl	Adjust Water:	0.0	gl / Load	Trim Water:	-2.0 gl /	CYD		
Actual W/C Ratio:	0.422	Actual Water:	277 gl	Batched Cement:	5476 lb		Allowable Water:	150 gl			



KNIFE RIVER
AN MDU RESOURCES COMPANY

SOUTH REGION/MAIN OFFICE
6310 State Highway 21 West
Bryan, TX 77807
PH: (979) 361-2900
FAX: (979) 361-2920

RB 0021556

Riverbend

TUCKER CONSTRUCTION
7425 MIZE RD
BRYAN

TTI TEN RAIL
LF 47 LF RELLIS CAMPUS STOP AT T
HE ENTRANCE AN WAIT THEY WILL HA
VE A PERSON PICK UP THE TRUCKS A
N TAKE TO JOB.

Disp Order#: 2002

TIME	FORMULA	LOAD SIZE	YARDS ORDERED		DRIVER/TRUCK		PLANT TRANSACTION #
9:28:21	CLCLS	10.00	20.00		FREDRICK	390141	
DATE		**LOAD #**	**YARDS DEL.**	**BATCH #**	**WATER TRIM**	**SLUMP**	**TICKET NUMBER**
06/05/18	TTITENRAI	2	20.00			5.00 in	20012676

WARNING
IRRITATING TO THE SKIN AND EYES

Contains Portland Cement. Wear Rubber Boots and Gloves. PROLONGED CONTACT MAY CAUSE BURNS. Avoid Contact With Eyes and Prolonged Contact With Skin. In Case of Contact With Skin or Eyes, Flush Thoroughly With Water. If Irritation Persists, Get Medical Attention. **KEEP CHILDREN AWAY.**

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PROPERTY DAMAGE RELEASE
(TO BE SIGNED IF DELIVERY TO BE MADE INSIDE CURB LINE)

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SIGNED:

X

Excessive Water is Detrimental to Concrete Performance.
H_2O Added by Request / Authorized By:

GAL X

WEIGHMASTER

Thank you for your business

NOTICE: MY SIGNATURE BELOW INDICATES THAT I HAVE READ THE HEALTH WARNING NOTICE AND SUPPLIER WILL NOT BE RESPONSIBLE FOR ANY DAMAGE CAUSED WHEN DELIVERING INSIDE CURB LINE.

LOAD RECEIVED BY

X Dominee Sarratt

QUANTITY	CODE	DESCRIPTION	OUR MIXES ARE DESIGNED TO ACHIEVE SPECIFICATIONS AT A MAX 4" SLUMP	UNIT PRICE	EXTENDED PRICE
10.00 yc	CLCLS	CLASS C 3600 PSI			

RETURNED TO PLANT	LEFT JOB	FINISH UNLOADING	ON SITE TESTING		AIR TEMP
			TESTING LAB:		
LEFT PLANT	**ARRIVED JOB**	**START UNLOADING**	**SLUMP**	**CONCRETE TEMP.**	
9:38					
TOTAL ROUND TRIP	**TOTAL AT JOB**	**UNLOADING TIME**	**AIR**	**CYLINDERS**	

Prev. AMT
Ticket Total
Grand Total

ADDITIONAL CHARGE 1

ADDITIONAL CHARGE 2

GRAND TOTAL

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
390141	424514	user	20012676	12622	9:28	

RB 0021556

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
10.00 CYDS	CLCLS'				D	8

Material	Design Qty	Required	Batched		%Var	%Moisture	Actual	Wat
CEMENT	396.00 lb	3960.00 lb	3960.00 lb		0.00%			
FLYASH	154.00 lb	1540.00 lb	1540.00 lb		0.00%			
SAND	1357 lb	13576 lb	13580 lb		0.02%	0.50% M	89 gl	
LMSTN1"	1380 lb	13969 lb	13990 lb		0.87%	0.50% M	8 gl	
GRAVEL3/8"	480 lb	4836 lb	5260 lb	+	8.56%	0.75% M	5 gl	
WATER	247 lb	1494 lb	1493 lb		-0.06%		179 gl	
POZZ80	28.00 oz	280.00 oz	280.00 oz		0.00%			

Actual Load	39831 lb	Num Batches:	1								
Slump:	5.00 in	Design W/C:	0.460	Water/Cement:	0.460 T	Design	296.6 gl	Actual	276.8 gl	To Add:	19.7 gl
Actual W/C Ratio:	0.420	Water In Truck:	0.0 gl	Adjust Water:	0.0 gl / Load	Trim Water:	-2.0 gl / CYL				
		Actual Water:	277 gl	Batched Cement:	5500 lb	Allowable Water:	164 gl				

3/4x12 Bolt

Vulcan
THREADED PRODUCTS, INC.

Vulcan Threaded Products
10 Cross Creek Trail
Pelham, AL 35124
Tel (205) 620-5100
Fax (205) 620-5150

JOB MATERIAL CERTIFICATION

Job Information

Job No: 545930 **Certified Date:** 8/29/17

Containers: S12836326

Customer: AmeriBolt, Inc 2/8 **Ship To:** 18060 Al Hwy 21 Sycamore, AL 35149

Vulcan Part No: ATR F1554-55 3/4x12 HDG

Customer Part No: ATR F1554-55 3/4x12 HDG

Customer PO No: 0075668 -10 **Shipped Qty:** 60 Ft

Order No: 338482 **Line No:** 2

Note: TR51-075 X 1800

Applicable Specifications

Type	Specification	Rev	Amend	Option
-	ASTM F1554 Gd 55	2015		

Test Results

Part No: ATR F1554-55 3/4x12 - 2A

Test No: 44335 **Test:** F1554-55 Physical Results1

Description	Tensile (ksi)	Yield (ksi)	Elongation (%)	Elongation GL (in)	Reduction of Area (%)	Note
	81	71	27	4D	63	

Certified Chemical Analysis

Heat No: DL17104915 **Lot:** .718 **Origin:** USA

C	Mn	P	S	Si	Cu
0.160	0.64	0.006	0.024	0.20	0.24
Ni	**Cr**	**Mo**	**V**	**Cb**	**RR**
0.08	0.10	0.02	0.004	0.004	120.6:1

Notes

No welds, no Mercury were used in production of this material. Melted and Manufactured in the USA.
Document is in accordance with EN 10204 - 3.1B of 2004 (3.1).

8/29/17

Griffin, Mitchell - Certification Engineer Date

Plex 8/29/17 7:35 AM vulc.mgri Page 1

SSAB

12400 Highway 43 North, Axis, Alabama 36505, US

H1A 85550, 85551, 85552
Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

Customer:	Customer P.O.No.:HOU-8544	Mill Order No. 41-522620-05	Shipping Manifest: AR255328
CHAPEL STEEL CO PO BOX 1000 SPRING HOUSE PA 19477	Product Description: ASTM A572-50/M345(15)/A709-50/M345(17) TYPE 2, .010% MAX S LCVN 20 FT.LBS @ -22F/A673-H	Ship Date: 11 Dec 17 Cert Date: 11 Dec17	Cert No: 0816374~9 (Page 1 of 1)
	Size: 1.000 X 120.0 X 480.0 (IN)		

Tested Pieces:				Tensiles:					Hardness	Charpy Impact Tests								
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in 8in	Tst Dir		Abs. Energy(FTLB) 1 2 3 Avg				% Shear 1 2 3 Avg				Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
E7L024	A14	1.001 (DISCRT)	L	56	74		25	T		61	96	72	76					-22F	L	10.	

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	IIW	ORGN
E7L024	.16	1.05	.011	.001	.20	.027	.026	.24	.08	.11	.03	.002	.042	.002	.39	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:
E7L024 A14 PCES: 3, LBS: 49005

Material provided by:
PRECISION FLAMECUTTING AND STEEL, INC.

HT# E7L024

(P) Cust Part #:

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Justin Ward
SENIOR METALLURGIST - PRODUCT

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLSES

US HWY 12 Burns Harbor, Indiana

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.	
8GA-09695	03-06-17	CUSTOMER TRUCK T RICH	PAGE

SOLD TO
SUNBELT GROUP L P
1990 POST OAK BLVD SUITE 950
HOUSTON TX 77056-3813

SHIP TO
SUNBELT GROUP L P
C/O ARROW STEEL PROCESSORS
8710 CLINTON DR
HOUSTON TX 77547

NOTE	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY: THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	AF FRAC. ELONG.	RED.
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN	% %

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - AASHTO M270-12 GR 50 KLD FINE GRAIN PRAC NO IMPACTS REQUIRED TYPE 2, ASTM A709-07 GR 50, ASTM A572-06 GR 50, ASME SA572 GR 50 2013 EDITION
MFST - MFST MILL SERIAL# & PATTERN# MFST PROC ON GH820-5721A LIFT MAX 15 TON-SIZES & GRADES SEP UNLDG FORK LIFT-SIDE FOR ULTIMATE DELIVERY LATER

CO# 23.127 GH 403-1151A

811S06140	1	1	96	240	6534	56100	80800	8	24
						60100	80400	8	26
B55205904									
811S06140	1	1	96	240	6534	56100	80800	8	24
						60100	80400	8	26
B55206001									
811S06140	1	1	96	240	6534	56100	80800	8	24
						60100	80400	8	26
B55206003									

H1A 85731, 85732

Q-QUENCH TEMPERATURE T-TEMPER TEMPERATURE N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN	BEND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP F	CHARPY IMPACT ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3

HEAT NUMBER	CHEMICAL ANALYSIS C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MQUAID GRAIN SIZE
811S06140	.18	1.20	.013	.003	.273	.018	.01	.02	.005	.055	.002	.030	.0002		.002	.003	

Material provided by:
Precision Flamecutting and Steel, Inc.

HT# 811S06140

I certify that the above results are a true and correct copy of actual results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.

R. SPANGLER II PER LSS

BHPLTRPT.TIF

SUPV. QUALITY ASSURANCE

Base Plate

NUCOR
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE

A0H 85647

1700 HOLT RD N.E.
Tuscaloosa, AL 35404-1000
800 800-8204
customerservice@nucortusk.com

Load Number	Tally	Mill Order Number	PO NO | Line NO	Part Number	Certificate Number	Prepared
R152486	00000000724815	N-154733-001	V10881Q217 01		S72481501-1	04/30/2017 16:58

Grade

Order Description:
Hot Roll Plate From Coil
A36, 0.2500 IN x 96.000 IN x 480.000 IN
Quality Plan Description:
A36MODMN-TRIPLE: ASTM A36-14/A709-36-15/ASME SA36-13 MOD MN

Customer:

Sold TO:
LEECO STEEL LLC Lisle IL
Ship TO:
LEECO STEEL LLC Hudson TX
Sent TO:

Shipped Item	Certified By	Heat Number	Yield ksi	Tensile ksi	Y/T %	ELONGATION % 2"	ELONGATION % 8"	Bend OK?	Hard HB	Charpy Impacts (ft-lbs) Size mm	1	2	3	Avg	Shear % 1	2	3	Avg	Test Temp
7D3213F	S7D3213MTT	B7Q4224 ***	49.4	65.5	75.4	31.1													

Items: 10 **PCS:** 50 **Weight:** 163353 **LBS**

Mercury has not come in contact with this product during the manufacturing process nor has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material. Material conforms to NACE MR0175 Annex 2.1.2 Manufactured to a fully killed fine grain practice. NUTEMPER TEMPER PASSED plate from coil
ISO 9001:2015 Registered, PED Certified

"***" indicates Heats melted and Manufactured in the U.S.A.

We hereby certify that the product described above passed all of the tests required by the specifications.

Dr. Quilin Yu - Metallurgist

NUCOR
NUCOR STEEL TUSCALOOSA, INC.

MILL TEST CERTIFICATE A0H 85647

1700 HOLT RD N.E.
Tuscaloosa, AL 35404-1000
800 800-8204
customerservice@nucortusk.com

Load Number	Tally	Mill Order Number	PO NO | Line NO	Part Number	Certificate Number	Prepared
R152486	00000000724815	N-154733-001	V10881Q217 01		S72481501-1	04/30/2017 16:58

Grade

Customer:

Order Description:
Hot Roll Plate From Coil
A36, 0.2500 IN x 96.000 IN x 480.000 IN
Quality Plan Description:
A36MODMN-TRIPLE: ASTM A36-14/A709-36-15/ASME SA36-13 MOD MN

Sold TO:
LEECO STEEL LLC Lisle IL
Ship TO:
LEECO STEEL LLC Hudson TX
Sent TO:

Shipped Item	Heat/Slab Number	Certified By	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Cb	V	Al	Ti	N2	B	Ca	Sn	CEV	ACI
7D3212B	B7Q4224-02 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3212C	B7Q4224-02 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3212D	B7Q4224-02 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3212E	B7Q4224-02 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3212F	B7Q4224-02 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3213B	B7Q4224-01 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3213C	B7Q4224-01 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3213D	B7Q4224-01 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3213E	B7Q4224-01 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	
7D3213F	B7Q4224-01 ***	B7Q4224	0.18	0.84	0.013	0.006	0.06	0.18	0.06	0.08	0.019	0.001	0.003	0.031	0.001	0.007	0.0001	0.0018	0.006	0.36	

Anchor Plate

Material provided by:
PRECISION FLAMECUTTING AND STEEL, INC.

HT# B7Q4224

Mercury has not come in contact with this product during the manufacturing process nor has any mercury been used by the manufacturing process. Certified in accordance with EN 10204 3.1. No weld repair has been performed on this material. Material conforms to NACE MR0175 Annex 2.1.2 Manufactured to a fully killed fine grain practice. NUTEMPER TEMPER PASSED plate from coil
ISO 9001:2015 Registered, PED Certified

"***" indicates Heats melted and Manufactured in the U.S.A.

We hereby certify that the product described above passed all of the tests required by the specifications.

Dr. Quilin Yu - Metallurgist

Plate Washers

SSAB

12400 Highway 43 North, Axis, Alabama 36505, US

A0K 85022
Test Certificate

Form TC1: Revision 2: Date 23 Apr 2014

Customer:	Customer P.O.No.:HOU-8540	Mill Order No. 41-522186-03	Shipping Manifest: AR256408
CHAPEL STEEL CO PO BOX 1000 SPRING HOUSE PA 19477	Product Description: ASTM A36(14)/A709(17)36/ASME SA36(17) AASHTO M270(15)36	Ship Date: 27 Dec 17 Cert Date: 27 Dec17	Cert No: 081640040 (Page 1 of 1)
	Size: 0.375 X 120.0 X 480.0 (IN)		

Tested Pieces:				Tensiles:						Charpy Impact Tests									
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (KSI)	UTS (KSI)	%RA	Elong % 2in	Elong % 8in	Tst Dir	Hardness	Abs. Energy(FTLB) 1	2	3	Avg	% Shear 1	2	3	Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
E7L229	A16	0.381 (DISCRT)	L	50	69		25		T													
M7L230	A28	0.372 (DISCRT)	L	53	68		27		T													
M7L714	D11	0.371 (DISCRT)	L	48	66		27		T													
W7L740	A17	0.380 (DISCRT)	L	49	68		25		T													
W7L741	A31	0.247 (DISCRT)	L	57	70		24		T													
W7L741	A34	0.373 (DISCRT)	L	53	67		23		T													

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	N	ORGN
E7L229	.19	.52	.011	.002	.14	.026	.33	.16	.13	.04	.000	.003	.014	.0001	.0079	USA
M7L230-A28	.18	.54	.007	.002	.13	.028	.26	.11	.10	.04	.001	.002	.012	.0001	.0071	USA
M7L714-D11	.17	.29	.010	.005	.18	.028	.30	.12	.11	.03	.001	.002	.020	.0001	.0082	USA
W7L740	.18	.52	.010	.001	.13	.025	.30	.15	.11	.05	.000	.003	.015	.0001	.0078	USA
W7L741	.18	.28	.008	.001	.15	.025	.26	.14	.08	.04	.001	.002	.012	.0001	.0068	USA

KILLED STEEL
MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT.
MTR EN 10204:2004 INSPECTION CERTIFICATE 3.1 COMPLIANT
100% MELTED AND MANUFACTURED IN THE USA.
PRODUCTS SHIPPED:

W7L741	A33	PCES:	7,	LBS:	42882	E7L229	A16	PCES:	1,	LBS:	6126
W7L740	A17	PCES:	2,	LBS:	12252	M7L230	A28	PCES:	6,	LBS:	36756
M7L714	D11	PCES:	3,	LBS:	18378						

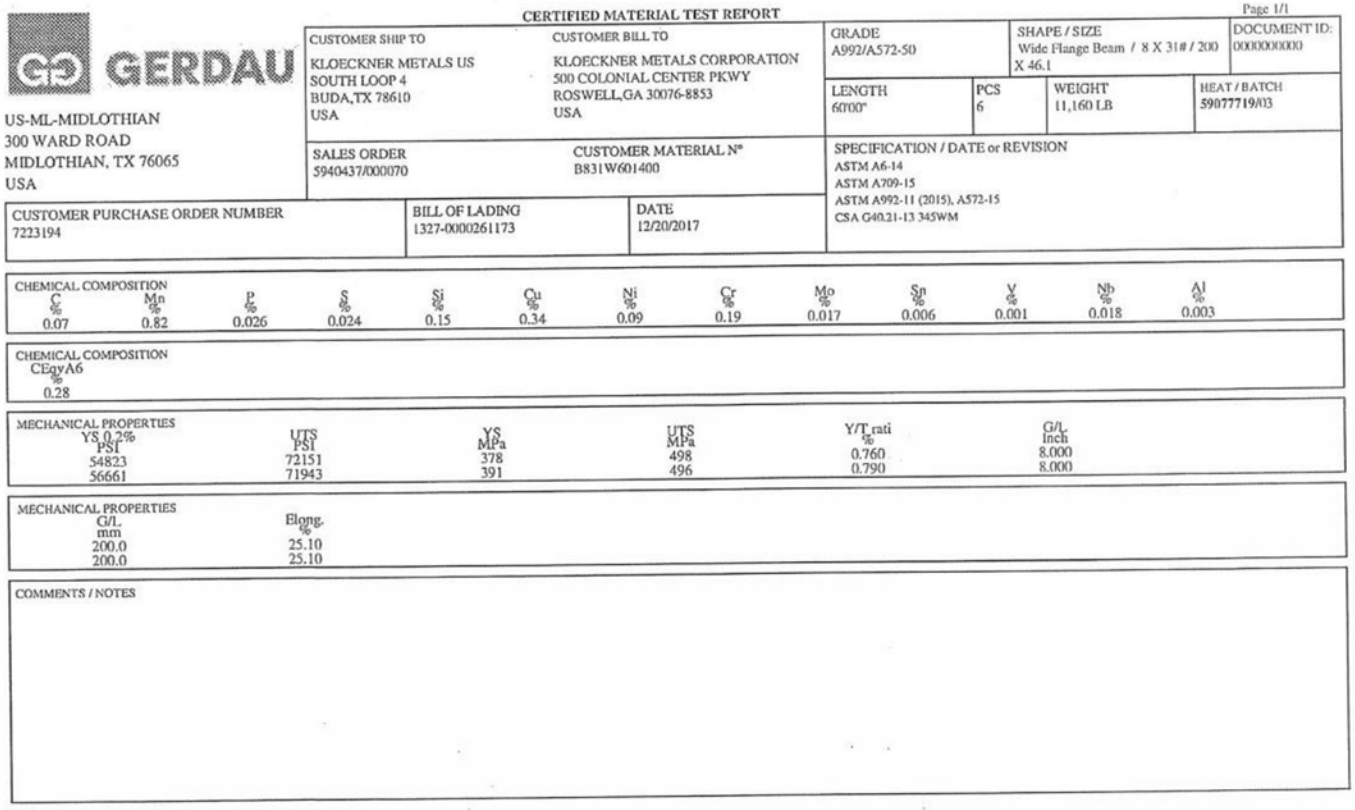
HT# M7L230

(P) Cust Part #:

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION

Justin Ward
SENIOR METALLURGIST - PRODUCT

Wide Flange Beam



GERDAU

CERTIFIED MATERIAL TEST REPORT

Page 1/1

US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO	CUSTOMER BILL TO
KLOECKNER METALS US SOUTH LOOP 4 BUDA,TX 78610 USA	KLOECKNER METALS CORPORATION 500 COLONIAL CENTER PKWY ROSWELL,GA 30076-8853 USA

GRADE	SHAPE / SIZE	DOCUMENT ID:
A992/A572-50	Wide Flange Beam / 8 X 31# / 200 X 46.1	0000000000

LENGTH	PCS	WEIGHT	HEAT / BATCH
60'00"	6	11,160 LB	59077719/03

SALES ORDER	CUSTOMER MATERIAL N°
5940437/000070	B831W601400

SPECIFICATION / DATE or REVISION
ASTM A6-14
ASTM A709-15
ASTM A992-11 (2015), A572-15
CSA G40.21-13 345WM

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
7223194	1327-0000261173	12/20/2017

CHEMICAL COMPOSITION

C %	Mn %	P %	S %	Si %	Cu %	Ni %	Cr %	Mo %	Sn %	V %	Nb %	Al %
0.07	0.82	0.026	0.024	0.15	0.34	0.09	0.19	0.017	0.006	0.001	0.018	0.003

CHEMICAL COMPOSITION

CEqvA6 %
0.28

MECHANICAL PROPERTIES

YS 0.2% PSI	UTS PSI	YS MPa	UTS MPa	Y/T rati %	G/L inch
54823	72151	378	498	0.760	8.000
56661	71943	391	496	0.790	8.000

MECHANICAL PROPERTIES

G/L mm	Elong. %
200.0	25.10
200.0	25.10

COMMENTS / NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

BHASKAR YALAMANCHILI
QUALITY DIRECTOR
Phone: (409) 769-1014 Email: Bhaskar.Yalamanchili@gerdau.com

WADE LUMPKINS
QUALITY ASSURANCE MGR.
Phone: 972-779-3118 Email: Wade.Lumpkins@gerdau.com

CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

We hereby certify that the test results presented here are accurate and conform to the reported grade specification

TOMMY HEWITT
Quality Assurance Manager

1SERIES-BPS ®

HEAT NO.:3067587 SECTION: CHANNEL 3"x6.0# 40'0" A36/52950 GRADE: ASTM A36-14/A529-14 Gr50 ROLL DATE: MELT DATE: 12/03/2016 Cert. No.: 82115476 / 067587A632	S O L D T O	Delta Steel Inc 7355 Roundhouse Ln Houston TX US 77078-4528 7136238080 7136350048	S H I P T O	Delta Steel Inc Houston Div 7355 Roundhouse Ln Houston TX US 77078-4528 7136351200 7136350048	Delivery#: 82115476 BOL#: 72095406 CUST PO#: DHO-151547 CUST P/N: DLVRY LBS / HEAT: 9360.000 LB DLVRY PCS / HEAT: 39 EA

Characteristic	Value	Characteristic	Value	Characteristic	Value
C	0.15%	Yield Strength test 2	53.2ksi		
Mn	0.68%	Tensile Strength test 2	75.3ksi		
P	0.023%	Elongation test 2	27%		
S	0.036%	Elongation Gage Lgth test 2	8IN		
Si	0.23%	Yield to tensile ratio test2	0.71		
Cu	0.35%				
Cr	0.15%				
Ni	0.09%				
Mo	0.027%				
V	0.013%				
Cb	0.002%				
Sn	0.012%			The Following is true of the material represented by this MTR:	
Al	0.000%			*Material is fully killed	
Carbon Eq A529	0.37%			*100% melted and rolled in the USA	
				*EN10204:2004 3.1 complaint	
Yield Strength test 1	51.9ksi			*Contains no weld repair	
Tensile Strength test 1	73.1ksi			*Contains no Mercury contamination	
Elongation test 1	33%			*Manufactured in accordance with the latest version of the plant quality manual	
Elongation Gage Lgth test 1	8IN			*Meets the "Buy America" requirements of 23 CFR635.410	
Yield to tensile ratio test1	0.71				

REMARKS :
ALSO MEETS ASTM GRADE A36, A529-50, A572-50, A709-36, A709-50, A992, AASHTO M270-36, M270-50, CSA G40.21-04 44W, 50W

06/22/2017 00:28:33
Page 1 OF 1

Certificate of Mill Test Results
Heat No: 3067587

Page 1 of 1

GERDAU

US-ML-CARTERSVILLE
384 OLD GRASSDALE ROAD NE
CARTERSVILLE, GA 30121
USA

CERTIFIED MATERIAL TEST REPORT

CUSTOMER SHIP TO	CUSTOMER BILL TO
KLOECKNER METALS US SOUTH LOOP 4 BUDA,TX 78610 USA	KLOECKNER METALS CORPORATION 500 COLONIAL CENTER PKWY ROSWELL,GA 30076-8853 USA

GRADE	SHAPE / SIZE	DOCUMENT ID:
A992/A572-50	Wide Flange Beam / 8 X 24# / 200 X 35.9	0000000000

LENGTH	PCS	WEIGHT	HEAT / BATCH
40'00"	10	9,600 LB	55053188/02

SALES ORDER	CUSTOMER MATERIAL N°
6155134/000010	B824W401400

SPECIFICATION / DATE or REVISION
ASTM A6-17
ASTM A709-17
ASTM A992-11 (2015), A572-15
CSA G40.21-13 345WM

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
7243904	1323-0000106083	02/21/2018

CHEMICAL COMPOSITION

C %	Mn %	P %	S %	Si %	Cu %	Ni %	Cr %	Mo %	Sn %	V %	Nb %
0.09	1.14	0.015	0.025	0.28	0.27	0.12	0.08	0.030	0.008	0.000	0.012

MECHANICAL PROPERTIES

YS 0.2% PSI	UTS PSI	YS MPa	UTS MPa	Y/T rati %	G/L Inch
54200	76600	374	528	0.710	8.000
55200	76800	381	530	0.720	8.000

MECHANICAL PROPERTIES

Elong. %
20.80
21.20

COMMENTS / NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

BHASKAR YALAMANCHILI
QUALITY DIRECTOR
Phone: (409) 769-1014 Email: Bhaskar.Yalamanchili@gerdau.com

YAN WANG
QUALITY ASSURANCE MGR.
Phone: (770) 387 5718 Email: yan.wang@gerdau.com

CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

We hereby certify that the test results presented here are accurate and conform to the reported grade specification

TOMMY HEWITT
Quality Assurance Manager

HEAT NO.:3079581 SECTION: REBAR 16MM (#5) 60'0" 420/60 GRADE: ASTM A615-16 Gr 420/60 ROLL DATE: 04/22/2018 MELT DATE: 04/22/2018 Cert. No.: 82366893 / 079581A002	SOLD TO CMC COATING WAXAHACHIE 901 CANTRELL STREET WAXAHACHIE TX US 75165-3120 972-937-9841	SHIP TO CMC Coatings Waxahachie 901 Cantrell St Waxahachie TX US 75165-3120 972 937 9841	Delivery#: 82366893 BOL#: 72448918 CUST PO#: CUST P/N: DLVRY LBS / HEAT: 15020.000 LB DLVRY PCS / HEAT: 240 EA

Characteristic	Value	Characteristic	Value	Characteristic	Value
C	0.41%				
Mn	0.89%				
P	0.013%				
S	0.046%				
Si	0.17%				
Cu	0.28%				
Cr	0.13%				
Ni	0.16%				
Mo	0.063%				
V	0.000%				
Cb	0.002%				
Sn	0.012%				
Al	0.001%				
Yield Strength test 1	66.4ksi				
Tensile Strength test 1	104.1ksi				
Elongation test 1	14%				
Elongation Gage Lgth test 1	8IN				
Bend Test Diameter	2.188IN				
Bend Test 1	Passed				

The Following is true of the material represented by this MTR:

- *Material is fully killed
- *100% melted and rolled in the USA
- *EN10204:2004 3.1 compliant
- *Contains no weld repair
- *Contains no Mercury contamination
- *Manufactured in accordance with the latest version of the plant quality manual
- *Meets the "Buy America" requirements of 23 CFR635.410

REMARKS :

05/15/2018 10:19:57
Page 1 OF 1

CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

We hereby certify that the test results presented here are accurate and conform to the reported grade specification

TOMMY HEWITT
Quality Assurance Manager

HEAT NO.:3079583 SECTION: REBAR 16MM (#5) 60'0" 420/60 GRADE: ASTM A615-16 Gr 420/60 ROLL DATE: 04/22/2018 MELT DATE: 04/22/2018 Cert. No.: 82366893 / 079583A002	SOLD TO CMC COATING WAXAHACHIE 901 CANTRELL STREET WAXAHACHIE TX US 75165-3120 972-937-9841	SHIP TO CMC Coatings Waxahachie 901 Cantrell St Waxahachie TX US 75165-3120 972 937 9841	Delivery#: 82366893 BOL#: 72448918 CUST PO#: CUST P/N: DLVRY LBS / HEAT: 30040.000 LB DLVRY PCS / HEAT: 480 EA

Characteristic	Value
C	0.42%
Mn	0.83%
P	0.013%
S	0.047%
Si	0.18%
Cu	0.29%
Cr	0.15%
Ni	0.20%
Mo	0.077%
V	0.000%
Cb	0.003%
Sn	0.013%
Al	0.001%
Yield Strength test 1	67.4ksi
Tensile Strength test 1	101.7ksi
Elongation test 1	14%
Elongation Gage Lgth test 1	8IN
Bend Test Diameter	2.188IN
Bend Test 1	Passed

Characteristic	Value

Characteristic	Value

The Following is true of the material represented by this MTR:

**Material is fully killed*
**100% melted and rolled in the USA*
**EN10204:2004 3.1 compliant*
**Contains no weld repair*
**Contains no Mercury contamination*
**Manufactured in accordance with the latest version of the plant quality manual*
**Meets the "Buy America" requirements of 23 CFR635.410*

REMARKS :

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Page 1 OF 1

CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

We hereby certify that the test results presented here are accurate and conform to the reported grade specification

TOMMY HEWITT
Quality Assurance Manager

HEAT NO.:3078975 SECTION: REBAR 13MM (#4) 60'0" 420/60 GRADE: ASTM A615-16 Gr 420/60 ROLL DATE: 04/05/2018 MELT DATE: 03/30/2018 Cert. No.: 82365532 / 078975A265	SOLD TO	CMC COATING WAXAHACHIE 901 CANTRELL STREET WAXAHACHIE TX US 75165-3120 972-937-9841	SHIP TO	CMC Coatings Waxahachie 901 Cantrell St Waxahachie TX US 75165-3120 972 937 9841	Delivery#: 82365532 BOL#: 72446899 CUST PO#: CUST P/N: DLVRY LBS / HEAT: 40404.000 LB DLVRY PCS / HEAT: 1008 EA

Characteristic	Value	Characteristic	Value	Characteristic	Value
C	0.42%				
Mn	0.79%				
P	0.009%				
S	0.042%				
Si	0.17%				
Cu	0.31%				
Cr	0.10%				
Ni	0.18%				
Mo	0.064%				
V	0.000%				
Cb	0.003%				
Sn	0.010%				
Al	0.002%				
Yield Strength test 1	65.8ksi				
Tensile Strength test 1	104.0ksi				
Elongation test 1	15%				
Elongation Gage Lgth test 1	8IN				
Bend Test Diameter	1.750IN				
Bend Test 1	Passed				

The Following is true of the material represented by this MTR:

**Material is fully killed*
**100% melted and rolled in the USA*
**EN10204:2004 3.1 compliant*
**Contains no weld repair*
**Contains no Mercury contamination*
**Manufactured in accordance with the latest version of the plant quality manual*
**Meets the "Buy America" requirements of 23 CFR635.410*

REMARKS :

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Valspar Corporation

CERTIFICATION of COMPLIANCE

Date: 4/18/2018

Specification: ASTM A775, ASTM A1078, AASHTO M284, AASHTO M254

Valspar Product Code: 720A009 (Epoxy Powder for Coating)
Batch Number: 8496026992
Production Date: 4/17/2018 (Expiration is 6 months post production date)
Batch Size: 18,000 lbs.

I hereby certify that the above lot of material was manufactured to formulation, meeting all the requirements of the above specifications and that this material is chemically the same material that was tested by Valley Forge Laboratories of Devon, PA. or Wiss, Janney, Elstner Associates of Northbrook, Il.

The individual signing below has the legal authority to bind Valspar to the material.

Eric Gregory / QC Supervisor
Name and Title

Signature

4/18/18
Date

10300 Claude Freeman Drive
Charlotte, NC 28262
Phone: (704) 548-2820
Fax: (704) 547-0634

State/Commonwealth NC County of Cabarrus

On this the 18th Day of April Month 2018 Year, before me Renee L. Motley Name of Notary Public

The undersigned Notary Public, personally appeared Eric Gregory Name(s) of Signer(s) ☒ personally known to me

RENEE L MOTLEY
MY COMMISSION EXPIRES
NOV 29 2020
CABARRUS COUNTY, NC
NOTARY PUBLIC

To be the person(s) whose name(s) is/are subscribed to the within instrument, and acknowledged to me that he/she/they executed the same for the purposes therein stated.

Witness my hand and official seal

Renee L. Motley
Signature of Notary Public

11-29-2020
Other Required Information (Printed Name of Notary, Residence, etc.)

The articles identified above were produced in the United States and qualify as "U.S.-made end products", "domestic construction materials" and "domestic manufactured goods"

The data on this sheet represent measured values. Since application variables are a major factor in product performance, this information should serve only as a general guide. Valspar assumes no obligation or liability for use of this information. UNLESS VALSPAR AGREES OTHERWISE IN WRITING, VALSPAR MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND DISCLAIMS ALL IMPLIED WARRANTIES INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR FREEDOM FROM PATENT INFRINGEMENT. VALSPAR WILL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES. Your only remedy for any defect in this product is the replacement of the defective product, or a refund of its purchase price, at our option.

NELSON STUD WELDING
A Nelson Fastener Systems Company

7/09/18 Certificate of Compliance 69

CUSTOM FABRICATORS
1379 N HARVEY MITCHELL PKWY
BRYAN TX
77803

Material Description/Part Numbers	Quantity	Heat Number	Lab Number
CPL 3/4-10 X 2 1/2 MS	90	10530700	
101017428			24071

Nelson Order Number: 1015428 Customer P.O.: 21486

The product supplied under the contract or purchase order number shown is certified to comply with the latest revision of one or more of the applicable product specifications therein; AWS D1.1, AWS D1.5, AWS D1.6, ISO 13918, BS 5950, ASTM A108, ASTM A29, ASTM A276, ASTM A493, ASTM A1064, ASTM A496, ASTM A479, ASTM A1022.

The chemical analysis reported below was extracted from the certified mill test report. This report will be supplied when specified in the customer order or upon request. The physical properties reported were determined to be in conformance using ASTM A370 testing procedure.

Nelson Stud Welding is an ISO/TS 16949:2009 certified supplier. Our IATF certificate # is 0222148. This material is free from mercury contamination and is RoHS compliant. This product is melted and manufactured in the USA. No weld repair was performed on the raw material or the studs. Parts are manufactured from cold drawn bar.

Grade	C-1015
Heat Number	10530700
Ultimate PSI	82,300
Yield PSI	77,400
% Reduction of Area	60.0
% Elong. (in 2"or4D)	22.0
% Elong. (in 5D)	19.000
Carbon	.160
Manganese	.550
Phosphorous	.005
Sulphur	.008

I hereby certify that the data listed in this Certificate of Compliance is true and correct as as contained in the company test records and that it complies with the specifications shown.

Authorized by:

CHERYL A. MCNEAL
MY COMMISSION EXPIRES
February 20, 2019

Nelson® Stud Welding · 2211 Century Center Blvd. #105 · Irving, TX 75062
PH: (972) 721-9055 · FAX: (972) 438-7883 · www.NelsonStud.com

CHARTER STEEL

A Division of
Charter Manufacturing Company, Inc.

FILE

1658 Cold Springs Road
Saukville, Wisconsin 53080
(262) 268-2400
1-800-437-8789
Fax (262) 268-2570

CHARTER STEEL TEST REPORT

Melted in USA Manufactured in USA

Nelson Stud Welding - A Nelson Fastener Systems Company
7900 West Ridge Road
QC Department
Elyria,OH-44035

Cust P.O.	425341
Customer Part #	103004036
Charter Sales Order	50049368
Heat #	10530700
Ship Lot #	1231181
Grade	1015 M SK FG RHQ 45/64 RNDCOIL
Process	HR
Finish Size	45/64
Ship date	17-JAN-18

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed below and that it satisfies these requirements. The recording of false, fictitious and fraudulent statements or entries on this document may be punishable as a felony under federal statute.

Test results of Heat Lot # 10530700

Lab Code: 7388

CHEM	C	MN	P	S	SI	NI	CR	MO	CU	SN	V
%Wt	.16	.55	.005	.008	.170	.04	.08	.02	.09	.006	.002

AL	N	B	TI	CA	NB	SB	AS
.024	.0080	.0001	.001	.0001	.001	.002	.004

PB
.001

JOMINY(HRC)

J1	J3
42	20

JOMINY SAMPLE TYPE ENGLISH=C

QUALITY CONTROL 180 2-27-18 NELSON STUD WELDING, INC.

Test results of Rolling Lot # 1231181

	# of Tests	Min Value	Max Value	Mean Value	
ROCKWELL B (HRBW)	1	72	72	72	RB LAB = 0358-02

REDUCTION RATIO=78:1

Specifications: Manufactured per Charter Steel Quality Manual Rev Date 05/12/17
Charter Steel certifies this product is indistinguishable from background radiation levels by having process radiation detectors in place to measure for the presence of radiation within our process & products.
Meets customer specifications with any applicable Charter Steel exceptions for the following customer documents:
Customer Document = MPS-102C Revision = G Dated = 17-OCT-16

Additional Comments: This material meets the chemistry requirements of ASTM-A108 (latest version), ASTM A29 (latest version), and EN 10025-2 S-235-J2G3

Lab 24071

Melt Source:
Charter Steel
Saukville, WI, USA

Trip: 1213927

ACCREDITED
Testing Laboratory

This MTR supersedes all previously dated MTRs for this order

Janice Barnard Division Mgr. of Quality Assurance
barnardJ@chartersteel.com
Printed Date : 01/17/2018

The following statements are applicable to the material described on the front of this Test Report:

1. Except as noted, the steel supplied for this order was melted, rolled, and processed in the United States meeting DFARS compliance, LEEDS compliance, REACH compliance, ROHS-WEEE compliance, and Conflict Materials Restrictions.
2. Mercury was not used during the manufacture of this product, nor was the steel contaminated with mercury during processing.
3. Unless directed by the customer, there are no welds in any of the coils produced for this order.
4. The laboratory that generated the analytical or test results can be identified by the following key:

Certificate Number	Lab Code	Laboratory		Address
0358-01	7388	**CSSM**	Charter Steel Melting Division	1658 Cold Springs Road, Saukville, WI 53080
0358-02	8171	**CSSR/ CSSP**	Charter Steel Rolling/ Processing Division	1658 Cold Springs Road, Saukville, WI 53080
0358-03	123633	**CSFP**	Charter Steel Ohio Processing Division	6255 US Highway 23, Rising Sun, OH 43457
0358-04	125544	**CSCM/ CSCR**	Charter Steel Cleveland	4300 E. 49th St., Cuyahoga Heights, OH 44125-1004
*	*	--	Subcontracted test performed by laboratory not in Charter Steel System	

5. When run by a Charter Steel laboratory, the following tests were performed according to the latest revisions of the specifications listed below, as noted in the Charter Steel Laboratory Quality Manual:

Test	Specifications	CSSM	CSSR/ CSSP	CSFP	CSCM/ CSCR
Chemistry Analysis	ASTM E415; ASTM E1019	X			X
Macroetch	ASTM E381	X			X
Hardenability (Jominy)	ASTM A255; SAE J406; JIS G0561	X			X
Grain Size	ASTM E112	X	X	X	X
Tensile Test	ASTM E8; ASTM A370		X	X	X
Rockwelll Hardness	ASTM E18; ASTM A370	X	X	X	X
Microstructure (spheroidization)	ASTM A892		X	X	
Inclusion Content (Methods A, E)	ASTM E45		X		X
Decarburization	ASTM E1077		X	X	X

Charter Steel has been accredited to perform all of the above tests by the American Association for Laboratory Accreditation (A2LA). These accreditations expire 01/31/19. All other test results associated with a Charter Steel laboratory that appear on the front of this report, if any, were performed according to documented procedures developed by Charter Steel and are not accredited by A2LA.

6. The test results on the front of this report are the true values measured on the samples taken from the production lot. They do not apply to any other sample.
7. This test report cannot be reproduced or distributed except in full without the written permission of Charter Steel. The primary customer whose name and address appear on the front of this form may reproduce this test report subject to the following restrictions:
   - It may be distributed only to their customers
   - Both sides of all pages must be reproduced in full
8. This certification is given subject to the terms and conditions of sale provided in Charter Steel's acknowledgement (designated by our Sales Order number) to the customer's purchase order. Both order numbers appear on the front page of this Report.
9. Where the customer has provided a specification, the results on the front of this test report conform to that specification unless otherwise noted on this test report.

A2LA ACCREDITED
Testing Laboratory

HANGZHOU SPRING WASHER CO.,LTD

QUALITY TEST CERTIFICATE OF SPRING LOCK WASHER

Standard: ASME B 18.21.1-2009 Contract No.: 14HZW11585/12650

Order No.: PO U23775 Invoice No.: 15SHD052

Chemical Composition (%)	C	Si	Mn	P	S	Cr	Ni	Cu
	0.65	0.2	0.55	0.01	0.004	0.02	0.02	0.03
Material Type.	65#			Heat No.		T490009102		
Specification	REGULAR HELICAL LOCK WASHER 3/4" HDG							
Quantity	162 M			COUNTRY OF ORIGIN:CHINA				
Lot No.	1412295							
Part No.	350006							

Testing Item	Ac/n	Norm	Result	Reject	Norm	Result	Reject
Inside Diameter	2/100	19.33-19.86	19.6-19.86	0			
Outside Diameter	1/32	Max32.93	Max32.27	0			
Width	1/32	Min6.04	Min6.04	0			
Thickness	1/32	4.88-5.33	5.18-5.31	0			
Height							
Section							
Surface Defects	2/100	None	None	0			
Hardness	0/8	HRC38-46	HRC44-45	0			
Springing							
Toughness	0/8	Qualified	Qualified	0			
Zinc Coating	0/8	Min53um	Min61.6um	0			

Zinc Coating Standard of:

Customer Name: BRIGHTON BEST INTERNATIONAL (TAIWAN) INC.

General: The spring lock washers are conformed with the standard of ASME B 18.21.1-2009. QUALIFIED.

Inspector: Shiweiqing Quality Inspection Chief: Date 2015.02.28

MILL TEST REPORT
Lot#: 5106740003 Part#: 313200

BRIGHTON-BEST INTERNATIONAL INC.
www.BrightonBest.com

This MTR contains 1 pages (Page: 1)

Certified Material Test Report to BS EN 10204-2004 3.1

FOR ASME SA194/ ASTM A194-14 GRADE 2H HVY HEX NUTS

FACTORY: NINGBO HAIXIN HARDWARE CO.,LTD.
ADDRESS: XIJINGTANG,LUOTUO NINGBO ZHEJIANG 315205 CHINA

DATE: APR.30.2016
COUNTRY OF ORIGIN: CHINA
MFG LOT NUMBER: 5106740003
PO NUMBER: MILL
PART NO: 313200
MANUFACTURER DATE:2016/3/28

CUSTOMER: BRIGHTON-BEST INTERNATIONAL (TAIWAN) INC
QNTY SHIPPED: 153.000MPCS
SAMPLE SIZE : ACC. TO ASME B18 . 18 . 1 - 11
SIZE & DESCRIPTION 3/4-10+0.020"(HDG)
FINISH:H. T. HOT DIP GAL PER ASTM A153-09/ASTM F2329-13

STEEL PROPERTIES:
STEEL GRADE: SWRCH45K SIZE: 30mm HEAT NO: 331508880
CHEMISTRY COMPOSITION:

CHEMIST	C %	Mn %	P %	S %	Si %	Cr %	Ni %	Cu %	Mo %	OTHERS
SPE:	MIN	MAX	MAX	MAX	MAX					
	0.40	1.00	0.04	0.05	0.40					
TEST:	0.44	0.7	0.012	0.003	0.18					

DIMENSIONAL INSPECTIONS SPECIFICATION: ASME/ANSI B18 . 2 . 2 - 2010

CHARACTERISTICS	TEST METHOD	SPECIFIED	ACTUAL RESULT	ACC.	REJ.
APPEARANCE	ASTM F812-12		PASSED	100	0
WIDTH A/F	1.212"-1.250"		1.232"-1.249"	32	0
WIDTH A/C	1.382"-1.443"		1.392"-1.434"	32	0
THREAD	ASME B1.1-03		PASSED	8	0
HEIGHT	0.710"-0.758"		0.735"-0.752"	32	0
MARK	2HZN LM		PASSED	100	0
HDG THICKNISS	ASTM A153-09/ASTM F2329-13 min:43um		70UM-82UM	20	0

MECHANICAL PROPERTIES: TO 1-1/2" in SPECIFICATION: ASME SA194/ ASTM A194-14

CHARACTERISTICS	TEST METHOD	SPECIFIED	ACTUAL RESULT	ACC.	REJ.
HARDNESS	ASTM E18-12	24-35HRC	HRC29-30	5	0
PROOF LOAD	ASTM F606-11	MIN58450LBF	58450LBF	5	0
HARDNESS AFTER 24H AT 540°C ASTM A194 MIN 89 HRB			HRB 96-98	5	0
TEMPERING TEMPERATURE Min455°C			PASSED(520°C)		
MACROETCH	ASTM E381-12	S1/R1/C1~S4/R4/C4	S2/R2/C2	5	0

PARTS ARE MANUFACTURED AND TESTED IN ACCORDANCE WITH ASME SA194/ ASTM A194-14 ALL TESTS IN ACCORDANCE WITH THE METHODS PRESCRIBED SPECIFICATION. WE CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIAL SUPPLIER AND OUR TESTING LABORATORY.

All parts meet the requirements of FQA and records of compliance are on file.

Maker's ISO#00109Q211593R0M/3302

(SIGNATURE OF QA/QC MGR.)
(NAME OF MANUFACTURER)

madden

Certificate of Compliance

CUSTOMER: CUSTOM FAB
CUSTOMER PO #: QUADTEX 21486
MADDEN BOLT SO#: 103681

BOLTS: F1554 GR 105
HEX NUTS: A194
FLAT WASHER: F436
LOCK WASHER:
COATING: A153
TEMPLATE:
OTHER:

NOTES:

Madden Bolt certifies that the above material is in compliance with the chemical and physical requirements of the ASTM or AISI specifications.

Thank you,

Authorized Signature: James Dagen

Date: April 11, 2018

13420 Hempstead HWY ● Houston, TX 77040 ● PH (713) 939-9999 ● FAX (713) 9397200

WWW.MADDENBOLT.COM

madden

April 11, 2018
Madden Bolt Corporation
13420 Hempstead Hwy.
Houston, TX 77040

RE: Galvanization Certificate of Compliance

To Whom It May Concern:

We certify that our Hot Dip process meets the requirements of ASTM A153 Specification on the following order.

CUSTOMER: CUSTOM FAB.

SALES ORDER: 103681 **PURCHASE ORDER:** QUADTEX 21486

Approved By: _____

Roger Trejo

13420 Hempstead HWY ● Houston, TX 77040 ● PH (713) 939-9999 ● FAX (713) 9397200

WWW.MADDENBOLT.COM

Vulcan
THREADED PRODUCTS, INC.

Vulcan Threaded Products
10 Cross Creek Trail
Pelham, AL 35124
Tel (205) 620-5100
Fax (205) 620-5150

JOB MATERIAL CERTIFICATION

Job No: 567407 **Job Information** **Certified Date:** 3/22/18

Containers: S13658914

Customer: Madden Bolt Corp

Ship To: 13420 Hempstead Hwy
Houston, TX 77040

Vulcan Part No: HRB B7 1.152x290 GR105

Customer Part No: HRB B7 1.152x290 GR105

Customer PO No: PE57890

Shipped Qty: 4456 lbs

Order No: 341568

Line No: 3

Note:

Applicable Specifications

Type	Specification	Rev	Amend	Option
-	ASTM F1554 Gd 105 S4	2015		
Heat Treat	ASME SA-193/SA-193M B7	2013		
	ASTM A193 B7	2016		
Quality	EN 10204 3.1	2004		

Test Results

See following pages for tests

Certified Chemical Analysis

Heat No: A181012 Lot: 1.152 Origin: USA

C	Mn	P	S	Si	Cr	Mo	Ni	V	Cu	Al
0.400	0.77	0.012	0.022	0.28	0.90	0.16	0.13	0.003	0.21	0.025
Sn	Ti	N	B	Ca	As	Sb	H, ppm	DI	RR	G.S.
0.009	0.001	0.0072	0.0002	0.0007	0.005	0.003	1.4	4.50	139.3:1	8
Macro S	Macro R	Macro C	J1	J2	J3	J4	J5	J6	J7	J8
1	1	2	56	56	56	56	56	53	52	50
J9	J10	J12	J14	J16	J18	J20	J24	J28	J32	
49	47	44	42	40	38	37	36	33	32	

Notes

Material was manufactured, tested and inspected in accordance with Vulcan Threaded Products Inc. Quality Assurance Program and Manual Rev. A, dated 8/23/11. Processed material is Quenched and Tempered - Stress Free. No weld repair performed on the material. No Mercury used in the production of this material. Melted and Manufactured in the USA.
Document is in accordance with EN 10204 - 3.1B of 2004 (3.1).

Plex 3/22/18 2:13 PM vulc.mgri Page 1 of 2

PE57890 3
A181012
Vulcan
1.152K24 B7

REVIEWED 4/10/18

Vulcan Threaded Products
10 Cross Creek Trail
Pelham, AL 35124
Tel (205) 620-5100
Fax (205) 620-5150

JOB MATERIAL CERTIFICATION

Job No: 567407 **Job Information** **Certified Date:** 3/22/18

Containers: S13658914

Test Results

Part No: HRB B7 1.152x290 GR105

Test No: 47488 Test: Quench & Temper Information (Lbs)

Description	Austenitizing Temp (F)	Tempering Temp (F)	Run Speed (Ft/min)	Quench Water Temp (F)	Note
	1,712	1,326	19.5	89	

Test No: 47491 Test: F1554-105 FB Requirements

Description	Tensile (ksi) (ksi)	Yield 0.2% Offset (ksi) (ksi)	Elongation (%)	Elongation Gage Length (8in)	ROA (%)	Note
	131	118	17	8in	61	

Test No: 47489 Test: A193 B7, F1554-105 Requirements

Description	Tensile (ksi)	Yield 0.2% Offset (ksi)	Elongation (%)	Elongation Gage Length	ROA (%)	Midradius Hardness	Surface Hardness	Center Hardness	Hardness Test Type	Note
	134	119	22	4D	64	29	28		HRC	
	135	119	21	4D	66	28	27		HRC	
	134	119	21	4D	65	28	27		HRC	
	135	121	21	4D	63	29	28		HRC	

Test No: 47490 Test: F1554-15 gd105 S4 Charpy ft/lbs Requirements

Description	Container	Test Temp (F)	Test1 (ft/lbs)	Test2 (ft/lbs)	Test3 (ft/lbs)	Results Avg (ft/lbs)	Note
		-20	95	95	93	94	

Griffin, Mitchell - Certification Engineer 3/22/18 Date

Plex 3/22/18 2:13 PM vulc.mgri Page 2 of 2

Purchaser:	BRIGHTON-BEST INTERNATIONAL (TAIWAN),INC.	**Date:**	2017-5-16
P.O.NO:	PO B17020241/U42733	**ISO NO:**	15/17Q5611R30
INV NO:	217ZL046L	**Expire:**	14-Sep-18
Manufacturer:	ZHEJIANG GUORUI CO.,LTD.		
Address:	No.283 Chengxi North Road,Wuyuan Town,Haiyan Zhejiang,P.R.China		
Commodity:	F436 HARD ROUND STRUCTURAL FLAT WASHER WITH MFG'S I.D.&F436 ON FACE	**CUSTOMER PART NO.:**	355120
Size:	1-1/8 X 2-1/4	**MANUFACTURING DATE:**	2017.3.15
Lot NO.:	217L0321-19	**HEAT NO.:**	H17000150
Ship quantity:	43.200 MPCS	**MATERIAL:**	45# CARBON STEEL
Finish:	PLN		

DIMENSIONAL INSPECTION ACCORDING TO: ASTM F436-11

INSPECTION ITEM	SAMPLE SIZE	SPECIFIED	ACTUAL RESULT	ACCEPT	REJECT
Appearance	100	ASTM F436-11	OK	100	0
Marking	100	F436 AND JLX	OK	100	0
Outside Dia	8	2.313-2.187	2.200-2.199	8	0
Inside Dia	8	1.251-1.188	1.238-1.236	8	0
Thickness	8	0.177-0.136	0.142-0.140	8	0

CHEMICAL COMPOSITION ACCORDING TO : ASTM F436-11

CHEMICAL ELEMENT (%)	C	Mn	P	S	Si	Cr	Mo	Ni	Al	Ti	V
SPECIFIED			0.040 MAX	0.050 MAX							
TEST RESULT	0.46	0.59	0.019	0.004	0.22	0.044	0.003	0.015			

MECHANICAL PROPERTIES ACCORDING TO : ASTM F436-11

TEST ITEM	SAMPLE SIZE	SPECIFIED	ACTUAL RESULT	ACCEPT	REJECT
HARDNESS(HR C)	8	38-45	40-42	8	0

WE CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIAL SUPPLIER AND OUR TESTING LABORATORY

Madden Bolt Receiving
PO #: PE57759 LN #: 6
Heat #: H17000150
Lot #: 217L0321-19
Supplier: BRIGHTON BEST
Size: 1 1/8 Grade: F436

SIGNATURE: HEMING TITLE: QC MANAGER

REVIEWED 2/14/18

MILL TEST REPORT
Lot#: 5105830005 Part#: 313370

BRIGHTON-BEST INTERNATIONAL INC.
www.BrightonBest.com

This MTR contains 1 pages (Page: 1)

Certified Material Test Report to BS EN 10204-2004 3.1
FOR ASME SA194/ ASTM A194-14 GRADE 2H HVY HEX NUTS

FACTORY NINGBO HAIXIN HARDWARE CO.,LTD. DATE: MAR.10.2016
ADDRESS XIJINGTANG,LUOTUO NINGBO ZHEJIANG 315205 CHINA COUNTRY OF ORIGIN: CHINA
MFG LOT NUMBER: 5105830005
CUSTOME BRIGHTON-BEST INTERNATIONAL (TAIWAN) INC PO NUMBER: MILL
QNTY SHIPPED: 2,160MPCS PART NO: 313370
SAMPLE SIZE : ACC. TO ASME B18 . 18 . 1 - 11 MANUFACTURER DATE: 2016/2/25
SIZE & DESCRIPTION 1.1/8-7+0.024"(HDG)
FINISH:H.T.HOT DIP GAL PER ASTM A153-09/ASTM F2329-13

STEEL PROPERTIES:
STEEL GRADE: 45# SIZE: 32mm HEAT NO: C5090582
CHEMISTRY COMPOSITION:

CHEMIST	C %	Mn %	P %	S %	Si %	Cr %	Ni %	Cu %	Mo %	OTHERS
SPE:	MIN 0.40	MAX 1.00	MAX 0.04	MAX 0.05	MAX 0.40					
TEST:	0.45	0.58	0.017	0.007	0.24					

DIMENSIONAL INSPECTIONS SPECIFICATION: ASME/ANSI B18 . 2 . 2 - 2010

CHARACTERISTICS	TEST METHOD	SPECIFIED	ACTUAL RESULT	ACC.	REJ.
APPEARANCE	ASTM F812-12		PASSED	100	0
WIDTH A/F	1.756"-1.812"		1.763"-1.779"	32	0
WIDTH A/C	2.002"-2.093"		2.012"-2.075"	32	0
THREAD	ASME B1.1-03		PASSED	8	0
HEIGHT	1.079"-1.139"		1.089"-1.129"	32	0
MARK	2HZN LM		PASSED	100	0
HDG THICKNISS	ASTM A153-09/ASTM F2329-13 min:43um		58UM-66UM	20	0

MECHANICAL PROPERTIES: TO 1-1/2" in SPECIFICATION: ASTM/ASME A194/SA194-14

CHARACTERISTICS	TEST METHOD	SPECIFIED	ACTUAL RESULT	ACC.	REJ.
HARDNESS	ASTM E18-12	24-35HRC	HRC29-30	5	0
PROOF LOAD	ASTM F606-11	MIN133525LBF	133525LBF	5	0
HARDNESS AFTER 24H AT 540°C ASTM A194 MIN 89 HRB			HRB 92-93	5	0
TEMPERING TEMPERATURE Min455°C			PASSED(520°C)		
MACROETCH	ASTM E381-12	S1/R1/C1~S4/R4/C	S2/R2/C2	5	0

PARTS ARE MANUFACTURED AND TESTED IN ACCORDANCE WITH ASTM/ASME A194/SA194-14
ALL TESTS IN ACCORDANCE WITH THE METHODS PRESCRIBED SPECIFICATION. WE CERTIFY
THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIAL
SUPPLIER AND OUR TESTING LABORATORY.

All parts meet the requirements of FQA and records of compliance are on file.

Maker's ISO#00109Q211593R0M/3302

Brighton Best Receiving #N
PO #: PE57791 Line #: 2
Heat #: C5090582
Lot #: 5105830005
Supplier: BRIGHTON Best
Size: 1 1/8 Grade: A194-2H

(SIGNATURE OF STANDARD MGR.)
(NAME OF MANUFACTURER)

REVIEWED
2/20/18

CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

We hereby certify that the test results presented here are accurate and conform to the reported grade specification

TOMMY HEWITT
Quality Assurance Manager

1SERIES-BPS ®

HEAT NO.:3077684 SECTION: ROUND 1.150 x 20'0" A36/52950 GRADE: ASTM A36-14/A529-14 Gr 50 ROLL DATE: 02/15/2018 MELT DATE: 02/08/2018 Cert. No.: 82330672 / 077684A738	SOLD TO	Madden Bolt Corp 13420 Hempstead Rd Houston TX US 77040-5813 7139399999 7139397200	SHIP	Madden Bolt Corp 13420 Hempstead Rd Houston TX US 77040-5813 7139399999 7139397200	Delivery#: 82330672 BOL#: 72394800 CUST PO#: PE57851 CUST P/N: DLVRY LBS / HEAT: 4450.000 LB DLVRY PCS / HEAT: 63 EA

Characteristic	Value
C	0.18%
Mn	0.82%
P	0.009%
S	0.024%
Si	0.18%
Cu	0.26%
Cr	0.09%
Ni	0.08%
Mo	0.024%
V	0.015%
Cb	0.002%
Sn	0.009%
Al	0.002%
Carbon Eq F1554	0.33%
Carbon Eq A529	0.40%
Yield Strength test 1	53.9ksi
Tensile Strength test 1	77.9ksi
Elongation test 1	25%
Elongation Gage Lgth test 1	8IN

Characteristic	Value
Reduction of Area test 1	56%
Yield to tensile ratio test1	0.69
Yield Strength test 2	53.6ksi
Tensile Strength test 2	77.5ksi
Elongation test 2	47%
Elongation Gage Lgth test 2	2IN
Reduction of Area test 2	53%
Yield to tensile ratio test2	0.69

PE57851 5
3077684
CMC
1.150x20 A36

The Following is true of the material represented by this MTR:

*Material is fully killed
*100% melted and rolled in the USA
*EN10204:2004 3.1 compliant
*Contains no weld repair
*Contains no Mercury contamination
*Manufactured in accordance with the latest version of the plant quality manual
*Meets the "Buy America" requirements of 23 CFR635.410

REMARKS :
ALSO MEETS ASTM GRADE A36, A529-50, A572-50, A709-36, A709-50, A992, AASHTO M270-36, M270-50, CSA G40.21-04 44W, 50W

03/07/2018 22:59:36
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3/9/18

TR No. 609591-03

103

2018-09-27

MAQUILACERO

MAQUILACERO, S.A. DE C.V.
Av. Adolfo López Mateos 1220, Col. Margarita Rdz Salazar, San Nicolas de Los Garza, N.L.
Codigo Postal / Postal Code: 66479 Telefono / Phone number: +52(81)8158-0300
www.maquilacero.com

CERTIFICADO DE CALIDAD - MILL TEST CERTIFICATE

Fecha de emision / (Date of invoice)
(DMA) 26-08-2017 14:47
No. / (Document number)

Codigo de cliente / (Customer ID)	Cliente / (Customer)	Factura / (Invoice Num.)
CME0025	TRIPLE-S STEEL SUPPLY	FAC/ 65261
Direccion / (Address)		Pedido / (Sales Order)
6000 JENSEN DRIVE HOUSTON TX 77026 95-713-697-7105 Estados		700004977
Destinatario / (Consignated to)		Orden de compra / (Purchase Order)
TRIPLE-S STEEL SUPPLY 8411 IRVINGTON HOUSTON TX 77022 Estados Unidos		HOU-177126

Datos generales / (General Data)

Part (Item)	Descripcion / (Description)	Cantidad Quantity	UND	No. Lote (Lot Number)	Colada (Heat)	ASTM	Composicion quimica (Chemical composition)				Prueba de tension (Tensile test)			
							C	Mn	P	S	Cedencia (Yield strength) ksi	Resistencia a la Tension (Tensile Strength) ksi	%Elong.	Dureza (Rockwell B Hardness)
PRE1501500740N	PTR1.50x1.50,C-3/16,40' WELDEN SQUARE TUBING NON ALLOY" STEEL 1.5"" X 1.5"" 3/16 GA 4	14.4000	CFT		1730631	A-500 GRADE B & C	0.083	0.390	0.007	0.002	60.0000	64.0000	24.0000	75.0000
PRE40030031240N	PTR4x3C-5/16 ,40' WELDED SQUARE TUBING NON ALLOY STEEL 4" X 3" 5/16 GA, 40'	6.4000	CFT	PT1222	1711482	A-500 GRADE B & C	0.082	0.420	0.018	0.002	70.0000	79.0000	25.0000	74.0000

Certificamos que el material descrito satisface las especificaciones requeridas. La composicion quimica son transcripcion de los certificados del Proveedor de acero.
We certify that the above described material satisfies the required specifications. The chemical composition is transcription from the mill test certificate. of the steel supplier.
NOTE: NINGUN PRODUCTO HA SIDO PROBADO HIDROSTATICAMENTE. NONE OF THIS PRODUCTS HAVE BEEN HYDROSTATICALLY TESTED. NO WELD REPAIR WAS MADE IN ALL THIS ITEMS.

Firma / (Signature)
Calidad / (Quality)

MAQUILACERO, S. A. DE C. V.
AV. ADOLFO LOPEZ MATEOS No. 1220
R.F.C. MAQ-860203-MX5

Independence Tube
a Nucor Company

6226 W. 74th St.
Chicago, IL 60638
708-496-0380
Fax: 708-563-1950

www.independencetube.com
itctube.com
Certificate Number: CHI 743245

Sold By:
INDEPENDENCE TUBE CORPORATION
6226 W. 74th St.
Chicago, IL 60638
Tel: 708-496-0380
Fax: 708-563-1950

Purchase Order No: 7253396
Sales Order No: CHI 280303 - 13
Bill of Lading No: CHI 167448 - 3
Invoice No:

Shipped: 3/20/2018
Invoiced:

Sold To:
1430 - KLOECKNER METALS CORPORATION
500 COLONIAL PARKWAY
SUITE 500
ROSWELL, GA 30076

Ship To:
4 - KLOECKNER METALS-NORTH
14806 W RIDGE LANE
563-583-7329
DUBUQUE, IA 52003

CERTIFICATE of ANALYSIS and TESTS

Customer Part No:

TUBING A500 GRADE B(C)
5" X 4" X 3/8" X 30'

Certificate No: CHI 743245
Test Date: 3/19/2018

Total Pieces	Total Weight
4	2,378

Bundle Tag	Mill	Heat	Specs	Y/T Ratio	Pieces	Weight
4680	4N	281552	YLD=67405/TEN=73366/ELG=27.66	0.9187	4	2,378

Mill #: 4N Heat #: 281552 Carbon Eq: 0.3098 Heat Src Origin: MELTED AND MANUFACTURED IN THE USA

C	Mn	P	S	Si	Al	Cu	Cr	Mo	V	Ni	Nb	Cb
0.2000	0.5300	0.0090	0.0050	0.0200	0.0370	0.0940	0.0460	0.0150	0.0020	0.0390	0.0020	0.0020

Sn	N	B	Ti	Sb	O	H
0.0040	0.0070	0.0000	0.0030	0.0010	0.0000	0.0000

LEED Information (based on the most recent LEED information from the producing mill)

Method	Location	Recycled Content	Post Consumer	Post Industrial
EAF	Crawfordsville, IN	81.1%	28.2%	52.9%

Certification:

I certify that the above results are a true and correct copy of records prepared and maintained by Independence Tube Corporation. Sworn this day, 3/19/2018

WE PROUDLY MANUFACTURE ALL OUR PRODUCT IN THE USA.
INDEPENDENCE TUBE PRODUCT IS MANUFACTURED, TESTED,
AND INSPECTED IN ACCORDANCE WITH ASTM STANDARDS.
MATERIAL IDENTIFIED AS A500 GRADE B(C) MEETS BOTH
ASTM A500 GRADE B AND A500 GRADE C SPECIFICATIONS.

Chris Allen, ASQ CMQ/OE
Quality Systems Supervisor

CURRENT STANDARDS:
A252-10
A500/A500M-13
A513-13
ASTM A53/A53M-12 | ASME SA-53/SA-53M-13
A847/A847M-14
A1085/A1085M-15

Vulcan Threaded Products
10 Cross Creek Trail
Pelham, AL 35124
Tel (205) 620-5100
Fax (205) 620-5150

Material Certification

Customer:	**Triple-S Steel**
Ship To:	**Houston**
Customer PO No:	**HOU-178081**
Vulcan Order No:	**332140**
Order Line:	**7**
Shipped Qty:	**4228**
Vulcan Part No:	**CDR 1018 .375x240 DOM**
Customer Part No:	**CDR 1018 .375x240 DOM**
Customer Part Description:	
Reference No:	
Country of Origin:	**USA**
Rolled Mill:	**Gerdau Ameristeel - Beaumont, TX**
Melted Mill:	**Gerdau Ameristeel - Beaumont, TX**
Grade:	**1018**
Heat:	**53147048/03**
Note:	**7/16**
Spec No:	**AISI 1018**
Spec Note:	
Spec No:	**ASTM A108-13**
Spec Note:	

Material Specification Type	Material Specification	Actual
Chemistry	Carbon (C)	0.1640 %
	Manganese (Mn)	0.62 %
	Phosphorus (P)	0.011 %
	Sulfur (S)	0.014 %
	Silicon (Si)	0.22 %
	Copper (Cu)	0.20 %
	Nickel (Ni)	0.08 %
	Chromium (Cr)	0.10 %
	Molybdenum (Mo)	0.019 %
	Tin (Sn)	0.008 %
	Nitrogen (N)	0.0095 %

This document certifies that the foregoing data is furnished by the producing mill and test lab.
No mercury, lead, radium, of alpha containing material or equipment is used or deliberately added in the production of this steel. No weld or weld repairs were performed on this material.

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APPENIDX C. *MASH* TEST 5-11 (CRASH TEST NO. 609591-03-1)

C1 VEHICLE PROPERTIES AND INFORMATION

Table C.1. Vehicle Properties for Test No. 609591-03-1.

Date:	2018-06-28	Test No.:	609591-03-1	VIN No.:	1C6RR6FT1DS712245
Year:	2013	Make:	RAM	Model:	1500
Tire Size:	265/70 R 17			Tire Inflation Pressure:	35 PSI
Tread Type:	HIGHWAY			Odometer:	236392

Note any damage to the vehicle prior to test: NONE

• Denotes accelerometer location.

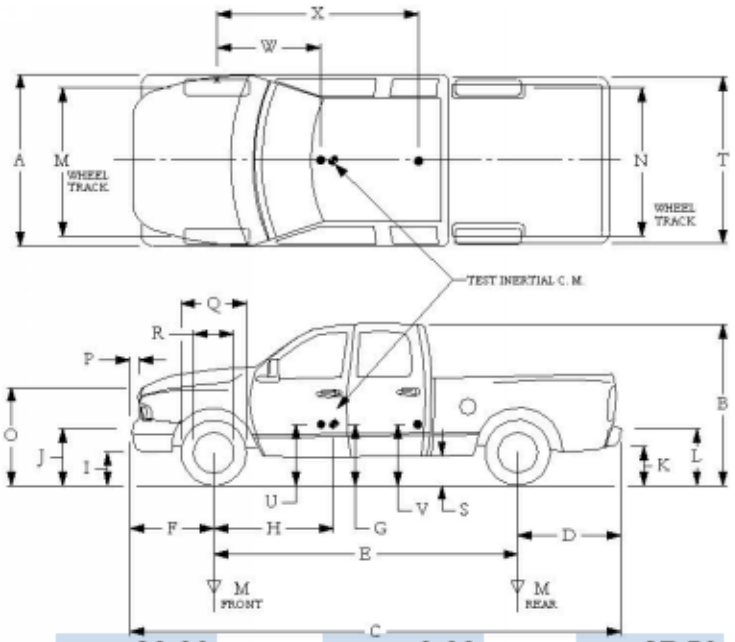
NOTES:

Engine Type: V-8
Engine CID: 4.7 L

Transmission Type:
☑ Auto or ☐ Manual
☐ FWD ☑ RWD ☐ 4WD

Optional Equipment:
NONE

Dummy Data:
Type: 50 PERCENTILE
Mass: 165 LBS
Seat Position: IMPACT SIDE



Geometry: inches

A	78.50	F	40.00	K	20.00	P	3.00	U	27.50		
B	74.00	G	29.00	L	30.00	Q	30.50	V	30.50		
C	227.50	H	60.98	M	68.50	R	18.00	W	60.98		
D	44.00	I	11.75	N	68.00	S	13.00	X	77.00		
E	140.50	J	27.00	O	46.00	T	77.00				

Wheel Center Height Front	14.75	Wheel Well Clearance (Front)	6.00	Bottom Frame Height - Front	12.00
Wheel Center Height Rear	14.75	Wheel Well Clearance (Rear)	9.25	Bottom Frame Height - Rear	25.50

RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; M+N/2=67 ±1.5 inches

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	3700	M_{front}	2908	2832	2917
Back	3900	M_{rear}	2044	2172	2252
Total	6700	M_{Total}	4952	5004	5169

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

Mass Distribution:

lb	LF:	RF:	LR:	RR:
	1400	1432	1085	1087

Table C.2. Measurements of Vehicle Vertical CG for Test No. 609591-03-1.

Date:	2018-06-28	Test No.:	609591-03-1	VIN:	1C6RR6FT1DS712245
Year:	2013	Make:	RAM	Model:	1500
Body Style:	QUAD CAB			Mileage:	236392
Engine:	4.7L V-8			Transmission:	AUTO
Fuel Level:	EMPTY	Ballast:	114 LBS		(440 lb max)
Tire Pressure: Front:	35 psi	Rear:	35 psi	Size:	265/70 R 17

Measured Vehicle Weights: (lb)

LF:	1400	RF:	1432	Front Axle:	2832
LR:	1085	RR:	1087	Rear Axle:	2172
Left:	2485	Right:	2519	Total:	5004
					5000 ±110 lb allowed

Wheel Base:	140.50	inches	Track: F:	68.50	inches	R:	68.00 inches
148 ±12 inches allowed			Track = (F+R)/2 = 67 ±1.5 inches allowed				

Center of Gravity, SAE J874 Suspension Method

X:	61.00 inches	Rear of Front Axle	(63 ±4 inches allowed)	
Y:	0.24 inches	Left -	Right +	of Vehicle Centerline
Z:	29.00 inches	Above Ground	(minumum 28.0 inches allowed)	

Hood Height:	46.00 inches	Front Bumper Height:	27.00 inches
	43 ±4 inches allowed		
Front Overhang:	40.00 inches	Rear Bumper Height:	30.00 inches
	39 ±3 inches allowed		
Overall Length:	227.50 inches		
	237 ±13 inches allowed		

Table C.3. Exterior Crush Measurements for Test No. 609591-03-1.

Date:	2018-06-28	Test No.:	609591-03-1	VIN No.:	1C6RR6FT1DS712245
Year:	2013	Make:	RAM	Model:	1500

VEHICLE CRUSH MEASUREMENT SHEET[1]

Complete When Applicable	
End Damage	Side Damage
Undeformed end width	Bowing: B1 X1
Corner shift: A1	B2 X2
A2	
End shift at frame (CDC)	Bowing constant
(check one)	$\frac{X1+X2}{2}$ =
< 4 inches	
≥ 4 inches	

Note: Measure C_1 to C_6 from Driver to Passenger Side in Front or Rear impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage		Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
		Width** (CDC)	Max*** Crush								
1	AT FT BUMPER	24	10	36	1	3	5	6	8	10	+18
2	ABOVE FT BUMPER	24	11	48	1	3	5	7	8	11	+76
	inches										

[1]Table taken from National Accident Sampling System (NASS).

*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

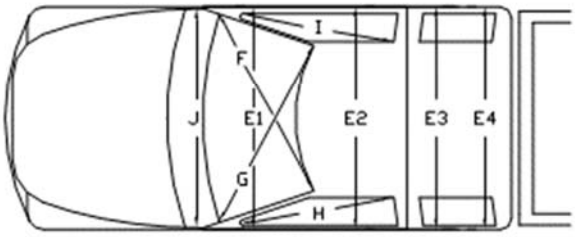
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

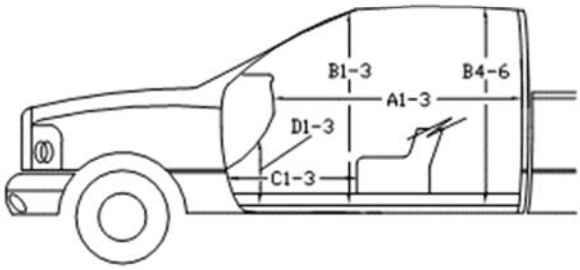
***Measure and document on the vehicle diagram the location of the maximum crush.

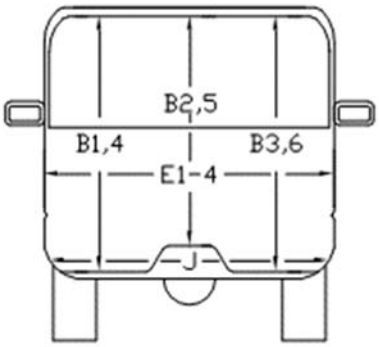
Note: Use as many lines/columns as necessary to describe each damage profile.

Table C.4. Occupant Compartment Measurements for Test No. 609591-03-1.

Date:	2018-06-28	Test No.:	609591-03-1	VIN No.:	1C6RR6FT1DS712245
Year:	2013	Make:	RAM	Model:	1500







*Lateral area across the cab from driver's side kickpanel to passenger's side kickpanel.

OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	65.00	65.00	0.00
A2	63.00	63.00	0.00
A3	65.50	64.00	-1.50
B1	45.00	45.00	0.00
B2	38.00	36.50	-1.50
B3	45.00	42.00	-3.00
B4	39.50	39.50	0.00
B5	43.00	43.00	0.00
B6	39.50	39.50	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	23.00	-3.00
D1	11.00	11.00	0.00
D2	0.00	0.00	0.00
D3	11.50	9.50	-2.00
E1	58.50	57.50	-1.00
E2	63.50	65.00	1.50
E3	63.50	63.50	0.00
E4	63.50	63.50	0.00
F	59.00	57.00	-2.00
G	59.00	59.00	0.00
H	37.50	37.50	0.00
I	37.50	36.50	-1.00
J*	25.00	22.00	-3.00

C2 SEQUENTIAL PHOTOGRAPHS

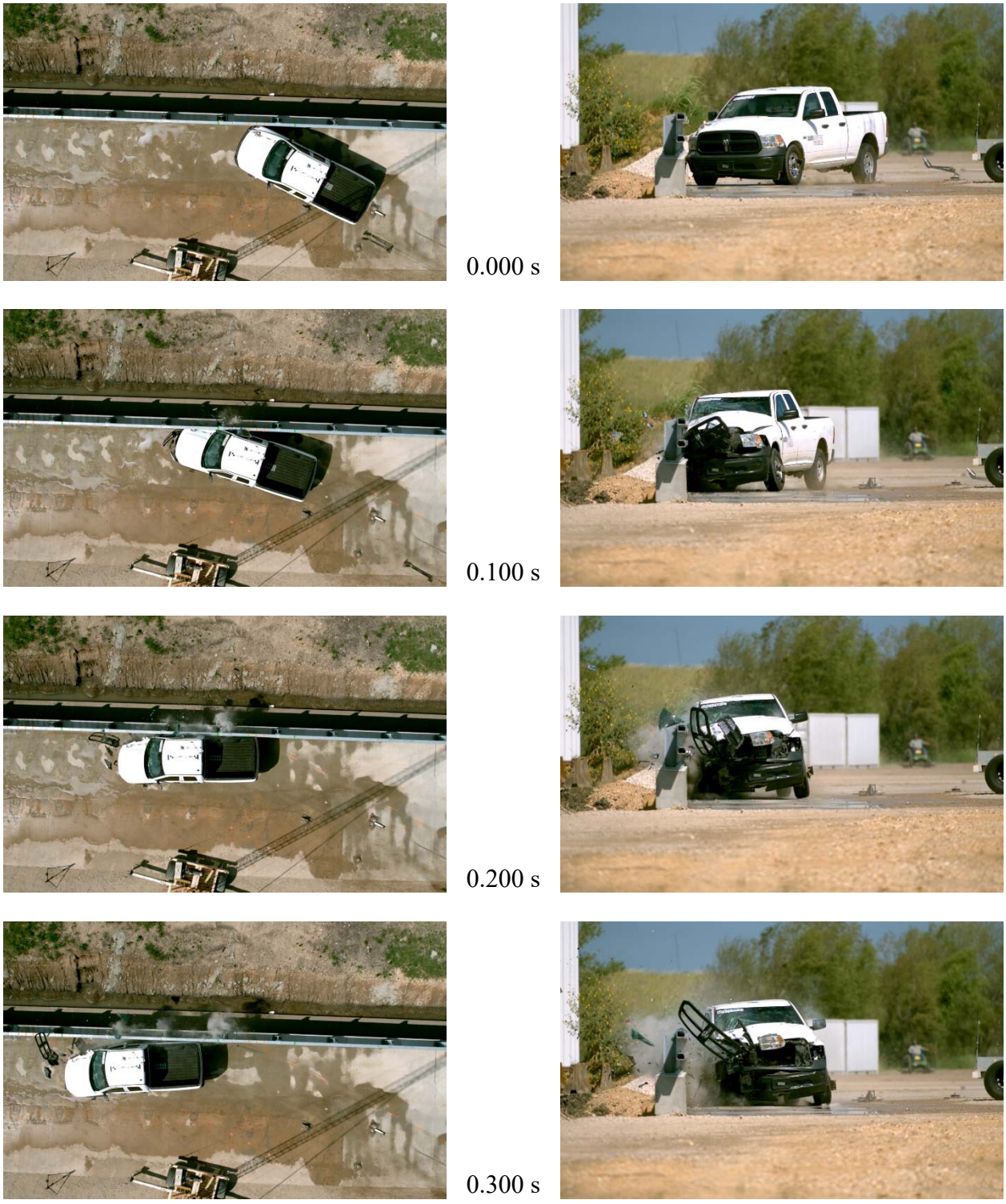
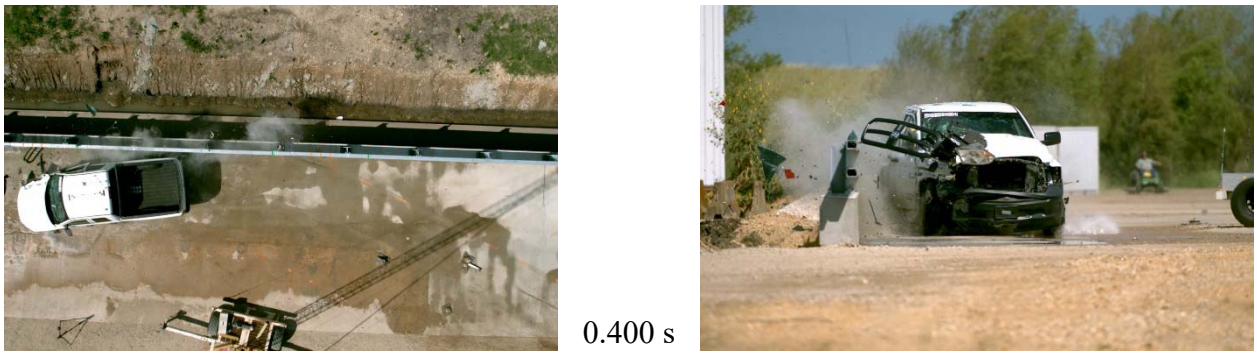


Figure C.1. Sequential Photographs for Test No. 609591-03-1 (Overhead and Gut Views).


0.400 s


0.500 s


0.600 s


0.700 s

Figure C.1. Sequential Photographs for Test No. 609591-03-1 (Overhead and Gut Views) (Continued).

0.000 s

0.100 s

0.200 s

0.300 s

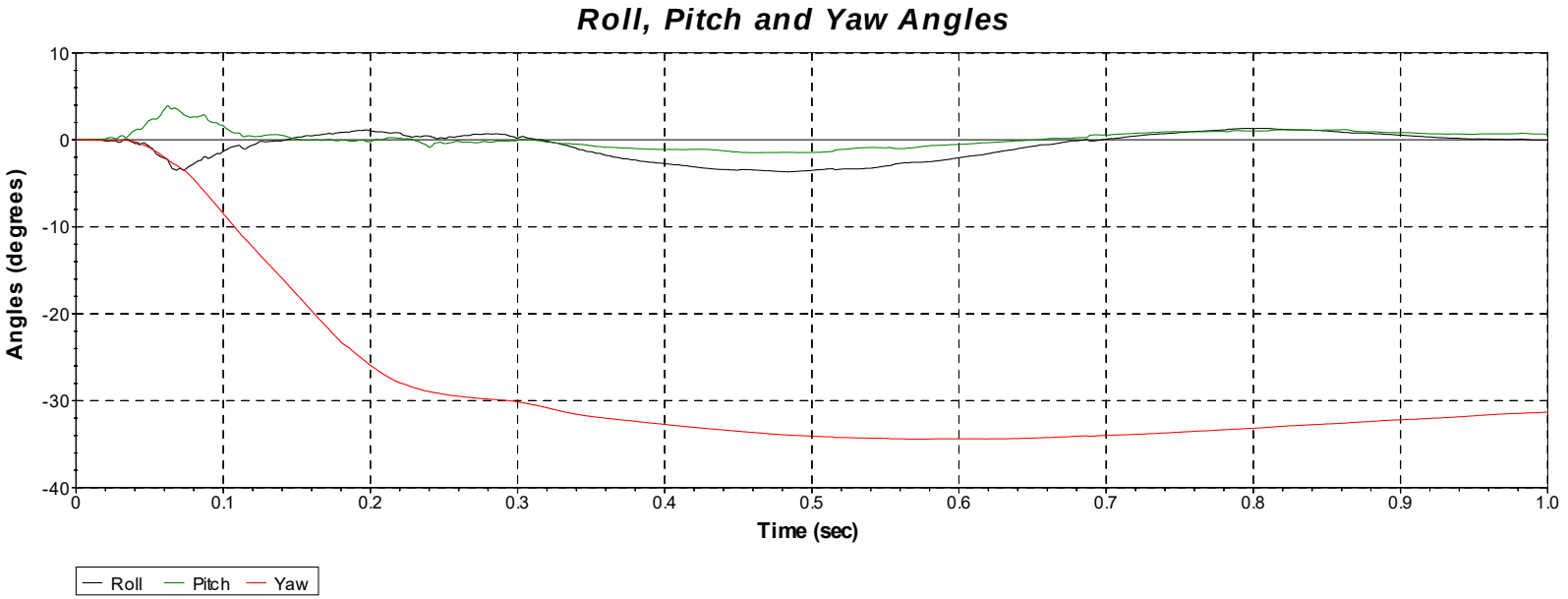
0.400 s

0.500 s

0.600 s

0.700 s

Figure C.2. Sequential Photographs for Test No. 609591-03-1 (Rear View).



Test Number: 609591-03-1
Test Standard Test Number: MASH 5-11
Test Article: PennDOT PA Bridge Barrier
Test Vehicle: 2013 RAM 1500 Pickup
Inertial Mass: 5004 lb
Gross Mass: 5169 lb
Impact Speed: 63.2 mi/h
Impact Angle: 24.8°

Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.

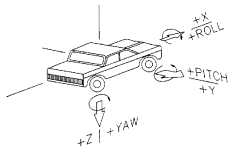


Figure C.3. Vehicle Angular Displacements for Test No. 609591-03-1.

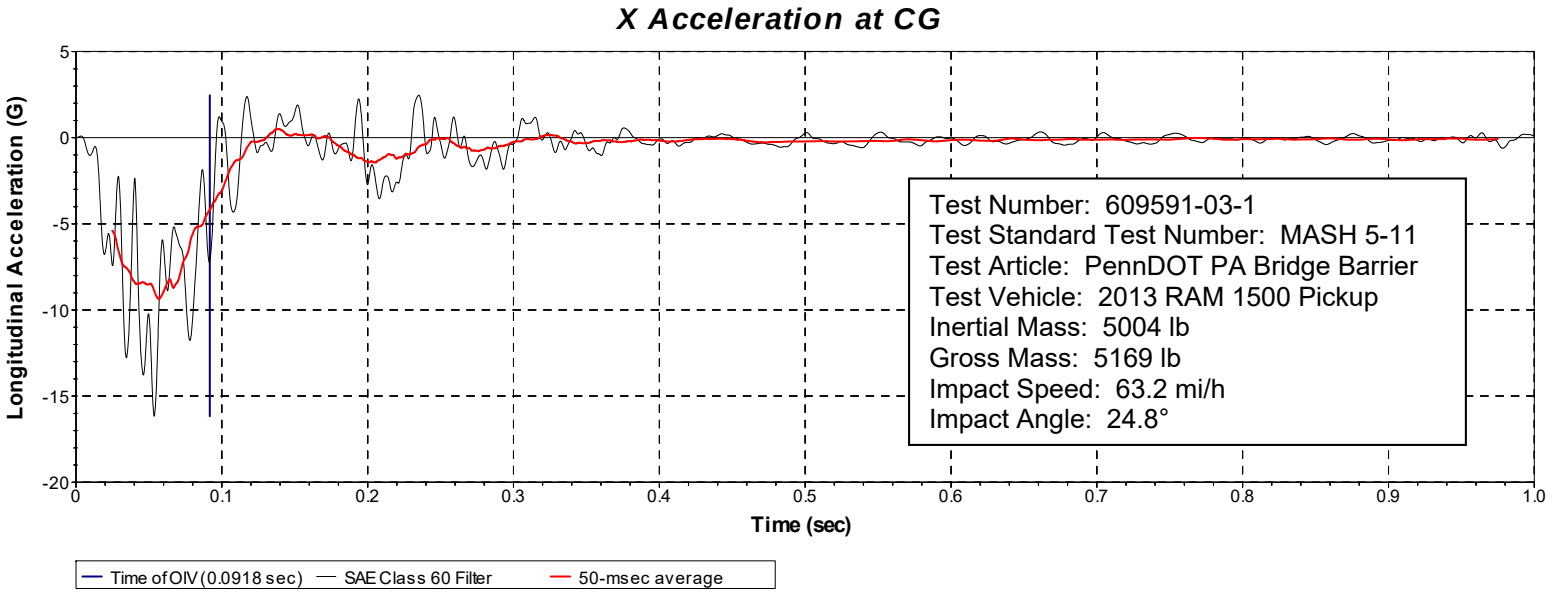


Figure C.4. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-1 (Accelerometer Located at Center of Gravity).

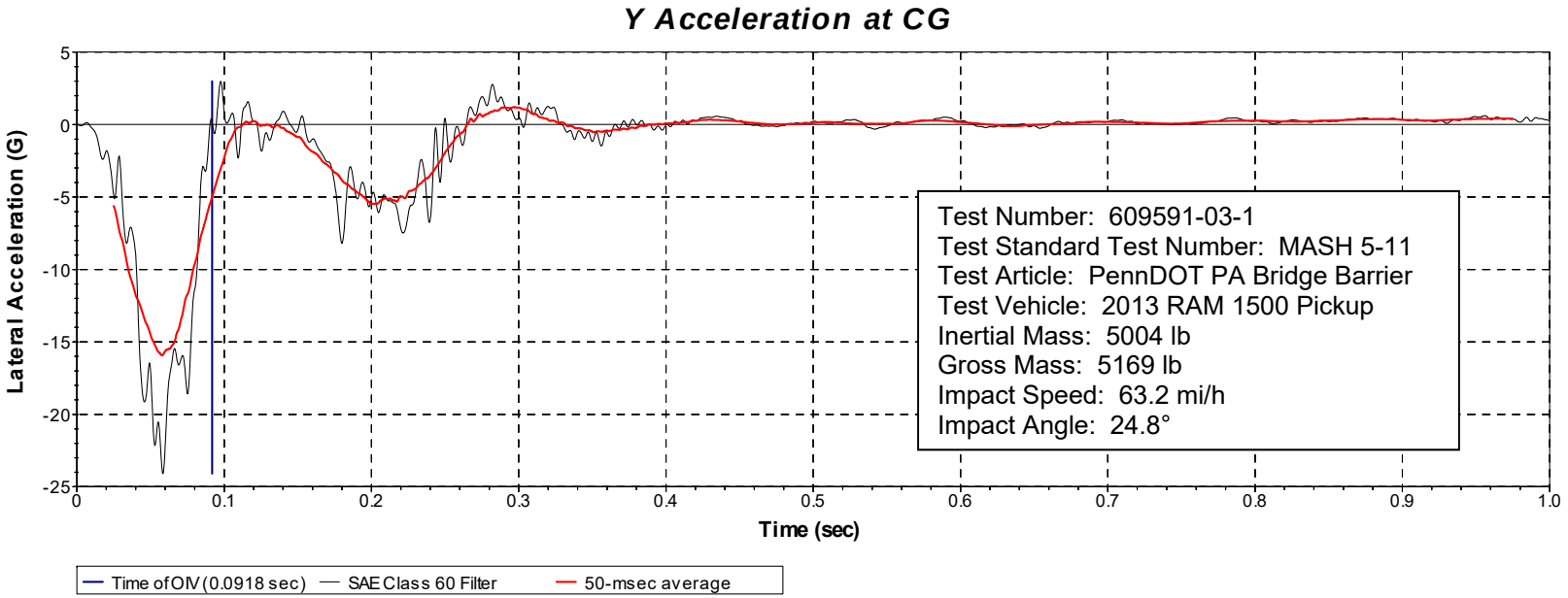
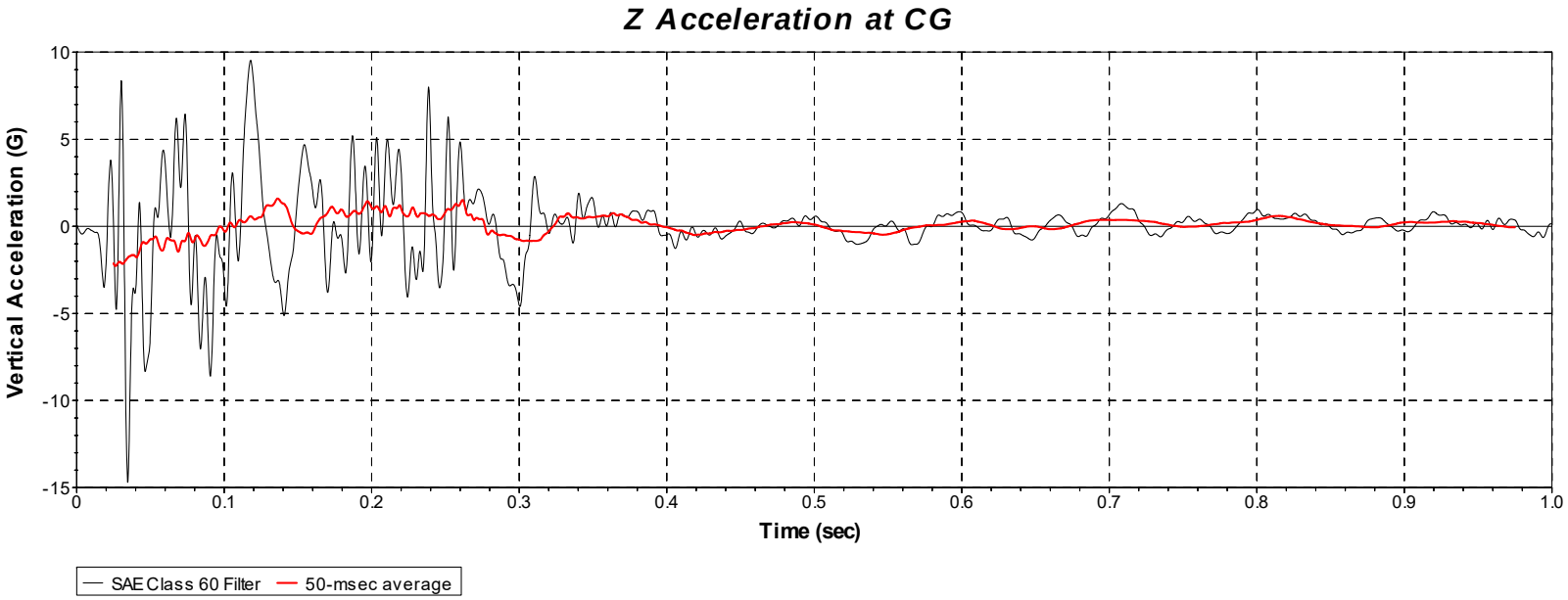


Figure C.5. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-1 (Accelerometer Located at Center of Gravity).



Test Number: 609591-03-1
Test Standard Test Number: MASH 5-11
Test Article: PennDOT PA Bridge Barrier
Test Vehicle: 2013 RAM 1500 Pickup
Inertial Mass: 5004 lb
Gross Mass: 5169 lb
Impact Speed: 63.2 mi/h
Impact Angle: 24.8°

Figure C.6. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-1 (Accelerometer Located at Center of Gravity).

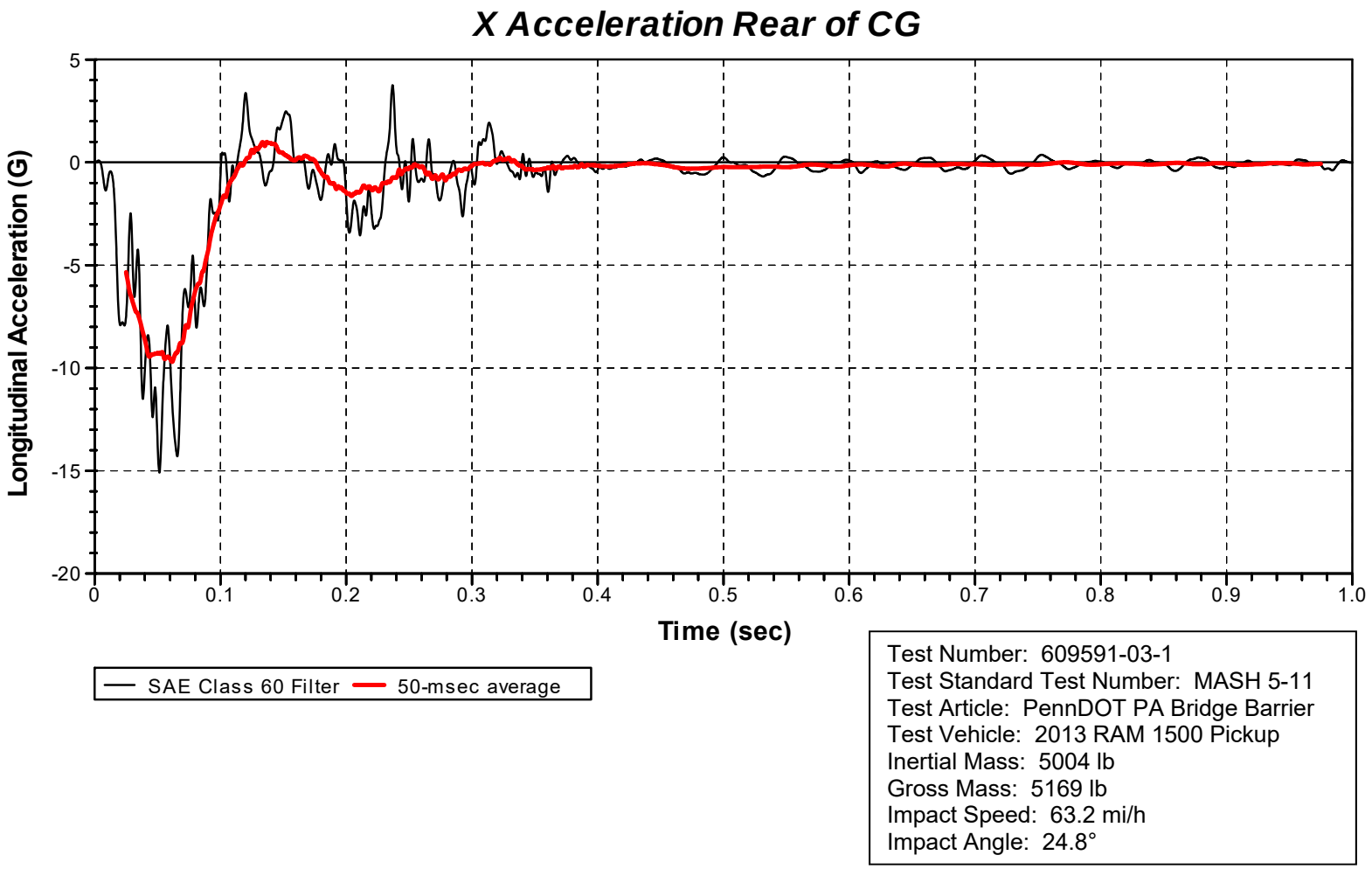
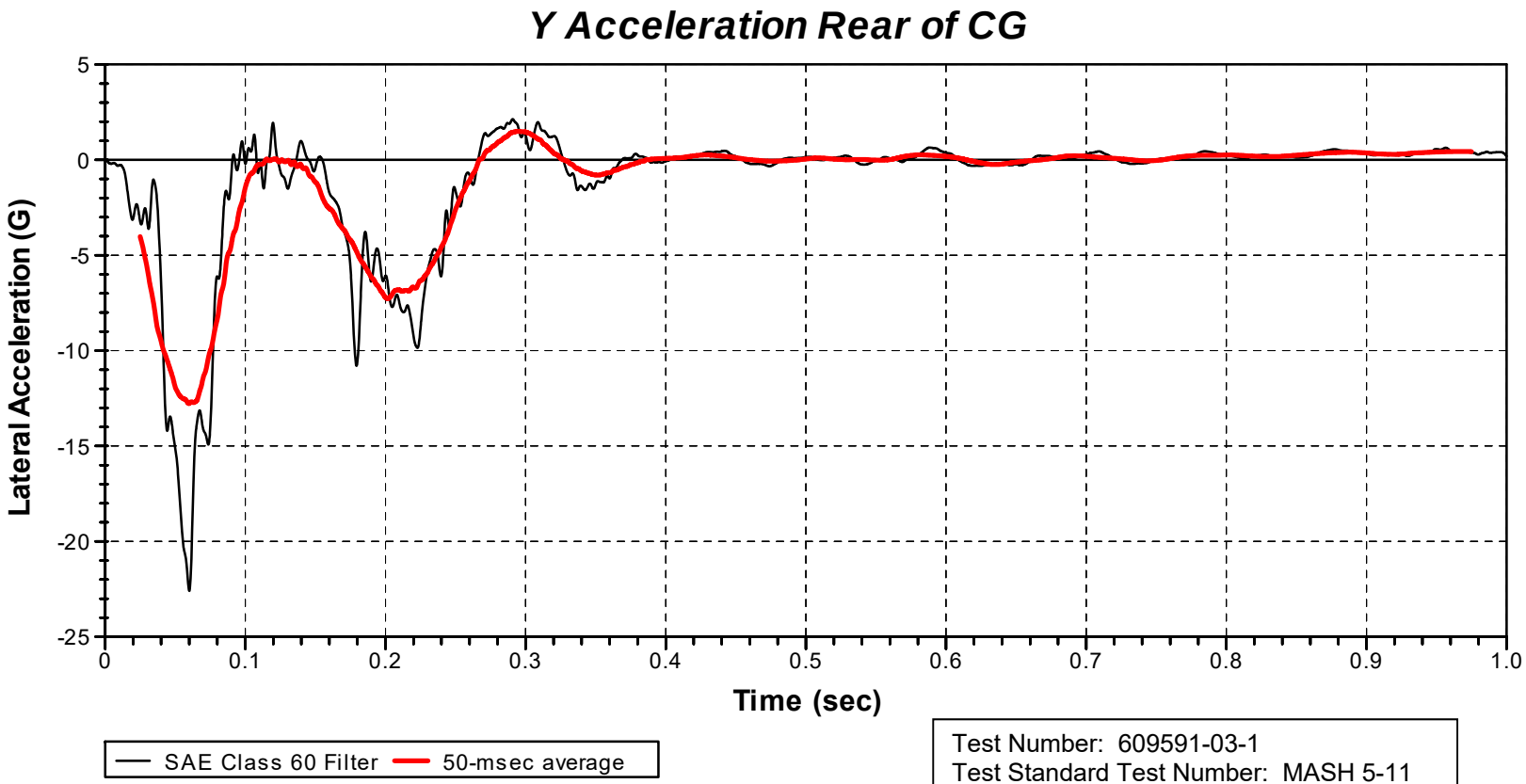


Figure C.7. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-1 (Accelerometer Located Rear of Center of Gravity).



Test Number: 609591-03-1
Test Standard Test Number: MASH 5-11
Test Article: PennDOT PA Bridge Barrier
Test Vehicle: 2013 RAM 1500 Pickup
Inertial Mass: 5004 lb
Gross Mass: 5169 lb
Impact Speed: 63.2 mi/h
Impact Angle: 24.8°

Figure C.8. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-1 (Accelerometer Located Rear of Center of Gravity).

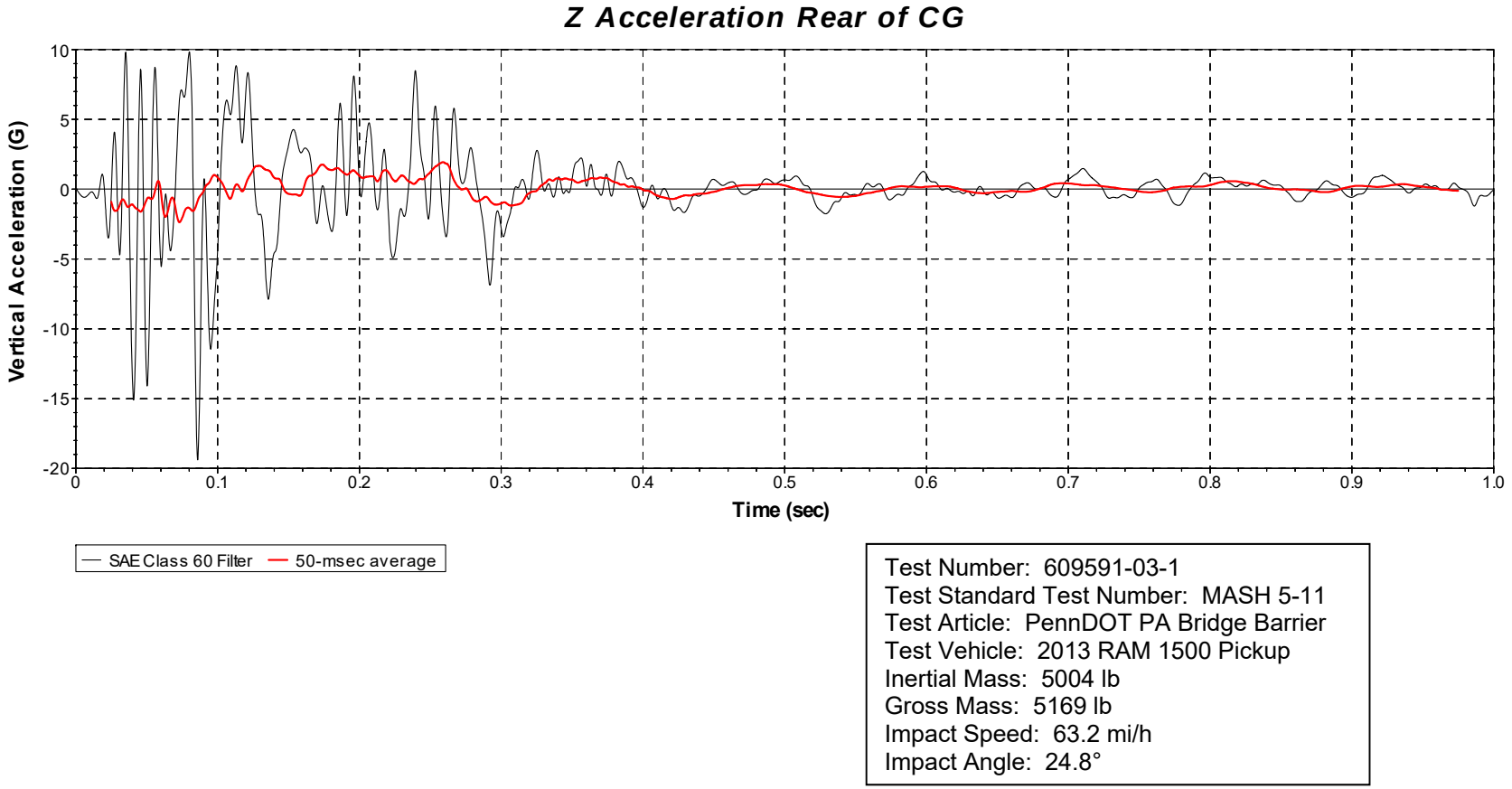


Figure C.9. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-1 (Accelerometer Located Rear of Center of Gravity).

APPENIDX D. *MASH* TEST 5-10 (CRASH TEST NO. 609591-03-2)

D1 VEHICLE PROPERTIES AND INFORMATION

Table D.1. Vehicle Properties for Test No. 609591-03-2.

Vehicle Inventory Number: 1331

Date: 2018-06-26 Test No.: 609591-03-02 VIN No.: KNADH4A3XB6926848

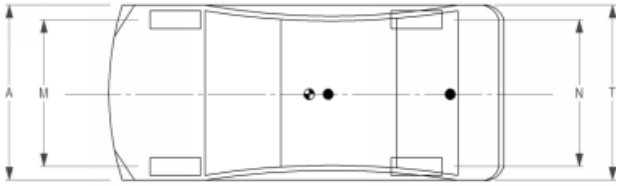
Year: 2011 Make: KIA Model: RIO

Tire Inflation Pressure: 32 PSI Odometer: 154005 Tire Size: 185/65R14

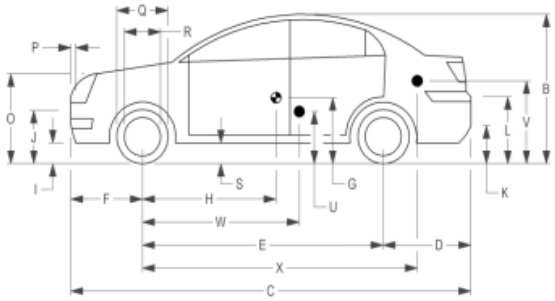
Describe any damage to the vehicle prior to test: None

• Denotes accelerometer location.

NOTES: None



Engine Type: 4 cylinder
Engine CID: 1.6 L
Transmission Type:
☑ Auto or ☐ Manual
☑ FWD ☐ RWD ☐ 4WD
Optional Equipment:
None



Dummy Data:
Type: 50th percentile male
Mass: 165 LBS
Seat Position: IMPACT SIDE

Geometry: inches

A	66.38	F	33.00	K	12.25	P	4.12	U	14.50
B	51.50	G		L	25.25	Q	22.50	V	19.75
C	165.75	H	35.90	M	57.75	R	15.50	W	35.90
D	34.00	I	7.75	N	57.70	S	8.25	X	100.65
E	98.75	J	21.50	O	28.25	T	66.20		
	Wheel Center Ht Front		11.00		Wheel Center Ht Rear		11.00	W-H	0.00

RANGE LIMIT: A = 65 ±3 inches; C = 168 ±8 inches; E = 98 ±5 inches; F = 35 ±4 inches; G = 39 ±4 inches; O = TOP OF RADIATOR SUPPORT ~~(34 ±4 inches);~~
M+N/2 = 56 ±2 inches; W-H < 2 inches or use MASH Paragraph A4.3.2

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	1718	M_{front}	1572	1544	1629
Back	1874	M_{rear}	885	883	963
Total	3638	M_{Total}	2457	2427	2592

Allowable TIM = 2420 lb ±55 lb | Allowable GSM = 2585 lb ± 55 lb

Mass Distribution:
lb LF: 773 RF: 771 LR: 449 RR: 434

Table D.2. Exterior Crush Measurements for Test No. 609591-03-2.

Vehicle Inventory Number: 1331

Date: 2018-06-26 Test No.: 609591-03-02 VIN No.: KNADH4A3XB6926848

Year: 2011 Make: KIA Model: RIO

VEHICLE CRUSH MEASUREMENT SHEET[1]

Complete When Applicable	
End Damage	Side Damage
Undeformed end width	Bowing: B1 X1
Corner shift: A1	B2 X2
A2	
End shift at frame (CDC)	Bowing constant
(check one)	$\frac{X1+X2}{2}$ =
< 4 inches	
≥ 4 inches	

Note: Measure C_1 to C_6 from Driver to Passenger Side in Front or Rear impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage Width** (CDC)	Direct Damage Max*** Crush	Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
1	AT FT BUMPER	14	6	16	6	4	1				+16
2	ABOVE FT BUMPER	14	6	30	1	3			5	6	+59
	Units in inches										

[1]Table taken from National Accident Sampling System (NASS).

*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

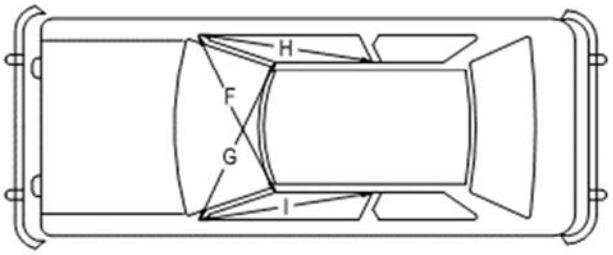
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

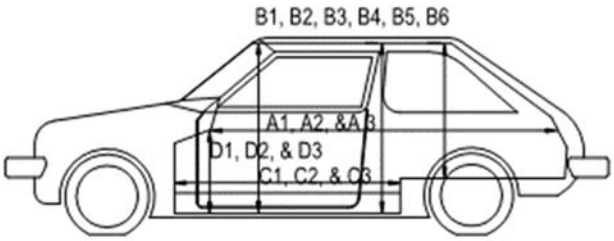
***Measure and document on the vehicle diagram the location of the maximum crush.

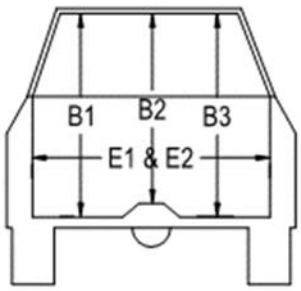
Note: Use as many lines/columns as necessary to describe each damage profile.

Table D.3. Occupant Compartment Measurements for Test No. 609591-03-2.

Vehicle Inventory Number:	1331				
Date:	2018-06-26	Test No.:	609591-03-02	VIN No.:	KNADH4A3XB6926848
Year:	2011	Make:	KIA	Model:	RIO







OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	67.50	67.50	0.00
A2	67.25	67.25	0.00
A3	67.75	67.75	0.00
B1	40.50	40.50	0.00
B2	39.00	39.00	0.00
B3	40.50	39.00	-1.50
B4	36.25	36.25	0.00
B5	36.00	36.00	0.00
B6	36.25	34.25	-2.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	25.00	-1.00
D1	9.50	9.50	0.00
D2	0.00	0.00	0.00
D3	9.50	6.50	-3.00
E1	51.50	53.25	1.75
E2	51.00	53.50	2.50
F	51.00	51.00	0.00
G	51.00	51.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	51.00	51.00	0.00

*Lateral area across the cab from driver's side kickpanel to passenger's side kickpanel.

D2 SEQUENTIAL PHOTOGRAPHS

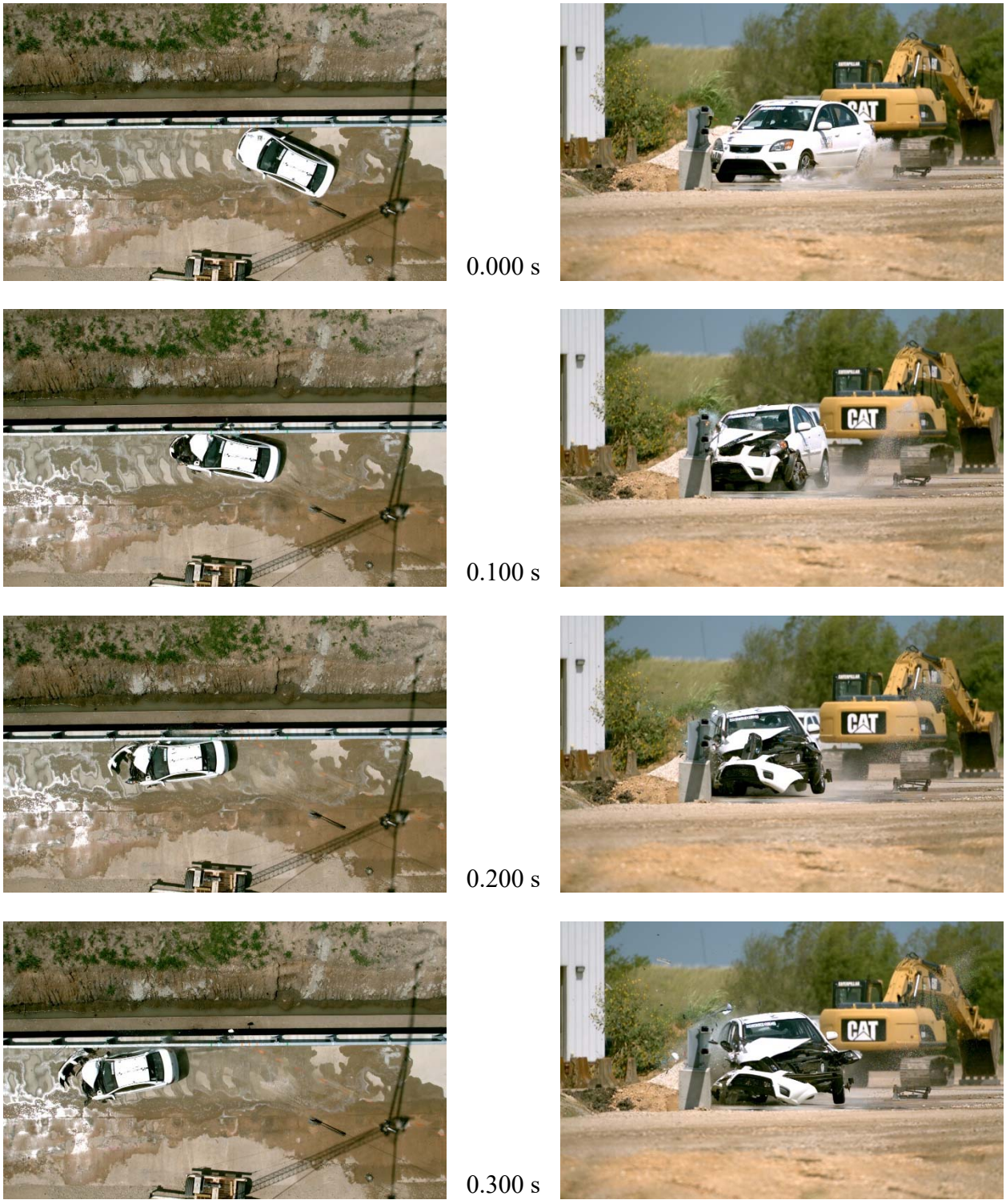


Figure D.1. Sequential Photographs for Test No. 609591-03-2 (Overhead and Gut Views).

Figure C.1. Sequential Photographs for Test No. 609591-03-2 (Overhead and Gut Views) (Continued).


0.000 s


0.100 s


0.200 s


0.300 s

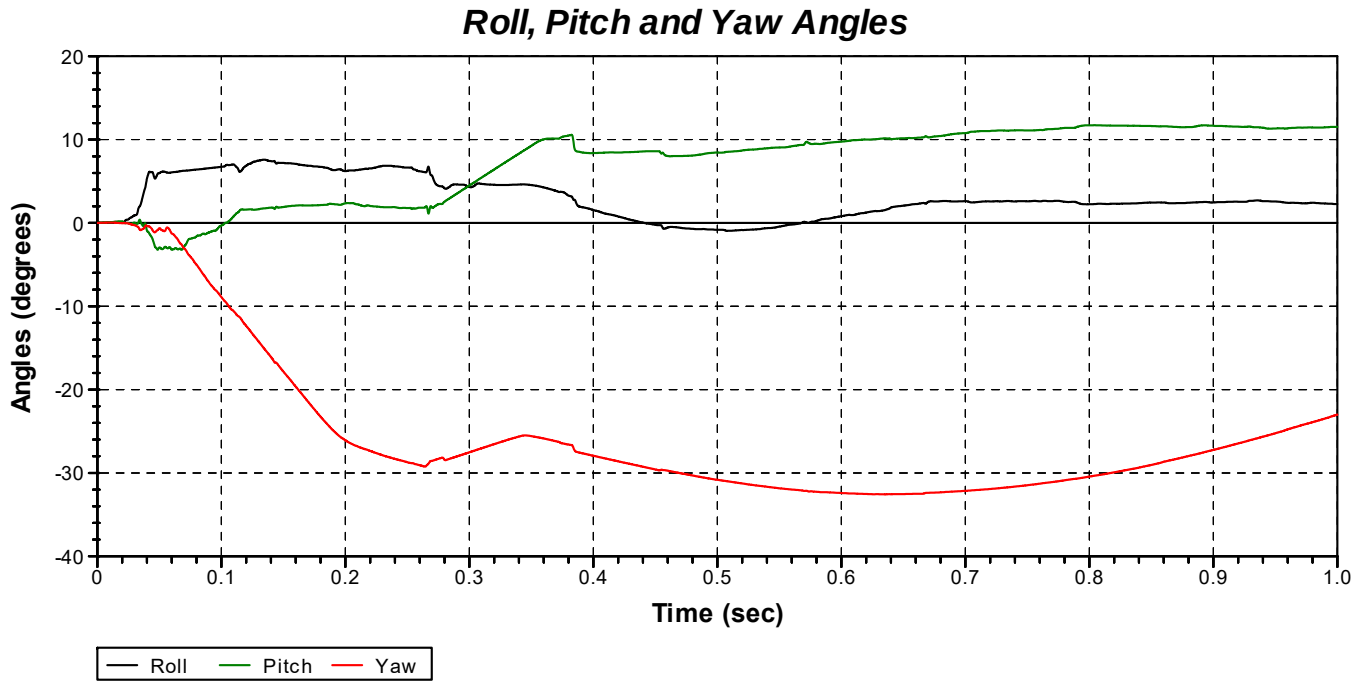

0.400 s

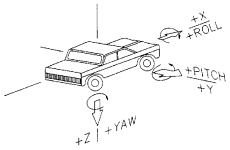

0.500 s


0.600 s


0.700 s

Figure D.2. Sequential Photographs for Test No. 609591-03-2 (Rear View).



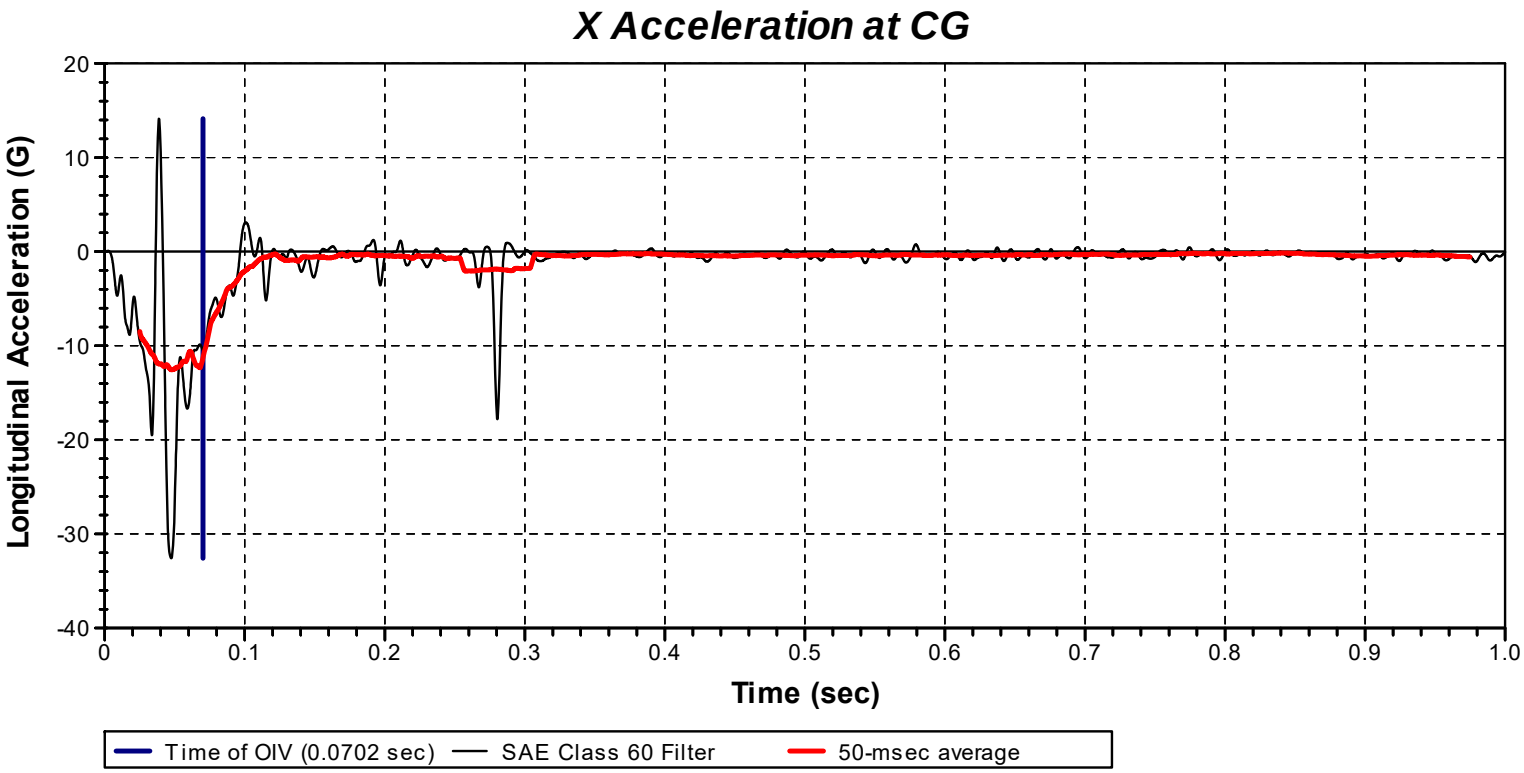


Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.

Test Number: 609591-03-2
Test Standard Test Number: MASH 5-10
Test Article: PennDOT PA Bridge Barrier
Test Vehicle: 2011 Kia Rio
Inertial Mass: 2,427 lb
Gross Mass: 2,592 lb
Impact Speed: 61.7 mi/h
Impact Angle: 25.3°

Figure D.3. Vehicle Angular Displacements for Test No. 609591-03-2.



Test Number: 609591-03-2
Test Standard Test Number: MASH 5-10
Test Article: PennDOT PA Bridge Barrier
Test Vehicle: 1100C, Small Car
Inertial Mass: 2,427 lb
Gross Mass: 2,592 lb
Impact Speed: 61.7 mi/h
Impact Angle: 25.3°

Figure D.4. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-2 (Accelerometer Located at Center of Gravity).

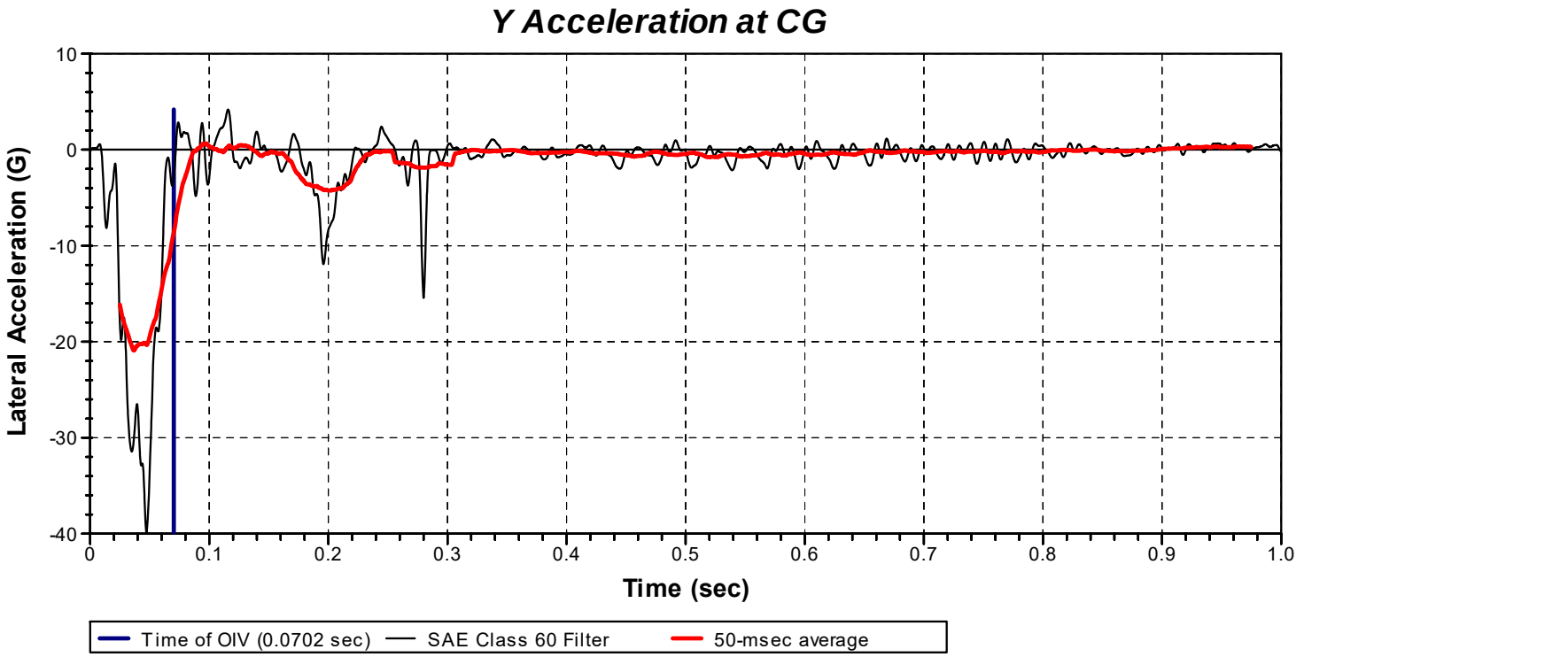


Figure D.5. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-2 (Accelerometer Located at Center of Gravity).

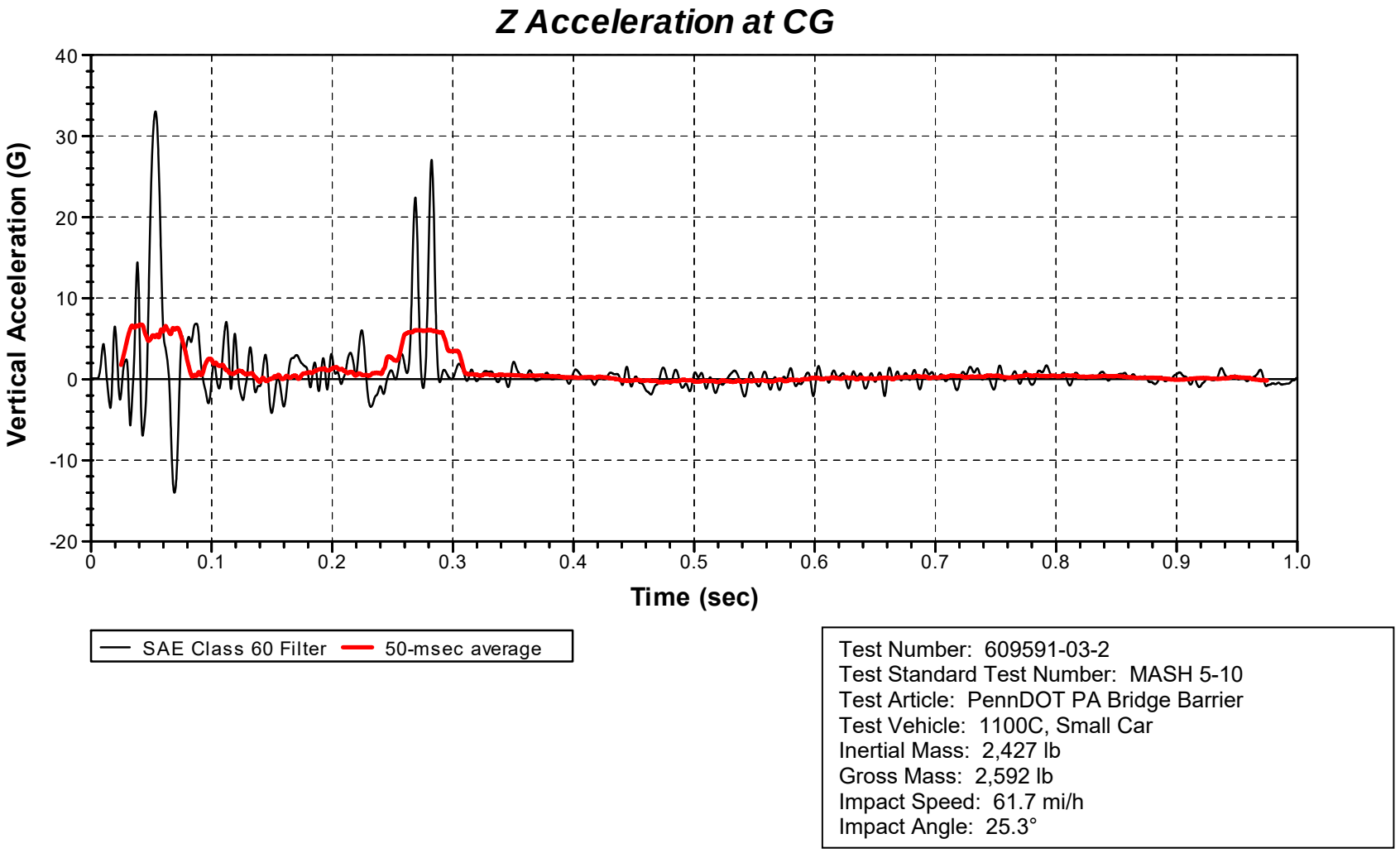


Figure D.6. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-2 (Accelerometer Located at Center of Gravity).

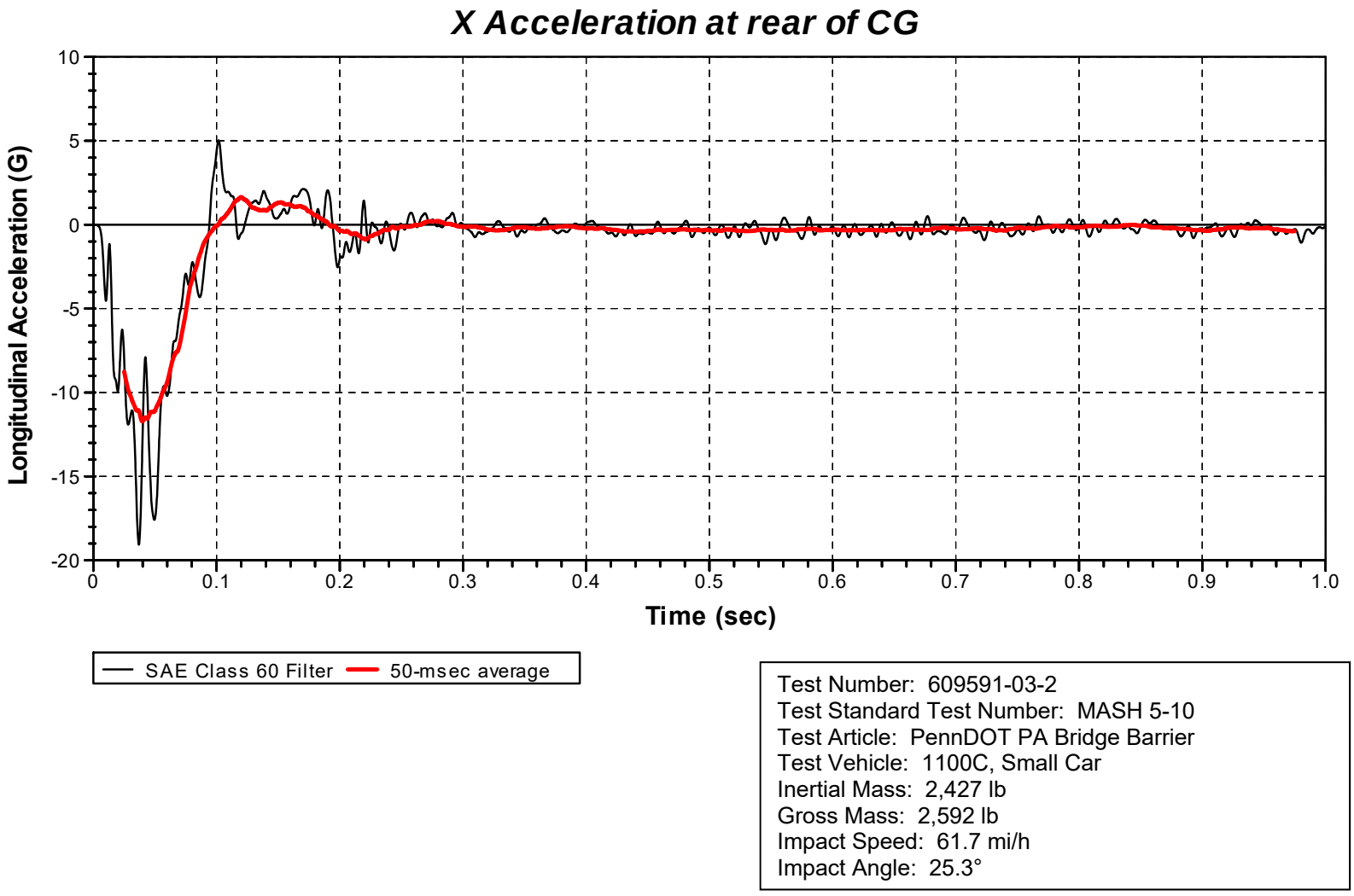


Figure D.7. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-2 (Accelerometer Located Rear of Center of Gravity).

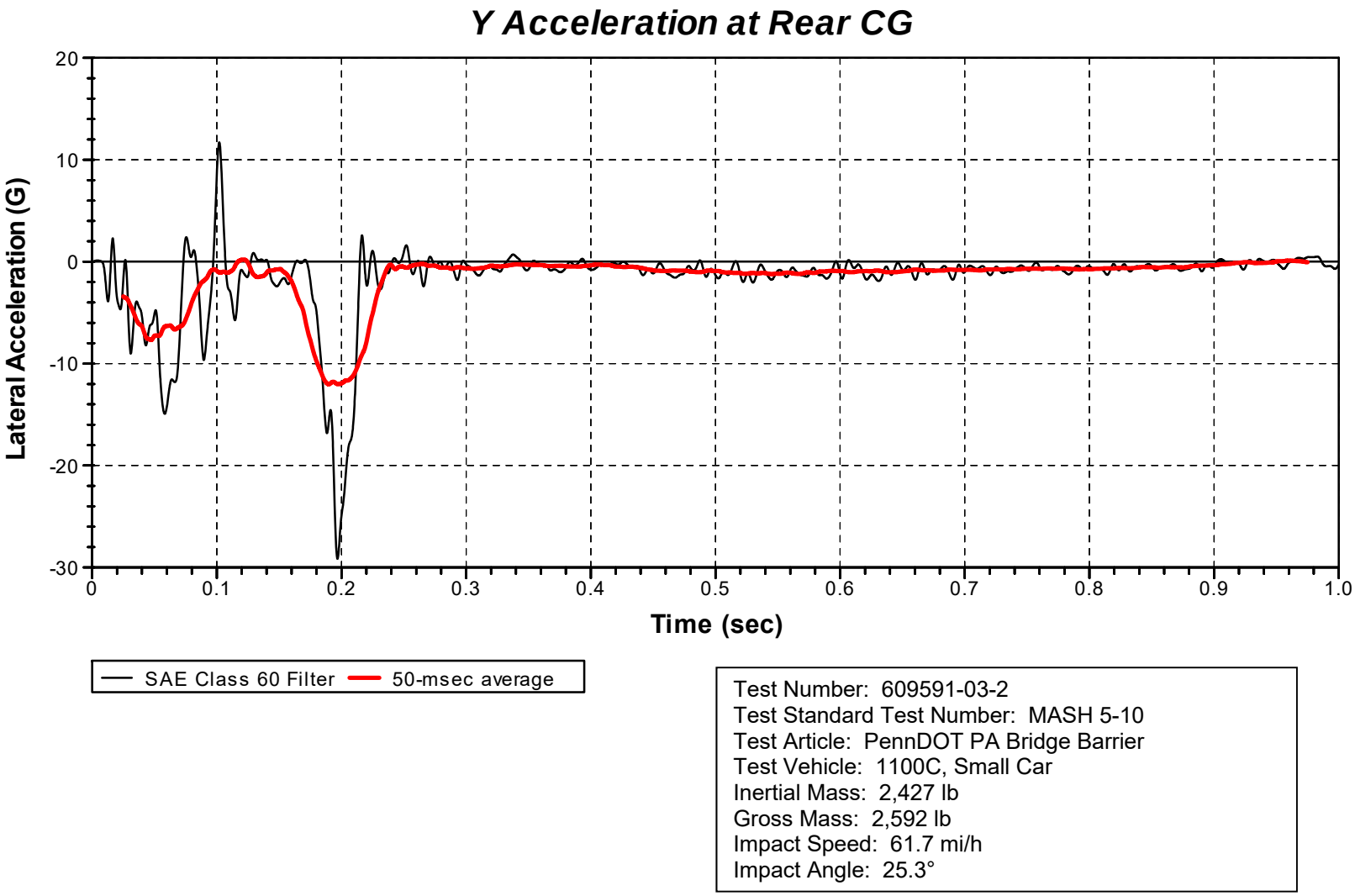


Figure D.8. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-2 (Accelerometer Located Rear of Center of Gravity).

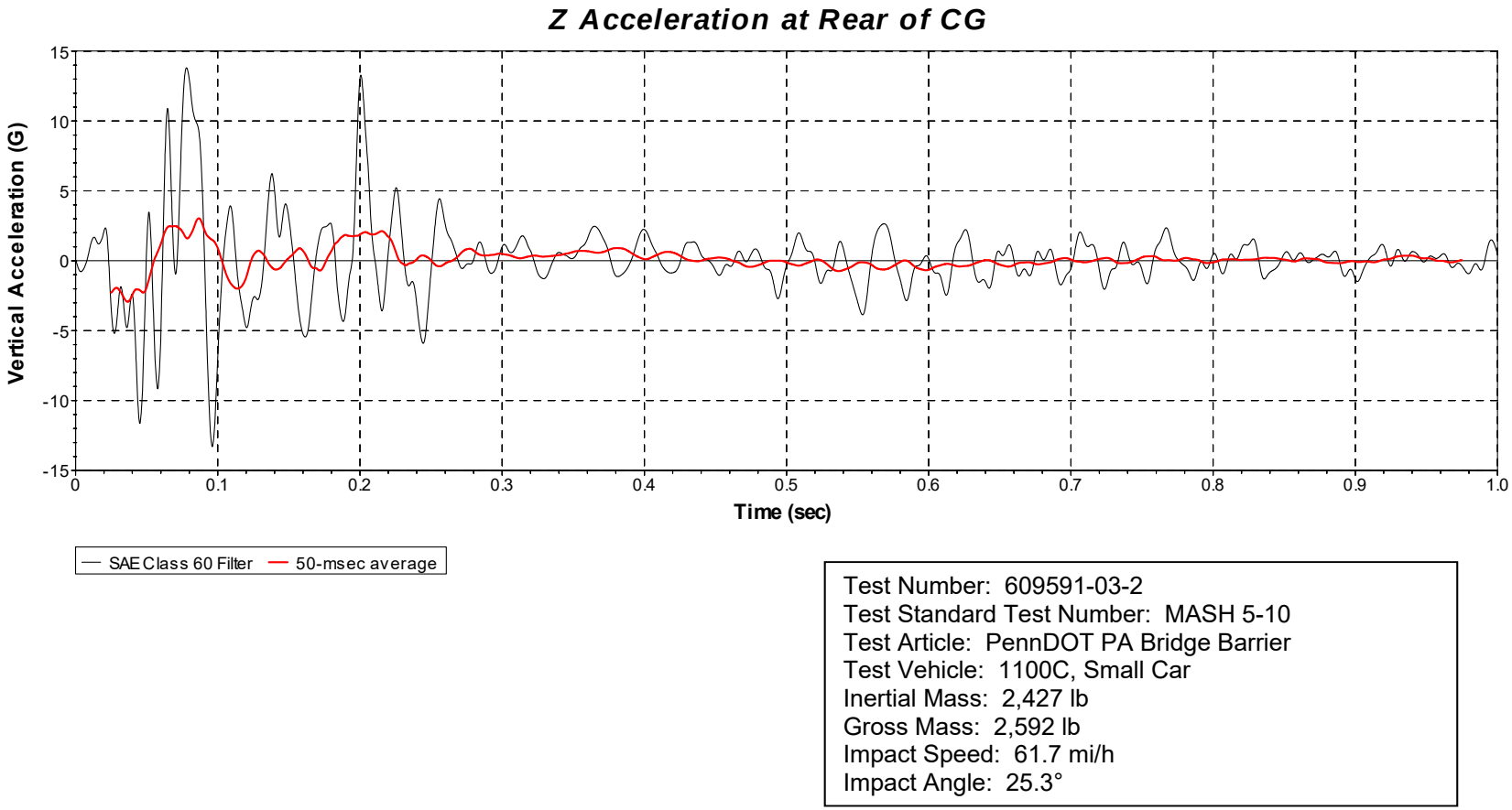


Figure D.9. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-2 (Accelerometer Located Rear of Center of Gravity).

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APPENIDX E. *MASH* TEST 5-12 (CRASH TEST NO. 609591-03-3)

E1 VEHICLE PROPERTIES AND INFORMATION

Table E.1. Vehicle Properties for Test No. 609591-03-3.

Vehicle Inventory Number: 13001299

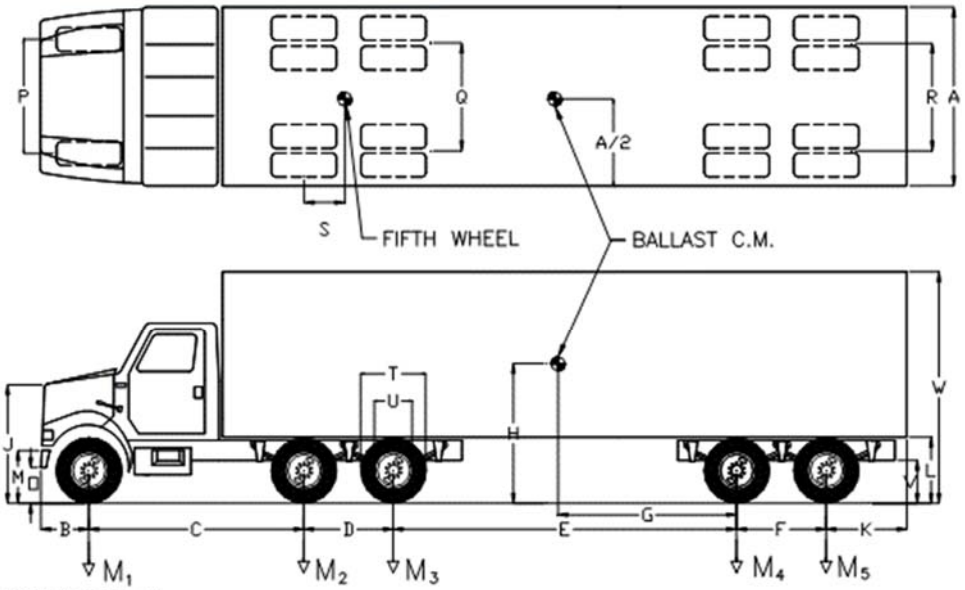
DATE: 2018-07-03 TEST NO.: 609591-03-3

TRACTOR
YEAR: 2008 MAKE: FREIGHTLINER MODEL: CL 120

VIN No.: 1FUJA6CV68DAA5274 ODOMETER: 846,840

TRAILER
YEAR: 2002 MAKE: UTILITY MODEL: 53'

VIN No.: 1UYVS25302P787333



GEOMETRY (inches)

A	96.00	D	50.00	G		K	50.00	O	15.00	R	73.00	U	23.00						
B	48.00	E	459.00	H	72.50	L	49.00	P	79.50	S	12.00	V	32.00						
C	144.00	F	48.00	J	67.00	M	34.50	Q	73.00	T	40.00	W	148.00						

Allowable Range: C = 200 inches max.; L = 52 ±2 inches; Overall Trailer Length = 600 inches max.; Overall Combination Length = 780 inches max.; Trailer Overhang = 87 inches max.; Ballast Center of Mass Ht = 73 ±2 inches above ground;

MASS (lb)	CURB		TEST INERTIAL	
M_1	8800		11250	
M_2	4960		18080.00	
M_3	4920		16770	
M_4	5890		17880	
M_5	4180	Allowable Range	15300	Allowable Range
M_{Total}	28750	29,000 ±3100 lb	79280	79,300 ±1100 lb

Height above ground:
A: 33 inches
B: 32 inches
C: 49.5 inches

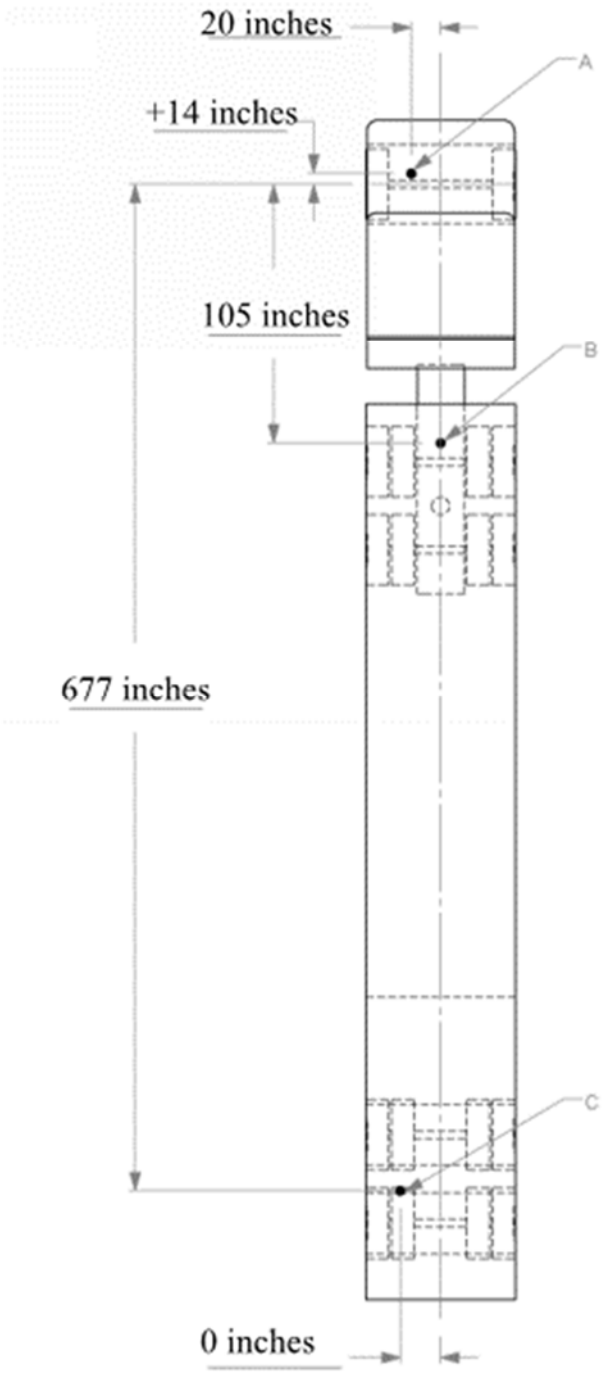


Figure E.1. Location of Accelerometers and Rate Transducers.

E2 SEQUENTIAL PHOTOGRAPHS

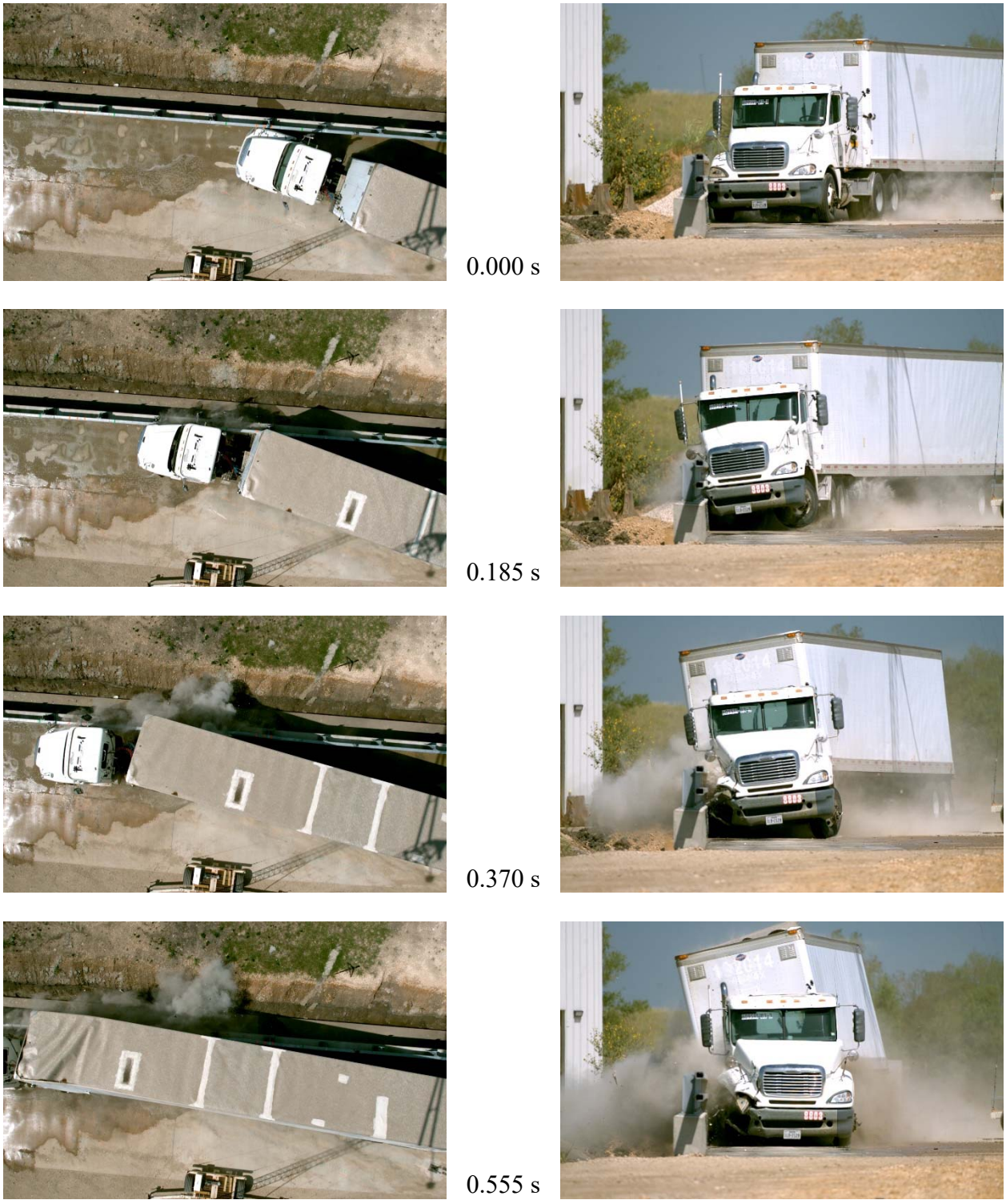


Figure E.2. Sequential Photographs for Test No. 609591-03-3 (Overhead and Gut Views).

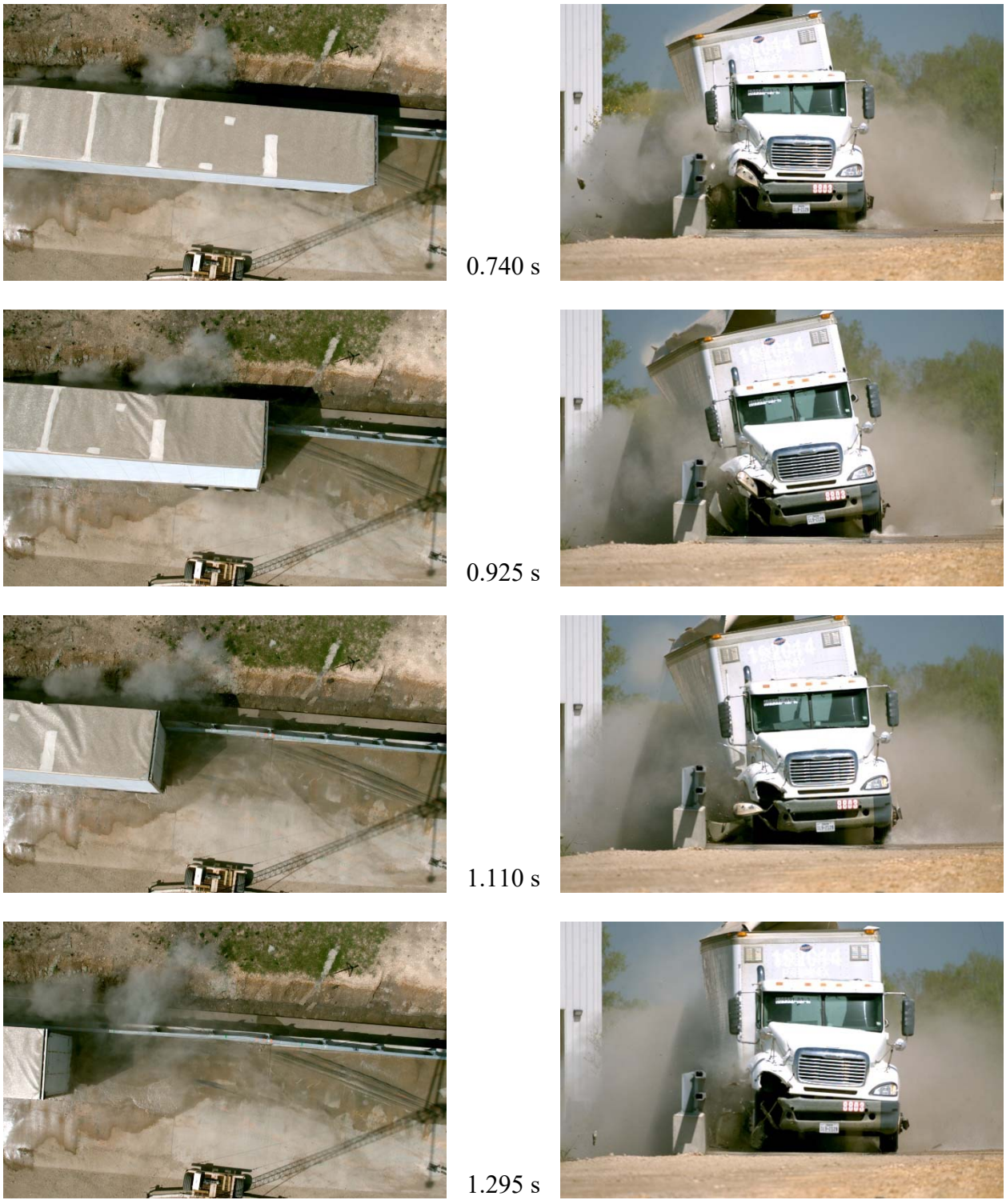


Figure E.2. Sequential Photographs for Test No. 609591-03-3 (Overhead and Gut Views) (Continued).


0.000 s


0.185 s


0.370 s

0.555 s

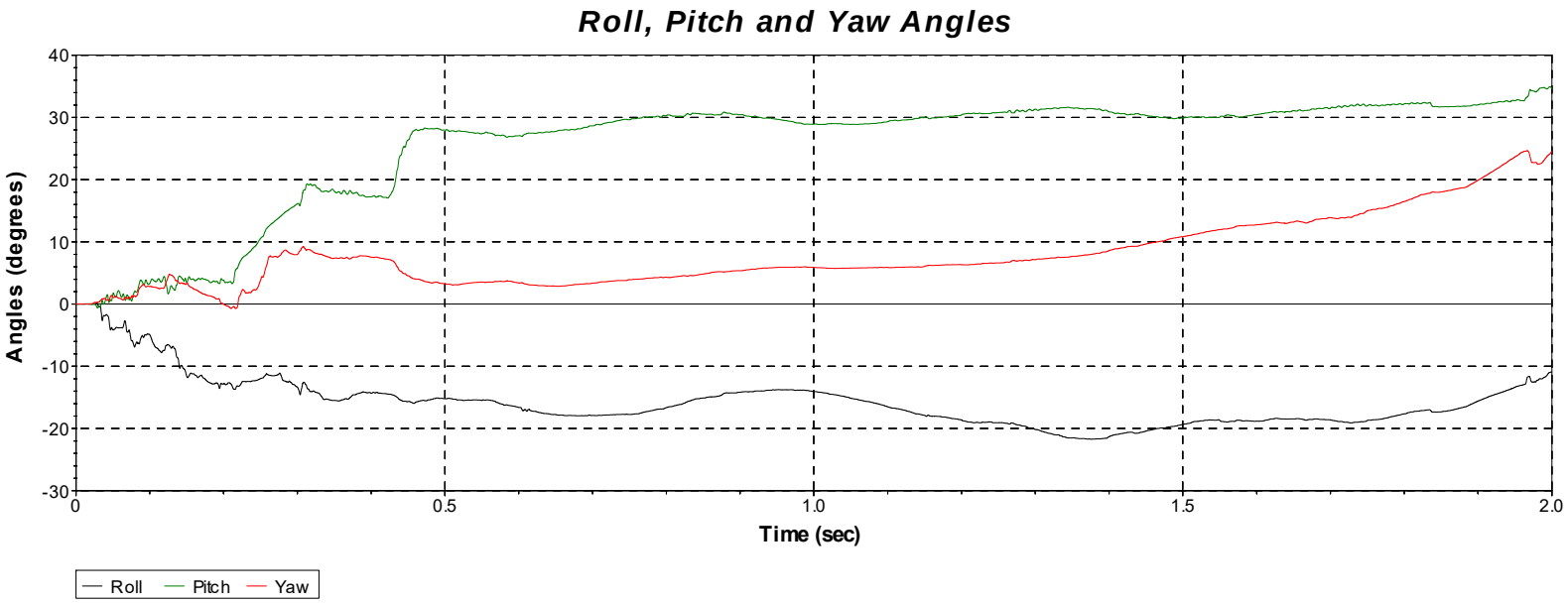
0.740 s

0.925 s


1.110 s


1.295 s

Figure E.3. Sequential Photographs for Test No. 609591-03-3 (Rear View).



Test Number: 609591-03-3
Test Standard Test Number: MASH 5-12
Test Article: PennDOT PA Bridge Barrier
Test Vehicle: 2008 Freightliner CL120/2002 Utility 53ftr
Inertial Mass: 79,280 lb
Gross Mass: 79,280 lb
Impact Speed: 49.9
Impact Angle: 14.8°

Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.

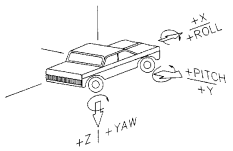


Figure E.4. Vehicle Angular Displacements for Test No. 609591-03-3.
(Accelerometer Located at Fifth Wheel)

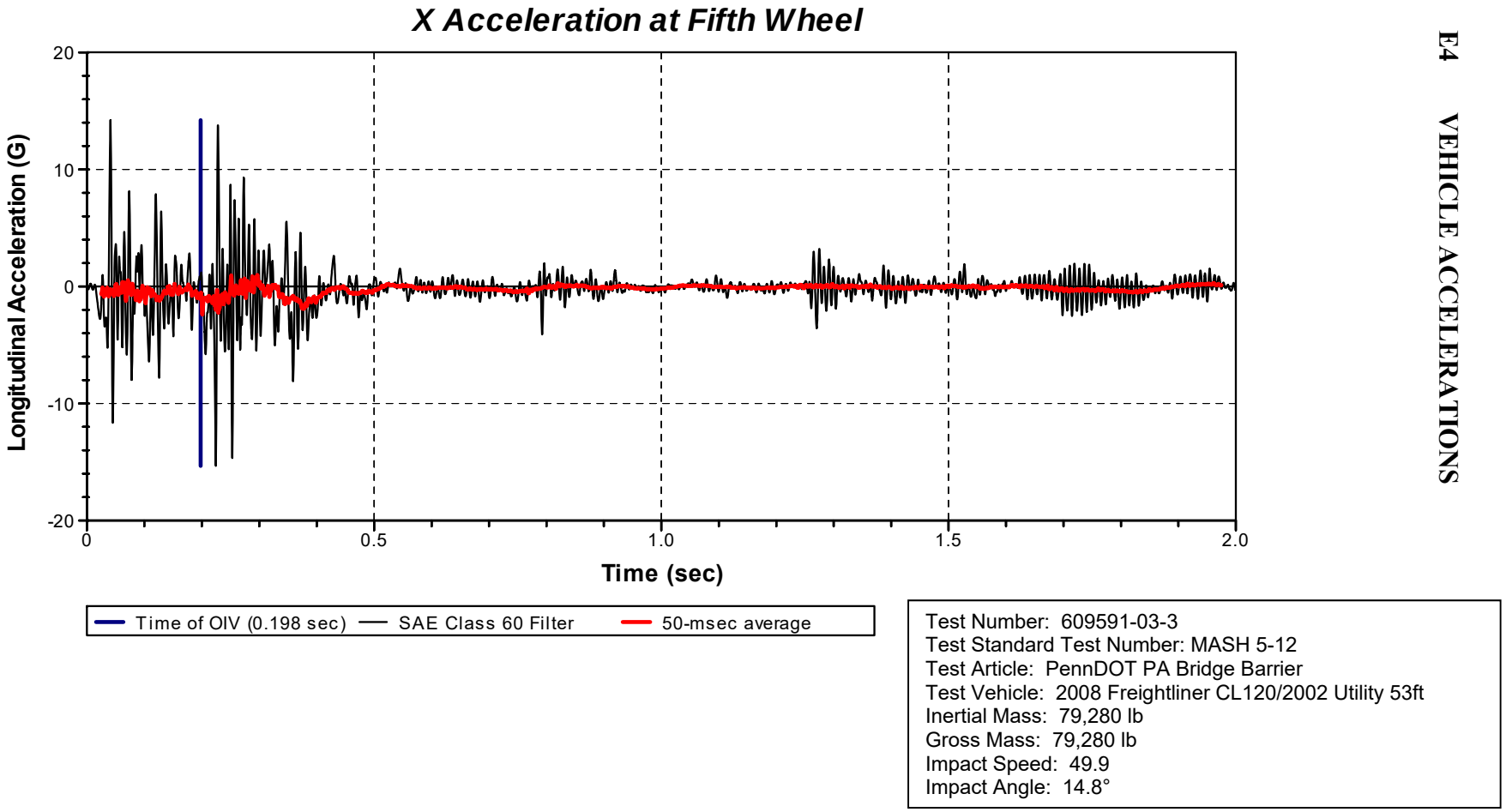


Figure E.5. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located at Fifth Wheel).

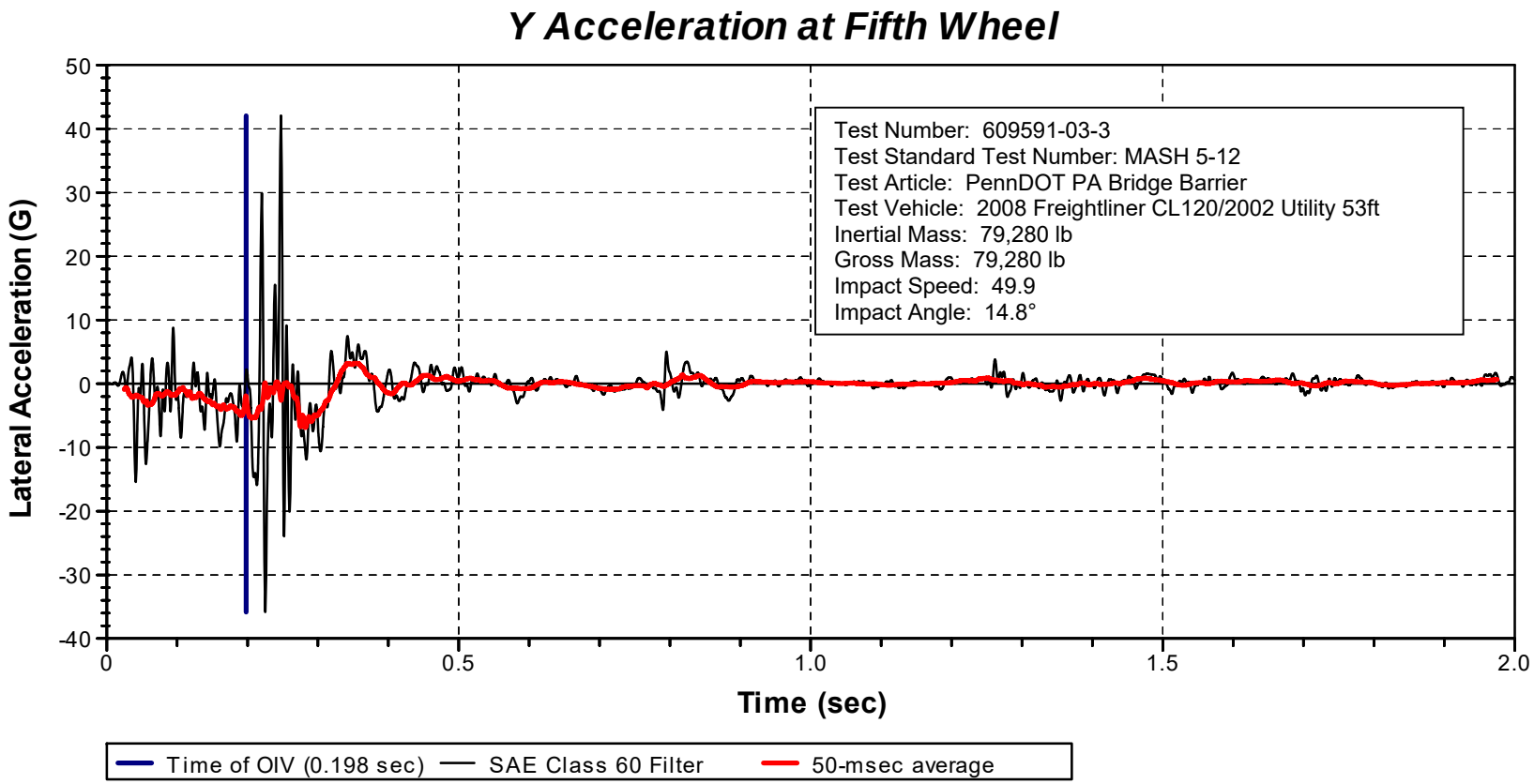


Figure E.6. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located at Fifth Wheel).

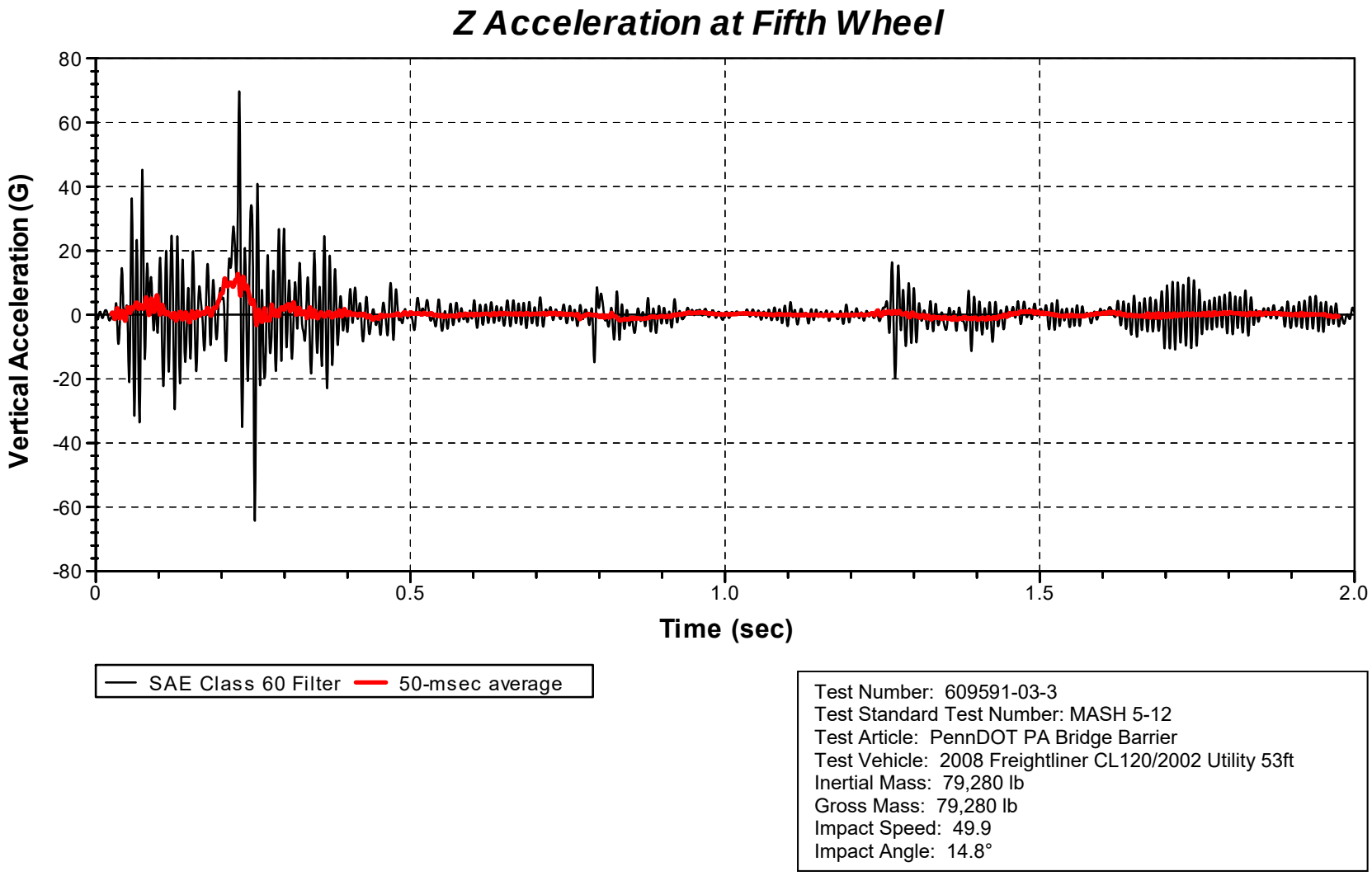


Figure E.7. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located at Fifth Wheel).

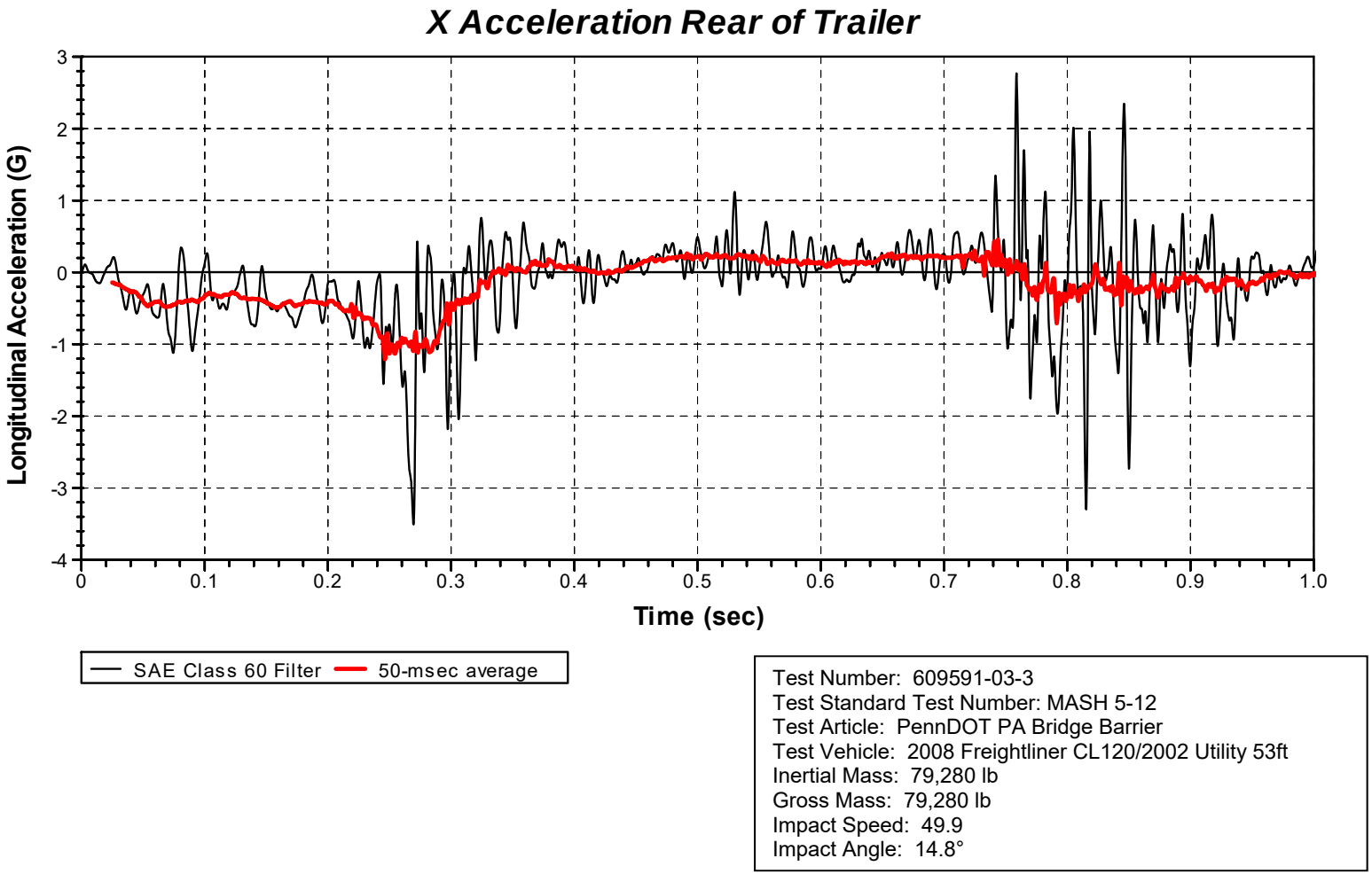


Figure E.8. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located Rear of Trailer).

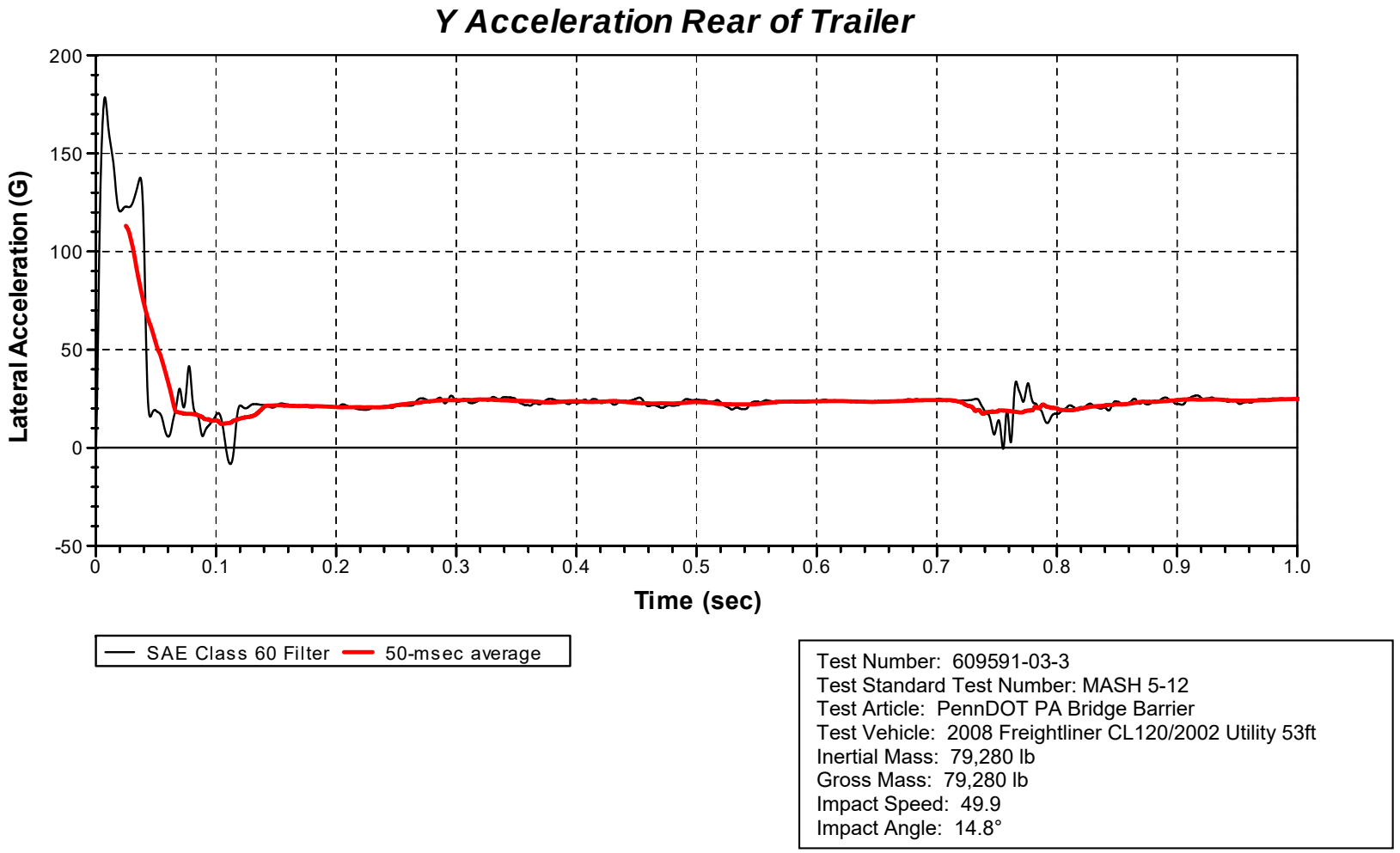


Figure E.9. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located Rear of Trailer).

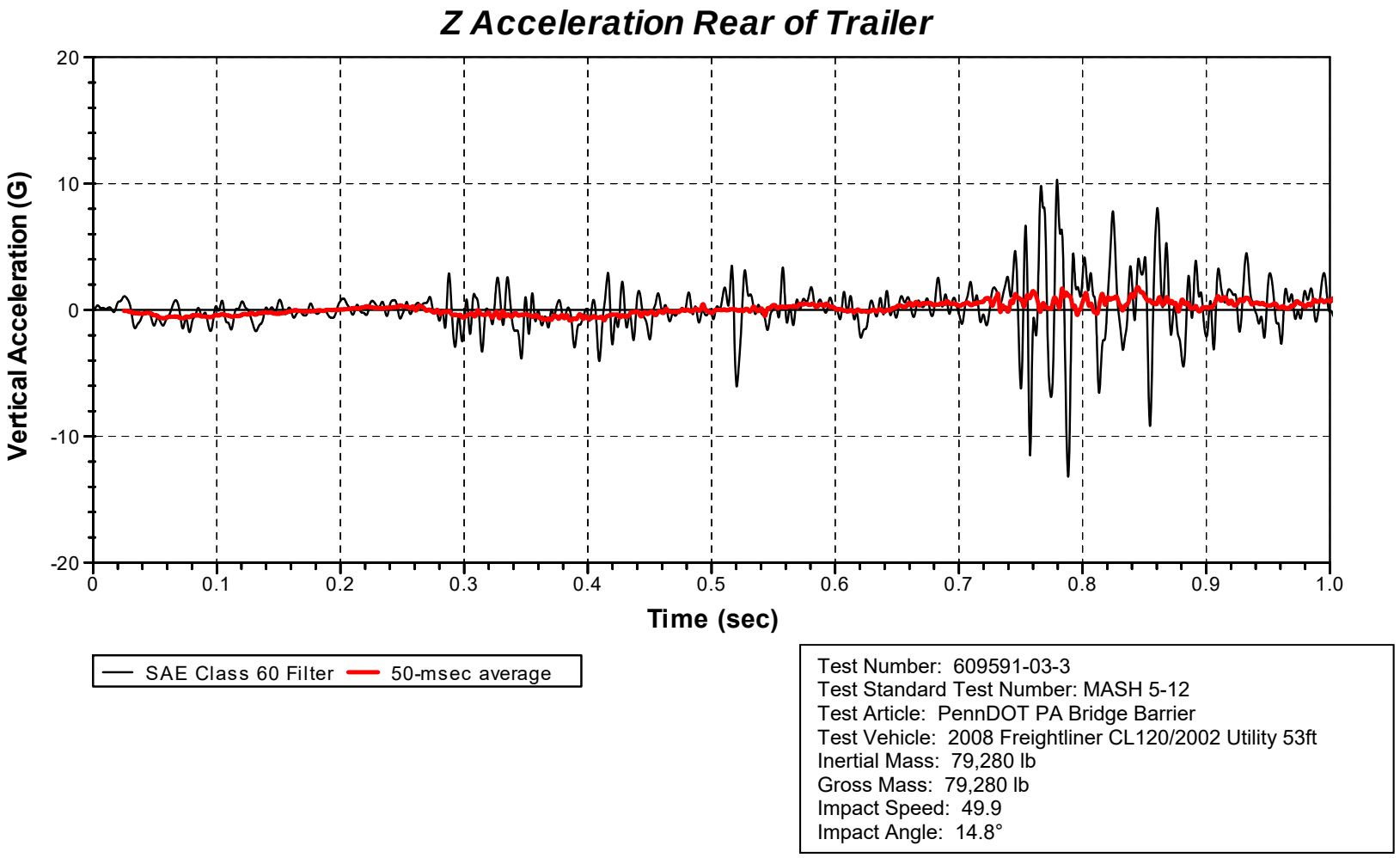


Figure E.10. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located Rear of Trailer)

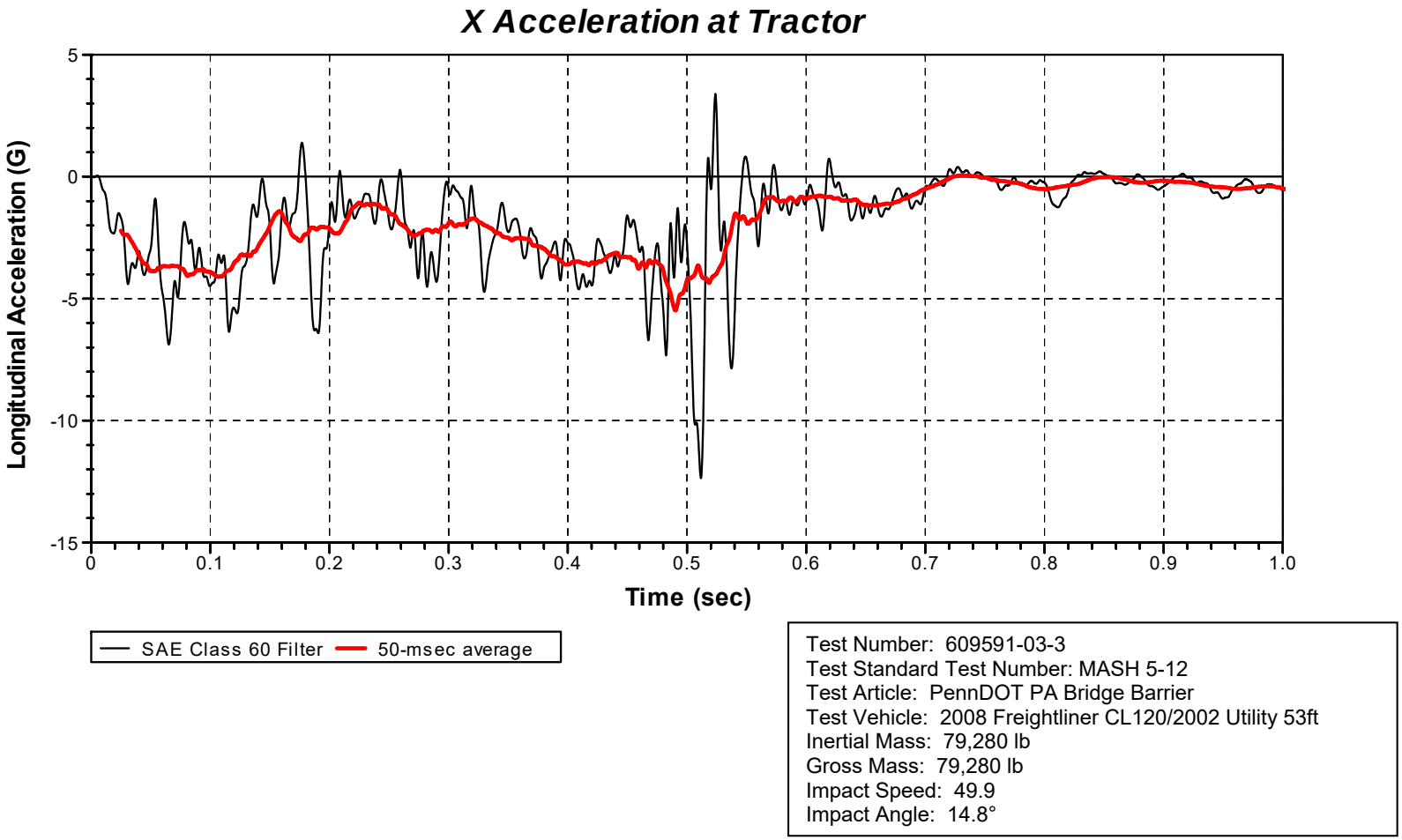


Figure E.11. Vehicle Longitudinal Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located at Tractor).

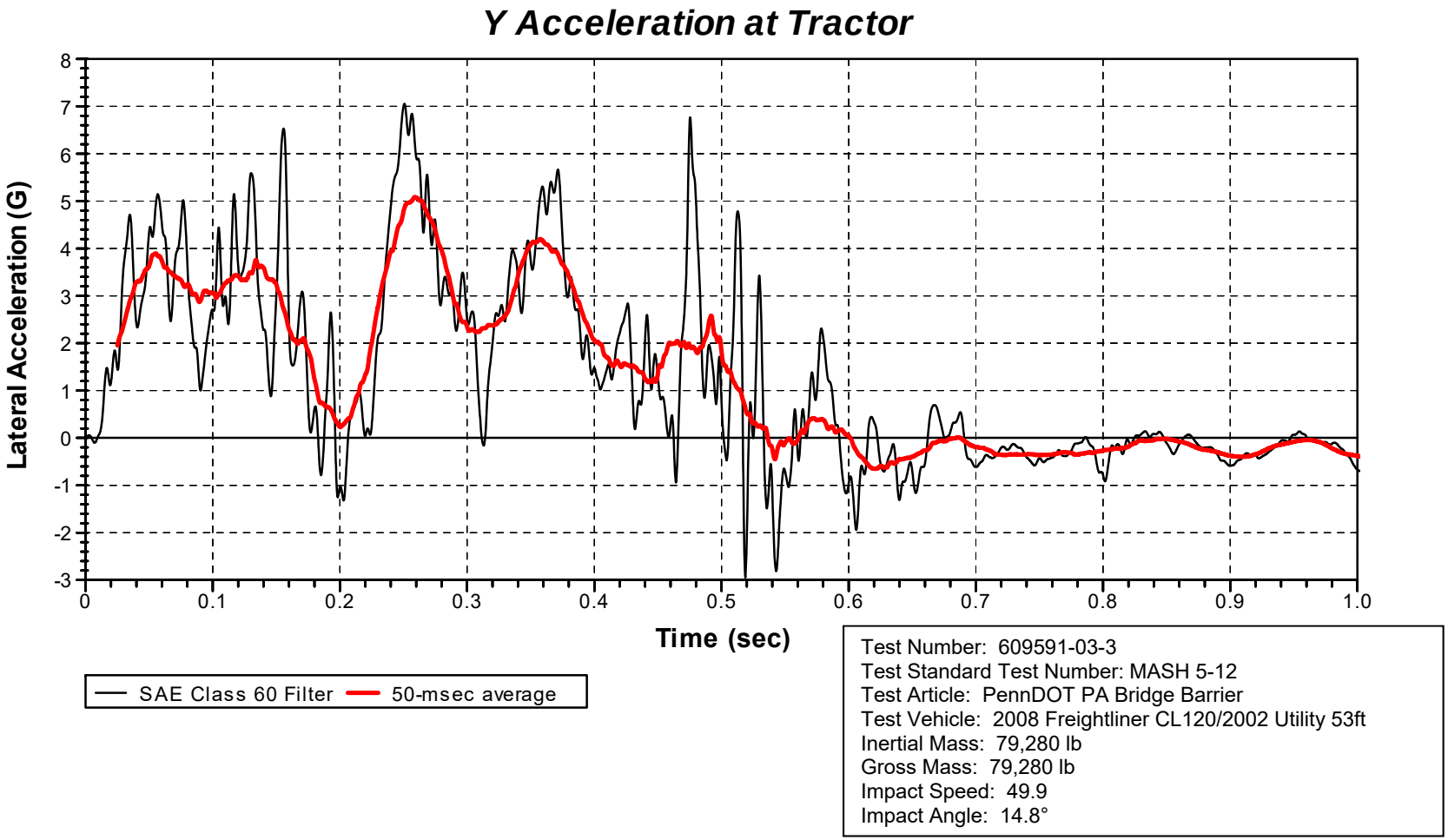


Figure E.12. Vehicle Lateral Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located at Tractor).

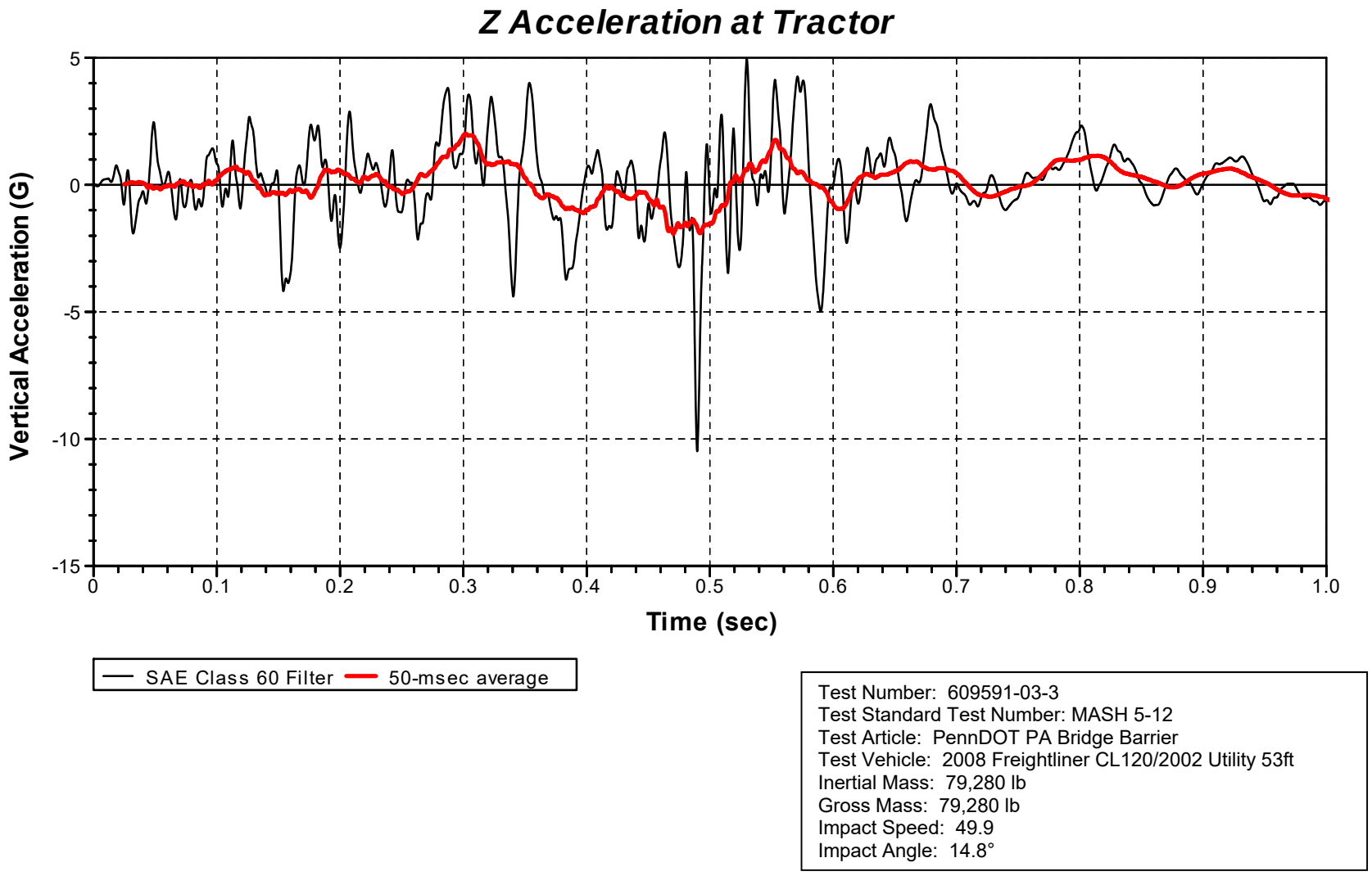


Figure E.13. Vehicle Vertical Accelerometer Trace for Test No. 609591-03-3 (Accelerometer Located at Tractor)

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSTIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSTIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	Square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lb/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)