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# **Laboratory Tire Bead Unseating – Evaluation of New Equipment, Pressures and “A” Dimension From ASTM F-2663-07as**

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16. Abstract Under the TREAD Act, NHTSA was assigned the task of revising and updating the Federal Motor Vehicle Safety Standards (FMVSS) for tires. Part of this effort included research to support a possible update or replacement of the FMVSS No. 109 Tubeless Tire Bead Unseating Resistance test. In the current FMVSS test, a profiled metal “block” is located perpendicular to the sidewall of a mounted and inflated tire, then force is applied until the bead component (region where the tire meets the rim) unseats with the resulting air loss or the specified minimum force value is achieved. The objective of the test is to evaluate the ability of the tubeless tire’s bead to remain seated on the rim and retain tire inflation pressure when the tire is subjected to high lateral forces such as during severe turning maneuvers, curb scrubbing, or negotiating deep ruts in the roadway. Since introduction of the FMVSS No. 109 in 1967, there has been a steady introduction of larger wheel diameters and smaller tire sidewall aspect ratios. For tires with rim codes above 18 (e.g., <i>P345/30R18</i> ), the bead unseating blocks in the current Federal standard can contact the rim or slide down the tread during tests (especially for low aspect ratio tires). To account for these issues, an ASTM task group working to develop a new standard test method for bead unseat testing (ASTM F2663-07a) proposed using the original FMVSS No. 109 equipment and two larger-radius bead-unseating blocks with a new method for positioning the block on the tire sidewall.  The agency conducted an independent evaluation of the new ASTM standard using nineteen models of passenger and light truck tires that ranged in nominal widths from 155 to 345 millimeters, aspect ratios from 30 to 80, and rim codes from 12 to 28. For some tires, tests were conducted at two inflation pressures to evaluate the effects of pressure on unseat force. The three blocks used in the ASTM standard (the original FMVSS No. 109 block and two new designs) allowed testing of all tires to the minimum FMVSS No. 109 bead unseat force requirements without contacting the rims. The new ASTM method for positioning the block on the sidewall generally produced lower unseat forces than the method in the current Federal standard, meaning that the ASTM method is more severe. Furthermore, occurrences of the test block sliding across the tread when testing with the FMVSS No. 109 positioning method did not occur when using the new ASTM method. As expected, the results of tests at two tire inflation pressures indicated that tire bead unseating force was sensitive to inflation pressure, with lower unseating forces recorded at lower pressures.			
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## Executive Summary

Under the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, the National Highway Traffic Safety Administration (NHTSA) was assigned the task of revising and updating the Federal Motor Vehicle Safety Standards (FMVSS) for tires. Part of this effort included research to support a possible update or replacement of the FMVSS No. 109 Tubeless Tire Bead Unseating Resistance test. The tire bead is defined in Standard No. 109 as “*that part of the tire made of steel wires, wrapped or reinforced by ply cords, that is shaped to fit the rim.*” The bead is the lowermost region of the tire that contacts a matching profile on the rim via an interference fit. In the process of tire pressurization, the bead is forced against the rim flange to form an airtight seal. During a bead unseat, exterior forces push the bead up over the interior bead retention safety hump in the rim profile, and the inflation pressure within the tire cavity is released.

The FMVSS No. 109 Tubeless Tire Bead Unseating Resistance test contains specifications for two profiled metal “bead unseating blocks.” The standard allows use of either the “Figure 2” or “Figure 2A” block for tire testing, with the exception that only the Figure 2A block can be used for tires with an inflation pressure of 60 psi (420 kPa), which are generally “T” type spare tires. In Standard No. 109, the bead unseat block is located perpendicular to the sidewall of a mounted and inflated tire at a specified distance from the wheel centerline (“Dimension A”). The block is then pushed into the tire sidewall at a rate of 50 mm/min (2 in/min). The force applied to the sidewall is increased until the bead region unseats with resulting air loss, or the specified minimum force value is achieved, whichever occurs first. The objective of the test is to evaluate the ability of the tubeless tire’s bead to remain seated on the rim and retain tire inflation pressure when the tire is subjected to high lateral forces such as during severe turning maneuvers, curb scrubbing, or negotiating deep ruts in the roadway.

The equipment and procedures in the Standard No. 109 bead unseat test, which was issued in 1967, appear to be derived from the 1965 version of SAE J918 - “*Passenger Car Tire Performance Requirements and Test Procedures.*” The test was designed in the 1960s to evaluate bias tires when tubes were eliminated from use. When Standard No. 109 was issued in 1967, the typical light vehicle tire had a 78 to 85 percent aspect ratio and was mounted a wheel with a 14- to 15-inch diameter (now referred to as “rim codes” 14 or 15). Since then, aftermarket tires have reached aspect ratios as low as 20 and rim codes as large as 32. While the bead unseat test in Standard No. 109 has specifications for testing tires to rim code 20, the equipment (test block) specified in the standard will often not accommodate testing of rim codes greater than 18 (*e.g.*, *P345/30R18*), especially for low aspect ratio tires such as a 30-series design (*e.g.*, *P345/30R18*).

As a result, the ASTM Committee F09.30 on Laboratory (Non-Vehicular) Testing established a cross-industry task group to develop a new tire bead unseat standard test method. In its development approach, the committee explored using the current bead unseat test machine in the Federal standard with a new assortment of test blocks. One of the two original blocks in the FMVSS No. 109, the “Figure 2A” block, was retained and two larger-radius blocks were substituted for the “Figure 2” block to allow for the testing of tires of rim codes 19 to 30. The task group also explored a new method for positioning the block 75 percent up the tire sidewall as an option to the Dimension A’s specified in Standard No. 109 as a means of accommodating the testing of low-

profile tires. The F09.30 task group's development effort eventually culminated in the ASTM F2663-07 and subsequent ASTM F2663-07a standard test methods.

As part of its own efforts to upgrade the bead unseat test in FMVSS No. 109, the agency conducted its own independent testing to evaluate the feasibility of the new equipment and procedures in ASTM F2663-07a. Testing was conducted on 14 passenger and 5 light truck (load ranges D & E) tire models that were selected to give a wide range of tire sizes, aspect ratios and rim codes. The test tires had widths from 155 to 345 millimeters, aspect ratios from 30 to 80, and rim codes from 12 to 28. The tires were selected to evaluate the limits of the test equipment in terms of physical dimensions and possible forces required to unseat the tire. The study was designed to provide the agency with its own evaluation of F2663-07a, as well as to evaluate the three major variables in the possible test design: 1) Block designs, 2) the "A" Dimension, and 3) inflation pressure.

The three new suggested ASTM blocks allowed testing of all tires to the minimum FMVSS No. 109 bead unseat force requirements without contacting the rims. One test block, "ASTM 2B," was tested but not ultimately selected by ASTM for inclusion in the F2663-7a test method due to the amount it varied from the profile of the original block in FMVSS No. 109. With the other two blocks, the new ASTM method for positioning the block on the sidewall generally produced lower unseat force results in 12 of 13 comparisons than the method in the current Federal standard, meaning that the ASTM method is more severe. Furthermore, occurrences of the test block sliding across the tread instead of pushing on the sidewall when testing with the FMVSS No. 109 positioning method, an issue with the test that is cited internationally<sup>1</sup>, did not occur when using the new ASTM method. However, since the blocks were only tested with aspect ratios as low as 30 percent and tires with lower aspect ratio tires are now available, instances of blocks sliding across the tread may still be possible.

The passenger tires exceeded the minimum force requirements when tested at the pressures currently specified in Standard No. 109. Due to a lack of pressure specifications for light-truck tires in Standard No. 109 at the time of testing, the five load range D or E light-truck tires were tested at a lower pressure (a more severe condition) than the pressures subsequently added to the Federal standard. Nevertheless, the light-truck tires still exceeded the minimum force requirements when tested at the lower pressures. As expected, the results of tests at two tire inflation pressures indicated that tire bead unseating force was sensitive to inflation pressure, with lower unseating forces recorded at lower pressures.

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<sup>1</sup> United Nations Economic Commission for Europe (UN ECE), (2007). *GTR-Tyres Industry Preliminary Information Sheet*. "The introduction of low aspect ratio tyres (small section height) in addition to large rim diameter tyres has rendered the current US regulation inadequate. Specifically, the specified test block geometry is of such curvature that the block contacts large diameter test rims during the test. The "A" dimension developed for large section height tyres can result in the test block barely contacting the tread shoulder, and subsequently slipping off the tread during the test. This can result in a low test result, but not a bead unseat." <http://www.unece.org/trans/doc/2007/wp29grrf/TYREgtr-02-05e.pdf>

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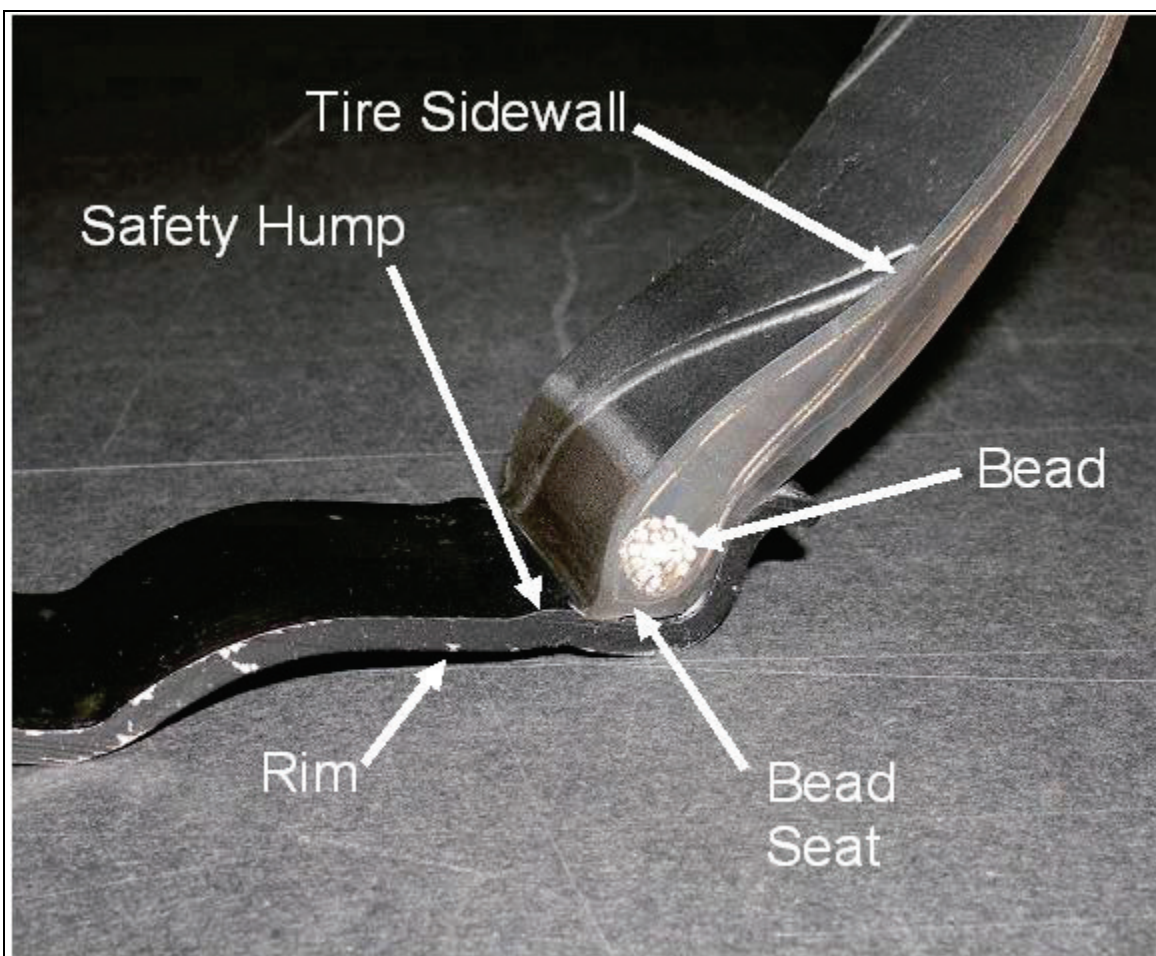
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## 1.0 INTRODUCTION

Under the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, the National Highway Traffic Safety Administration (NHTSA) was assigned the task of revising and updating the Federal Motor Vehicle Safety Standards (FMVSS) for tires. Part of this effort included research to support a possible update or replacement of the FMVSS No. 109 Tubeless Tire Bead Unseating Resistance test. The tire bead is defined in Standard No. 109 as “that part of the tire made of steel wires, wrapped or reinforced by ply cords, that is shaped to fit the rim.”<sup>2</sup> The bead is the lowermost region of the tire that contacts a matching profile on the rim via an interference fit (Figure 1.1). In the process of pressurization, the bead is forced against the rim flange to form an airtight seal. During a bead unseat, exterior forces push the bead up over the interior bead retention safety hump in the rim profile and the air inside the tire cavity is released.



**Figure 1.1. Cross-Section of Rim and Tire Bead Area (Photo Used With Permission From Standards Testing Laboratories, Inc.)**

The FMVSS No. 109 Tubeless Tire Bead Unseating Resistance test contains specifications for two profiled metal “bead unseating blocks.” The standard allows use of either the “Figure 2” or

<sup>2</sup> 49 CFR § 571.109, paragraph S3, *Definitions*.

“Figure 2A” block for tire testing, with the exception that only the Figure 2A block can be used for tires with an inflation pressure of 60 psi (420 kPa), which are generally “T” type spare tires. In Standard No. 109, the bead unseat block is located perpendicular to the sidewall of a mounted and inflated tire at a specified distance from the wheel centerline (“Dimension A”). The block is then pushed into the sidewall at a rate of 50 mm/min (2 in/min). The force applied to the tire sidewall is increased until the bead region unseats with resulting inflation pressure loss, or the specified minimum force value is achieved. (More details on the test fixture are located in the test equipment section.) The objective of the test is to evaluate the ability of the tubeless tire’s bead to remain seated on the rim and retain tire inflation pressure when the tire is subjected to real-world high lateral forces such as during severe turning maneuvers, curb scrubbing, or negotiating deep ruts in the roadway.

The equipment and procedures in the FMVSS No. 109 Tubeless Tire Bead Unseating Resistance test, which was issued in 1967, were adopted from the 1965 version of SAE J918 - “*Passenger Car Tire Performance Requirements and Test Procedures.*”(1),(2),(3) This test was designed to evaluate bias tires when tubes were eliminated from use. When Standard No. 109 was issued in 1967, the typical light vehicle tire had a 78 to 85 percent aspect ratio and was mounted on a wheel with a 14- to 15-inch diameter (now referred to as “rim codes” 14 or 15). From 1949 to 1970, the majority of passenger tire had aspect ratios of 90 to 80-series on 10 to 15-inch diameter wheels.<sup>3</sup> The bias and bias belted tire of the 1970s included 78 to 50 series tires in 13, 14, and 15 rim codes. The Tire Business publication has tracked the growth of tire aspect ratios<sup>4</sup> and rim sizes<sup>5</sup> recognized by the Tire & Rim Association since 1985. In 1985 there were five aspect ratios of 80, 75, 70, 60, 50 and five rim codes of 12 to 16. By 2009 there were twelve aspect ratios of 80 to 25 and thirteen rim codes of 12 to 24. Since then, replacement tire and wheel packages have become available in aspect ratios as small as 20 series<sup>6</sup> and rim codes up to 32.<sup>7</sup> Also happening during this timeframe was the almost total conversion of passenger and light truck tire technology from bias and bias-belted designs to radial designs.<sup>8</sup>

The primary issue with testing the larger size rim codes is the small radius of the test block specified in Standard No. 109. The block has too small of a radius to accommodate the larger rim codes, often resulting in contact with the rim before the test has completed. The second issue is the specifications for distance or “dimension A” in Standard No. 109, which determines where the block is located on the sidewall in relation to the centerline of the wheel. This distance is defined as “dimension A” in Standard No. 109 and the “A” Dimension in F2663-07. Both terms are synonymous. For clarity in this report, the term “A” Dimension will be used. Standard No. 109 specifies fixed distances for the block placement on the tire sidewall based on wheel size, with dimensions that were determined for prior era tires with relatively tall cross-sections in comparison to today’s low aspect ratio tires. For low aspect ratio tires, this issue can result in the block sliding down the outside of the tire tread rather than continuing to push on the sidewall. Due to the ambiguity in Standard No. 109, a tire still passes the test if the specified minimum force val-

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<sup>3</sup> The TireRack website has a Tire Size Conversion Chart from that contains equivalent sizes from 1949 onward (03/17/2009). [http://www.tirerack.com/tires/tiretech/45\\_conversionchart.html](http://www.tirerack.com/tires/tiretech/45_conversionchart.html)

<sup>4</sup> Tire Business, February 2010, chart “Growth in tire aspect ratios,” source the Tire & Rim Association.

<sup>5</sup> Tire Business, February 2010, chart “Growth in auto rim diameters,” source the Tire & Rim Association.

<sup>6</sup> E.g. Kuhmo Exasta SPT KU31 375/20R21 103Y, 220/AA/A tires.

<sup>7</sup> E.g. Asanti AF401 or Lexani LT-703 32-inch wheels with 335/30R32 116V Yokohama Parada tires.

<sup>8</sup> Radial tires were 99 percent of passenger tire shipments in 2005 (Modern Tire Dealer 2006, 51).

ue is achieved by contact with the rim or by sliding across the tread. However, in an attempt to get a meaningful result, some testers would reposition the bead unseat shoe to an alternate location on the sidewall. One company equated the original “A” dimension to being 75 percent of the height of the original 1960s-era tires, and therefore used that as an alternate position if the Standard No. 109 “A” dimension could not be used.

Following the TREAD Act, the March 5, 2002, Notice of Proposed Rulemaking for FMVSS No. 139 proposed completely replacing the Standard No. 109 bead unseating test equipment and procedures with the Toyota “air loss test.”<sup>9</sup> The Toyota test was thought to better resemble the tire-road interaction during severe handling maneuvers in that the test applied the unseat force though the tread and tread shoulder (rather than on the sidewall) via travel of a wedge-shaped ram. However, subsequent agency evaluations of the Toyota test yielded results identical (i.e., no failures) to those derived from testing tires with the current test. The agency therefore decided in the final rule that there would be no advantage to switching to the Toyota test, and deferred upgrading the test in the new FMVSS No. 139.<sup>10</sup> Later, drafts of the new ASTM F2663-07a standard test method were made available to participating task group members for preliminary evaluation. The ASTM method suggested using the current bead unseat test machine in the Federal standard with up to three larger-radius blocks and a new method for positioning the block 75 percent up the sidewall, which automatically compensates for the wide range in tire aspect ratios.

In 2005, the agency initiated independent testing to evaluate the feasibility of ASTM F2663-07a. Testing was conducted on 19 tire models that were selected to give a wide range of tire sizes, aspect ratios, and rim codes. The tires used had widths from 155 to 345 millimeters, aspect ratios from 30 to 80, and rim codes from 12 to 28. The tires were selected to evaluate the limits of the test equipment in terms of physical dimensions and possible forces required to unseat the tire. The study was designed to provide NHTSA with its own evaluation of F2663-07a and of the three major variables in the possible test design: 1) Block designs, 2) the “A” Dimension (which determines the placement of the block on the tire sidewall), and 3) inflation pressure. The original FMVSS No. 109 block was designated “Historical 2A.” The new blocks were designated “ASTM 2B,” “BFNT 2B,” and “BFNT 2C.” Block Historical 2A was for rim codes 12 to 20.<sup>11</sup> Block ASTM 2B was for rim codes 19 to 30, Block BFNT 2B was for rim codes 19 to 24, and BFNT 2C was for rim codes 25 to 30. The Akron Rubber Development Laboratory (ARDL) in Akron, OH was contracted by NHTSA to do the testing. The evaluation included inspections of physical clearances and effect of the test variables on the unseating force.

The “A” Dimension is used to adjust the fixture for different rim sizes. This dimension in the current version of FMVSS No. 109 specifies fixed “A” Dimensions in ½-inch increments based on the rim codes (in whole inches). These fixed “A” Dimensions based on the relatively tall tires of the 1960s can prevent the block from contacting the tire or allows the block to slide across the tread on the new tire designs. ASTM F2663 contains a provision to calculate the “A” Dimension based on the rim code and overall diameter of the tire. This study completed testing at both positions on multiple tires.

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<sup>9</sup> 67 Fed. Reg. 10050, 10061 (Mar. 5, 2002).

<sup>10</sup> 68 Fed. Reg. 38116, 38118 (Jun, 26, 2003).

<sup>11</sup> FMVSS No. 109 has “Dimension A” specifications for rim codes up to 20.

To gain an understanding on how test pressures affect bead unseat force, two test pressures were evaluated for passenger and light-truck tires. Prior to the issuance of FMVSS No. 139, LT tires were not covered in FMVSS No. 109, and consequently the standard did not contain bead unseat test pressures for light truck (LT) tire testing. Therefore, 241 kPa (35 psi) was used as the base-line test pressure for all LT tires testing since it was the lowest known pressure for OE fitments using LT Load Range E (LT LRE) tires. The FMVSS No. 139 was modified in December 2005 to adopt the following pressures for LT tires:

FMVSS No. 139<sup>12</sup> S6.6 *Tubeless tire bead unseating resistance*.  
...Each tire shall comply with the requirements of S5.2 of § 571.109.  
For light truck tires, the maximum permissible inflation pressure to be used  
for the bead unseating test is as follows:  
Load Range C ..... 260 kPa.  
Load Range D ..... 340 kPa.  
Load Range E ..... 410 kPa.

The pressures used for bead unseat testing of light truck tires in this test program were lower than those used in FMVSS No. 109, which in terms of tire bead unseating mean that they were more severe.

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<sup>12</sup> 49 CFR § 571.139, Paragraph S6.6, *Tubeless tire bead unseating resistance*.

## 2.0 TIRE BEAD UNSEATING TEST AND EQUIPMENT

The FMVSS No. 109 Bead Unseat test was designed to push the tire sidewall with a test “block” to force the bead area of the tire away from the rim flange. At this point, the bead rides up over the rim’s safety hump, which is designed to retain the bead, and the inflation gas inside the tire cavity is released. The block is attached to an arm that has a pivot 465 millimeters on the opposite side of the rim center (Figure 2.1). The distance to the pivot is the sum of 465 mm and the “A” Dimension. The “A” dimension is the dimension from the center of the tire and determines where the block is located in relation to the tire. The force to unseat the bead is measured directly above the block center of pressure. Since the force is measured directly above the block it is not a lever, only a method to maintain the location and consistent geometry.

In testing some low aspect ratio tires, the FMVSS No. 109 specified “A” Dimension (Figure 2.1) and equipment results in the bead unseat shoe not contacting the sidewall, or in some cases even the tread. Therefore, in these instances the test setting specified in FMVSS No. 109 could not produce a test result. When such instances occurred in this test program, the “best result” was obtained and used to compare with using the ASTM method. ASTM F2663-07a contains a provision to calculate the “A” Dimension to place the block at 75 percent of the sidewall (away from the rim flange) or the FMVSS No. 109 “A” Dimension, whichever is less. The “75% rule” was incorporated into the ASTM standard to compensate for the reduced sidewall heights with the newer lower aspect ratio designs. Due to the larger diameter rims on modern tires, in developing F-2663-07a, ASTM researched and designed two new blocks for rim codes 19-24 and 25-30.

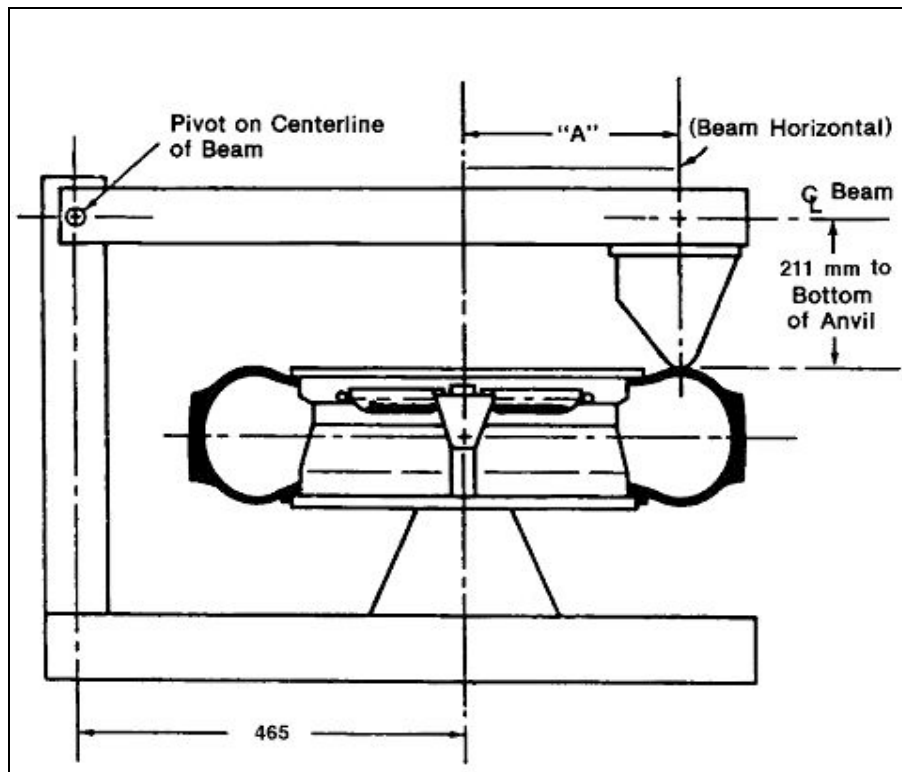


Figure 2.1. Bead Unseating Fixture Schematic (Source: FMVSS No. 109)

**Table 2.1. Bead Unseating FMVSS No. 109 “A” Dimension Values<sup>13</sup>**

Wheel size	“A” Dimension for tires with maximum inflation pressure			
	Other than 60 psi (in)	Other than 420 kPa, mm	60 psi (in)	420 kPa, mm
20	13.50	345		
19	13.00	330	12.00	305
18	12.50	318	11.40	290
17	12.00	305	10.60	269
16	11.50	292	9.90	251
15	11.00	279	9.40	239
14	10.50	267	8.90	226
13	10.00	254	8.40	213
12	9.50	241		
11	9.00	229		
10	8.50	216		
320	8.50	216		
340	9.00	229		
345	9.25	235		
365	9.75	248		
370	10.00	254		
390	11.00	279		
415	11.50	292		

Note: 60-psi (420-kPa) tires are generally “T” type spare tires

## **2.1 Laboratory Bead Unseating by Akron Rubber Development Labs (ARDL)**

All laboratory bead unseat testing was completed under contract by the Akron Rubber Development Labs (ARDL) in Akron, OH. The geometry of the test apparatus is the same as specified in FMVSS No. 109 and ASTM F2663-07a. However, the fixture included a test arm long enough to adjust for the increased “A” Dimensions. ARDL purchased all of the test blocks from the same vendor as used by ASTM in their development program.

### **2.1.1 Bead Unseating Fixture**

The bead unseat test fixture at ARDL (Figure 2.2) was designed to fit into an existing MTS load frame (Figure 2.2 & Figure 2.3). The load frame was computer controlled and programmed to travel at the required 50 mm (2.0 inches) per minute. It was also capable of recording the load and deflection during each application of the load, in which the data was collected and plotted.

<sup>13</sup> 571.109 Standard No. 109; New pneumatic and certain specialty tires 10/11/2007.





**Figure 2.2. Bead Unseating Fixture at ARDL**



**Figure 2.3. MTS Load Frame and Computer at ARDL**

Four blocks (also called anvils or shoes) were obtained for the testing. The FMVSS No. 109 contains two bead unseat block designs, with dimensions defined in either Figure 2 or Figure 2A of the standard. The FMVSS No. 109 block used by this project is the block specified in Figure 2A of the standard and is the original block design for testing passenger car tires and Temporary

Spare tires. The relief on the inside radius is to permit clearance for the rim on “T” type tires. It was identified as “Historical 2A” (Figure 2.5).

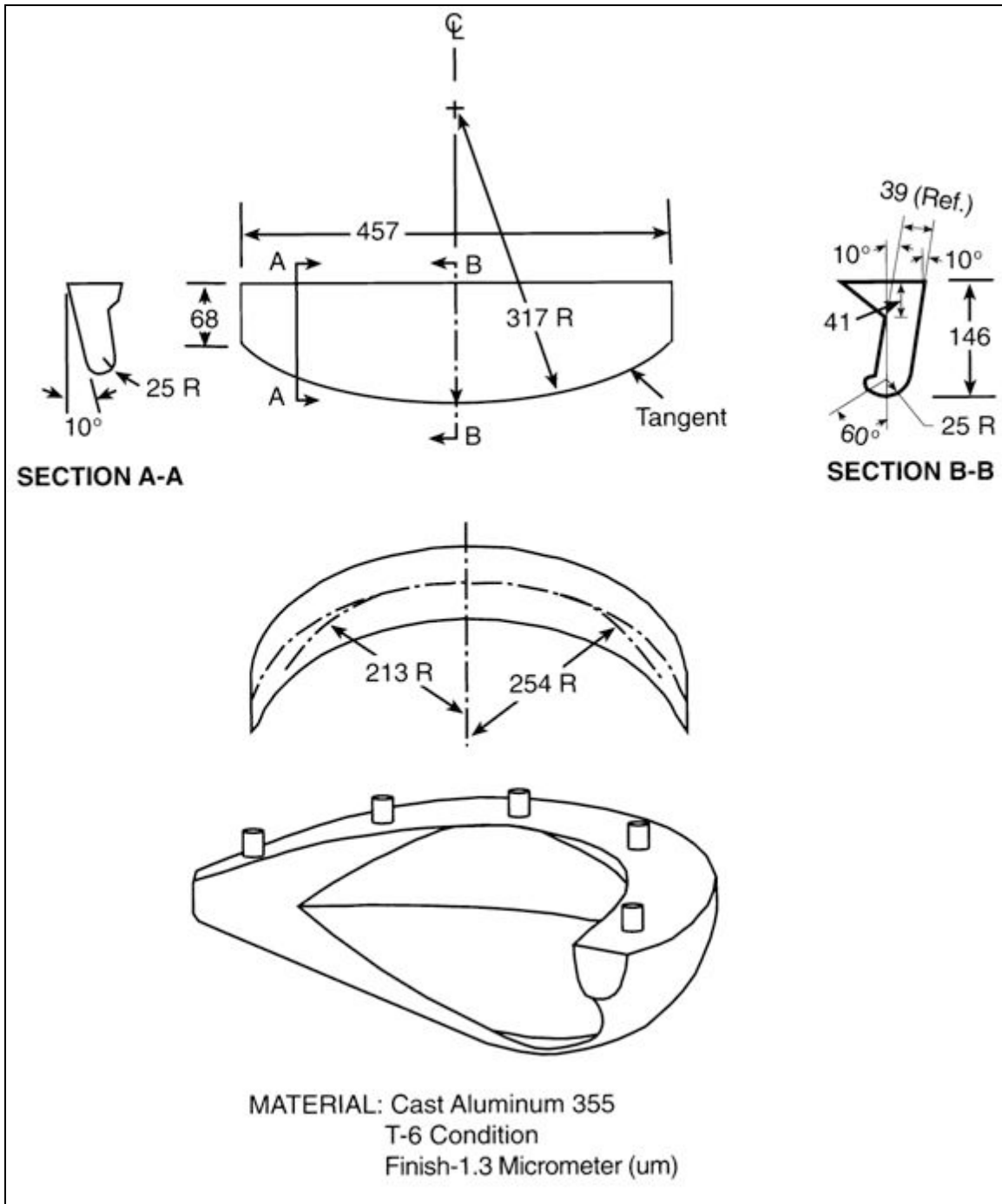


Figure 2.4. Bead Unseating Block Historical 2A Diagram (FMVSS No. 109)





**Figure 2.5. Bead Unseating Block Historical 2A (FMVSS No. 109)**

During the development of ASTM F2663-7a, three new blocks were proposed and tested. The two blocks designed to test tires with rim codes 19 to 24 were evaluated by NHTSA (independently) and are shown in Figure 2.6. Block ASTM 2B was an early prototype, which was later eliminated by the ASTM test program in favor of the BFNT 2B block. The BFNT 2B (Figure 2.7) block was designed to follow more closely the original block designs for the smaller rim codes. This was accomplished by scaling up the approximate surface area contact from the Historical 2A block in the FMVSS No. 109.



**Figure 2.6. Bead Unseating Blocks BFNT 2B and ASTM 2B**



**Figure 2.7. Bead Unseating Block BFNT 2B**

The fourth and final block BFNT 2C (Figure 2.8) was designed, as was 2B, to provide a surface area contact scaled up from the block in FMVSS No. 109, but with larger diameters for tires with rim codes from 25 to 30. Complete dimensions for all of the blocks are available in ASTM F-2663-07a.



**Figure 2.8. Bead Unseating Block BFNT 2C**

### **2.1.2 Test Procedure**

The tire is mounted on a test rim without lubrication and is conditioned in the laboratory environment for 24 hours. The air pressure is set as specified in the test procedure. The tire and wheel assembly is installed on the machine with the valve side facing up. The diameter and width of the tire are measured. The rim code and tire diameter are used to determine or calculate the “A” Dimension. The width is used to determine the minimum load requirement it must meet.

The tire is marked at five equally spaced locations at 0 degrees, 72 degrees, 144 degrees, 216 degrees and 288 degrees to denote the radial distance from the DOT number. The block is mechanically forced against the side of the tire at 50 millimeters (2 inches) per minute at each location, while measuring the force and pressure, until the minimum required force is reached or the bead unseats. The corresponding force is then recorded. During the FMVSS No. 109 test, this step is repeated once at each location for a total five measurements. The final test result for passing the test is the lowest value of the five. This test matrix included multiple block configurations, “A” Dimensions, and test tire pressures to evaluate the differences between them

During the testing, the load would be applied to the sidewall of each of the tires with the test criteria being specified in the test plan until: 1) air loss was heard, 2) the bead unseated, or 3) metal-to-metal contact was imminent. Photographs were taken at the start and end of each test. The data was recorded and assembled into Excel workbooks for each test.

### **2.1.3 Test Tires and Wheels**

The tires selected for testing represented the dimensional extremes that could be used on the highway. Tires were selected to evaluate the limits of the test equipment in terms of physical dimensions and possible forces required to unseat the tire. Nineteen tire models were selected to give a wide range of tire sizes, aspect ratios, and rim codes. The tires used had widths from 155 to 345 millimeters, aspect ratios from 30 to 80, and rim codes from 12 to 28. Five of the sizes were light-truck (LT) tires to allow evaluation of the equipment for use with FMVSS Nos. 139 / 109 requirements. The tires focused on the extremes of sizes, from those used for “high flotation” (off-road traction) to those designed for “high performance” applications. The 14 tire groups selected to represent commercially available passenger tires included very small tires (155R12) to very large (325/30R28). Within these groups, tire aspect ratios of 30 to 80 were selected. While some tires were exotic, all tires selected for testing were certified to DOT standards for street use. A complete list of the tires is found in Table 2.2. Figure 2.9 contains a photograph of many but not all of the tires tested.

**Table 2.2. Test Tires Specifications**

<b>Tire Type</b>	<b>Construction</b>	<b>Designation</b>	<b>Tire Brand Name</b>	<b>Tire Model</b>	<b>Tire Size</b>	<b>Test Wheel Size</b>
M7	Light Truck	High Flotation	BFGoodrich	MUD Terrain T/A KM	35x12.50R18LT LRD	18x10J
M5	Light Truck	High Flotation	BFGoodrich	All Terrain T/A KO	37x12.50R20LT LRD	20x10J
T1	Light Truck	LT-Metric	Mickey Thompson	Baja Radial MTZ Tire	LT375/50R18 LRE	18x12J
G5	Light Truck	LT-Metric	Goodyear	WRANGLER AT/S	LT275/65R20 LRE	20x8J
R1	Light Truck	LT-Metric	Pirelli	Scorpion ATR	LT325/45R24 LRE	24x11J
D1	Passenger	Metric	Arizonian [Discount Tire]	Premium Metric	155R12	12x4
C1	Passenger	Metric	General	Ameri G4S	155/80R13	13x4.5J
M2	Passenger	Metric	Michelin	Pilot Sport Cup	345/30R18	18x12J
A1	Passenger	Metric	Avon	Tech ST	275/45R20	20x9J
K1	Passenger	Metric	Kumho	ECSTA STX	305/40R23	23x11J
M8	Passenger	Metric	BFGoodrich	gForce T/A KDW 2	305/35R24	24x11J
Y1	Passenger	Metric	Yokohama	ADVAN ST	305/35R24	24x11J
K2	Passenger	Metric	Kumho	ECSTA STX	325/35R28	28x10.0
M9	Passenger	P-Metric	Uniroyal	TigerPaw AWP	P155/80R13	13x4.5B
U1	Passenger	P-Metric	Dunlop	SP Sport 5000	P205/60R15	15x6J
M6	Passenger	P-Metric	BFGoodrich	gForce T/A Drag Radial	P345/30R18	18x12J
G7	Passenger	P-Metric	Goodyear	Eagle F1	P325/30ZR19	19x12J
Z1	Passenger	P-Metric	Fuzion	ZRi	P275/45R20	20x9J
C6	Passenger	P-Metric	Continental	CrossContact UHP	305/40R23	23x11J



**Figure 2.9. Test Tires**

All wheels were purchased new for the test project. All were the approved rim width and contour for the tire size specified by T&RA (Tire and Rim Association) or ETRTO (European Tire and Rim Technical Organization). This contour specifies the dimensions of the seat area and safety hump of the rim (refer back to Figure 1.1). The tire beads were washed and dried before being mounted on a clean, corrosion free test rim. No lubrication or adhesives were used during the mounting and testing.

### **3.0 TEST PLAN**

#### **3.1 Laboratory Bead Unseating Test Plan**

This test plan was designed to provide NHTSA with its own evaluation of F2663-07a and of the three major variables in the possible test design: 1) block designs, 2) the “A” Dimension that determines the placement of the block on the tire sidewall (from FMVSS No. 109 or the calculated 75-percent rule found in the ASTM standard), and 3) inflation pressures. The complete list of tires and test schedule is shown in Table 3.1 and Table 3.2. All comparisons would use the lowest of the five test runs for each combination. This is the same as the FMVSS No. 109 test procedure reporting criteria.

##### **3.1.1 Light-Truck Tires**

The light-truck tires tested ranged from rim codes 18 to 24. Two tire models in the 12-18 rim code range were tested with the Historical 2A block. Seven tire models in the 19-24 rim code range were tested with the ASTM 2B and BFNT 2B test blocks. All five light truck tire models were tested at two pressures. Due to the fact that the test pressures for light-truck tire bead unseat testing were not yet specified in the FMVSS at the time of the test program, the baseline test pressure for all light-truck tires was set at 35 psi, which was the lowest known OE fitment for load range E light-truck tires. The second test pressure was set to 50 psi for load range D tires, and either 50 or 60 psi for load range E tires. Since the light truck tires tested were not low profile designs, they were only tested with the standard FMVSS No. 109 “A” Dimension (i.e., did not require ASTM’s alternate method of placing the unseat block 75% up the sidewall).

##### **3.1.2 Passenger Car Tires**

The passenger car tires tested ranged from rim codes 12 to 28. Six tire models in the 12-18 rim code range were tested with the Historical 2A block. Two new tires of the first three tire models in Table 3.2 in the 12-18 rim code range (C1, D1, & M9) were tested per the standard FMVSS No. 109 test conditions to evaluate the variability of the bead unseat force between two new tires of the same model. Only one tire of model C1 was tested at the correct pressure and could not be included in the evaluation of variability. One new tire of each of the other three tire models in the 12-18 rim code range was tested using either the FMVSS No. 109 “A” Dimension or the ASTM 75-percent rule. No evaluation of the effects of pressure was done for these smaller tires.

Members of the ASTM committee were concerned that the ASTM 2B block submitted for evaluation had too little contact area on the tire. Therefore, a second block (BFNT 2B) was designed with the goal of matching the contact area of the Historical 2A block. The new BFNT 2B profile had increased arc and flattened impact radius when compared to the ASTM 2B block profile. Therefore, a comparison was needed to determine clearance and load generation properties of the two blocks, as well as their overall effects on the severity of the test. As a result, all seven tire models in the 19-24 rim code range were evaluated using both the ASTM 2B and BFNT 2B test blocks. One tire of each of the first two tire models was tested at the standard FMVSS No. 109 test conditions using two different blocks. Two more tire models were tested at the standard test conditions and again at a higher pressure. One tire model was tested at the standard pressure but

with the 109 “A” Dimension and the ASTM 75-percent rule “A” Dimension. Two more tire models were tested at two test pressures using both the FMVSS No. 109 “A” Dimension and the ASTM 75-percent rule.

The single tire model in the 25-30 rim code range was tested with the BFNT 2C block using both the FMVSS No. 109 “A” Dimension and the ASTM 75-percent block-positioning rule.

**Table 3.1. Test Plan – Light-Truck Tires**

Rim Code Range	Tire Type	Load Range	Tire Number	Block (Designation)	Test Pressure (psi)	FMVSS No. 109 “A” Dimension (inch)
12-18	M7	D	3043	Historical 2A	35	12.5
			3043	Historical 2A	50	12.5
	T1	E	3022	Historical 2A	35	12.5
			3022	Historical 2A	50	12.5
19-24	M5	D	3046	ASTM 2B	35	13.5
			3046	ASTM 2B	50	13.5
			3047	BFNT 2B	35	13.5
			3047	BFNT 2B	50	13.5
			3047	BFNT 2B	50	13.5
	R1	E	3031	ASTM 2B	35	15.5
			3031	BFNT 2B	35	15.5
			3032	ASTM 2B	50	15.5
			3032	BFNT 2B	50	15.5
	G5	E	3016	ASTM 2B	35	13.5
			3016	BFNT 2B	35	13.5
			3018	ASTM 2B	60*	13.5
3018			BFNT 2B	60*	13.5	

\*Note: The upper limit test pressure for light-truck load range E tires were set at either 50 psi or 60 psi to provide data for a scenario where load range E tires could have been assigned a higher bead unseat test pressure than load range D tires.

**Table 3.2. Test Plan – Passenger Car Tires**

<b>Rim Code Range</b>	<b>Tire Type</b>	<b>Tire Number</b>	<b>Block (Designation)</b>	<b>Test Pressure (psi)</b>	<b>FMVSS No. 109 "A" Dimension (inch)</b>	<b>75% Rule "A" Dimension (inch)</b>
12-18	C1	3049	Historical 2A	26	10	
		3050	Historical 2A	26	10	
	D1	3034	Historical 2A	26	9.5	
		3035	Historical 2A	26	9.5	
	M9	3025	Historical 2A	26	10	
		3026	Historical 2A	26	10	
	M2	3037	Historical 2A	26	12.5	
		3037	Historical 2A	26		12.15
	M6	3004	Historical 2A	26	12.5	
		3004	Historical 2A	26		12.11
	U1	3013	Historical 2A	26	11.5	
		3013	Historical 2A	26		11.14
19-24	A1	3001	ASTM 2B	32 (XL Tire)	13.5	
		3001	BFNT 2B	32 (XL Tire)	13.5	
	Z1	3040	ASTM 2B	26	13.5	
		3040	BFNT 2B	26	13.5	
	C6	3011	ASTM 2B	26	15	
		3011	ASTM 2B	32	15	
		3012	BFNT 2B	26	15	
		3012	BFNT 2B	32	15	
	K1	3019	ASTM 2B	26	15	
		3019	ASTM 2B	32	15	
		3020	BFNT 2B	26	15	
		3020	BFNT 2B	32	15	
	G7	3064	ASTM 2B	26	13.0	
		3064	ASTM 2B	26		12.42
		3065	BFNT 2B	26	13.0	
		3065	BFNT 2B	26		12.42
	M8	3007	ASTM 2B	26	15.5	
		3007	ASTM 2B	26		15.17
		3007	BFNT 2B	26	15.5	
		3007	BFNT 2B	26		15.17
		3008	ASTM 2B	32	15.5	
		3008	ASTM 2B	32		15.2
		3008	BFNT 2B	32	15.5	
		3008	BFNT 2B	32		15.2
Y1	3028	ASTM 2B	26	15.5		
	3028	ASTM 2B	26		15.16	
	3028	BFNT 2B	26	15.5		
	3028	BFNT 2B	26		15.16	
	3029	ASTM 2B	32	15.5		
	3029	ASTM 2B	32		15.16	
	3029	BFNT 2B	32	15.5		
K2	3070	BFNT 2C	32	17.5		
	3071	BFNT 2C	32	17.5		
	3072	BFNT 2C	32		17.26	
	3073	BFNT 2C	32		17.25	



## **4.0 LABORATORY BEAD UNSEATING TEST RESULTS**

### **4.1 Test Results**

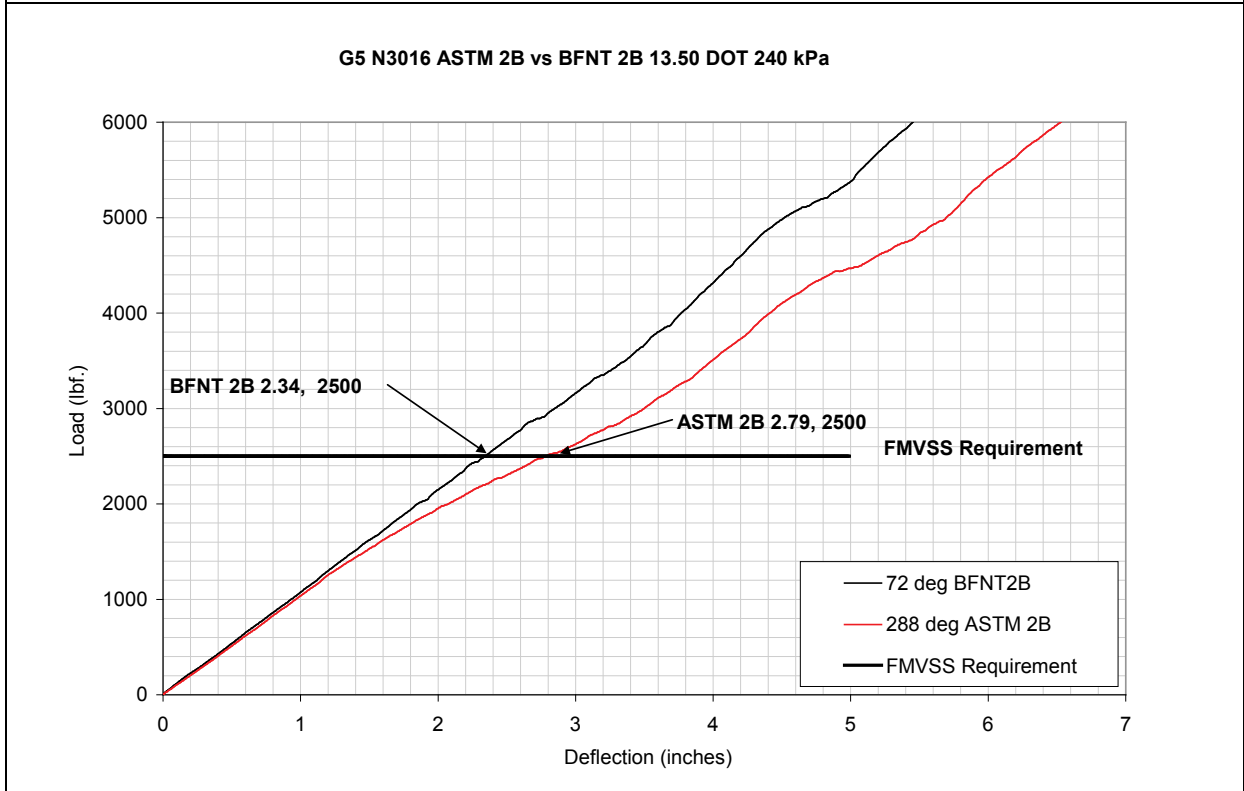
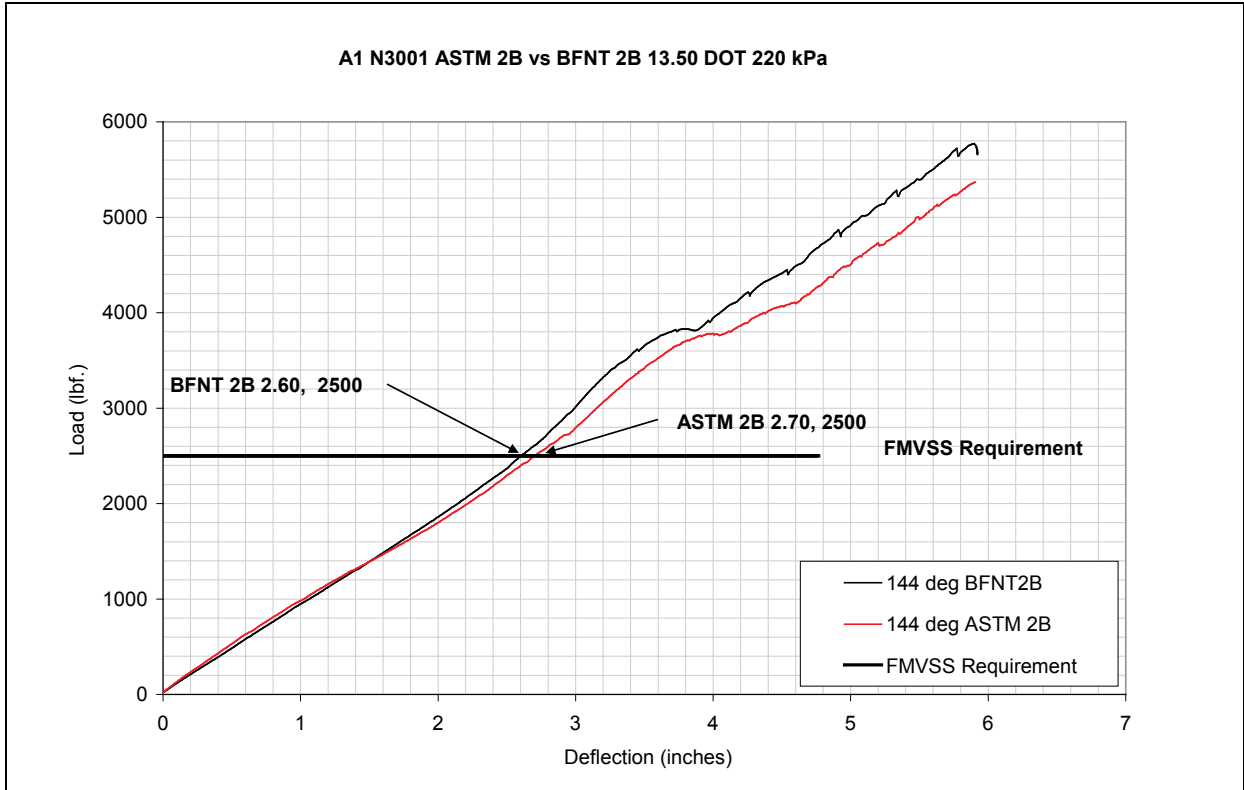
#### **4.1.1 ASTM 2B and BFNT 2B Block Comparisons**

No clearance problems were noted during the testing with these tires and blocks. All of the tests exceeded the FMVSS No. 109 minimum force requirements. The newly designed blocks 2B (rim codes 19 to 24) and 2C (rim codes 25 to 30) did not contact the rim during these tests before exceeding the FMVSS minimum force requirement.

In all cases, the BFNT 2B block caused the load to build 0.10 to 0.49 inches (2.54 to 12.45 mm) sooner than the ASTM 2B block. Results are found in Table 4.1. The graphs in Figure 4.1 show how the load deflection curve rises sooner with the BFNT 2B block. Complete graphs for the lowest load deflection curve for each of the tire and block combinations are in Appendix 1.

**Table 4.1. Test Results for 2B Blocks**

Tire Type	Tire Number	Pressure		"A" Dim. (inch)	Deflection ASTM 2B @FMVSS Minimum (inch)	Deflection BFNT 2B @FMVSS Minimum (inch)	Difference in Deflection (inch)
		(psi)	(kPa)				
Z1	3040	26	180	13.50	3.47	3.08	0.39
A1	3001	32	220	12.50	2.70	2.60	0.10
G5	3016	35	240	13.50	2.79	2.34	0.45
R1	3031	35	240	15.50	2.97	2.64	0.33
R1	3032	50	350	15.50	2.30	2.04	0.26
G5	3018	60	410	13.50	1.73	1.63	0.10
M8	3007	26	180	15.50	3.78	3.37	0.41
M8	3007	26	180	15.17	3.85	3.47	0.38
M8	3008	32	220	15.50	3.31	2.92	0.39
M8	3008	32	220	15.20	3.32	3.03	0.29
Y1	3028	26	180	15.50	3.10	2.65	0.45
Y1	3028	26	180	15.16	3.15	2.89	0.26
Y1	3029	32	220	15.50	2.75	2.50	0.25
Y1	3029	32	220	15.20	2.82	2.56	0.26



**Figure 4.1. Tire Types A1 and G5 With Block ASTM 2B vs. BFNT 2B Comparisons**

#### **4.2 Effect of Block Positioning on Bead Unseat Test Results**

Comparisons were made between positioning the block on the tire sidewall using the FMVSS No. 109 “A” Dimension or ASTM 75-percent rule in terms of ability to conduct the test, ability to meet the FMVSS No. 109 bead unseat force requirement, as well as the deflection and force profiles of each test. Figure 4.2 shows the starting point of the test with the two different “A” Dimensions for tire N3064 (a low aspect ratio P325/30ZR19 passenger tire). As can be seen in Figure 4.2, the test using the FMVSS No. 109 “A” Dimension produced a clear tread slide situation. The graph in Figure 4.3 shows how the test using the FMVSS No. 109 “A” Dimension could not generate the 2500 lbf needed to pass the FMVSS minimum requirement. However, when a second test was conducted on tire N3064 using the ASTM 75-percent rule, the FMVSS minimum force requirement was reached at 3.27 inches of deflection. Similar graphs of all thirteen tires that used the two means of determining block positioning are located in Appendix 2.

In a total of 12 of 13 comparisons, the new ASTM 75-percent rule for positioning the block on the sidewall produced lower unseat force results than the method in the current Federal standard, meaning that the ASTM method is generally more severe.

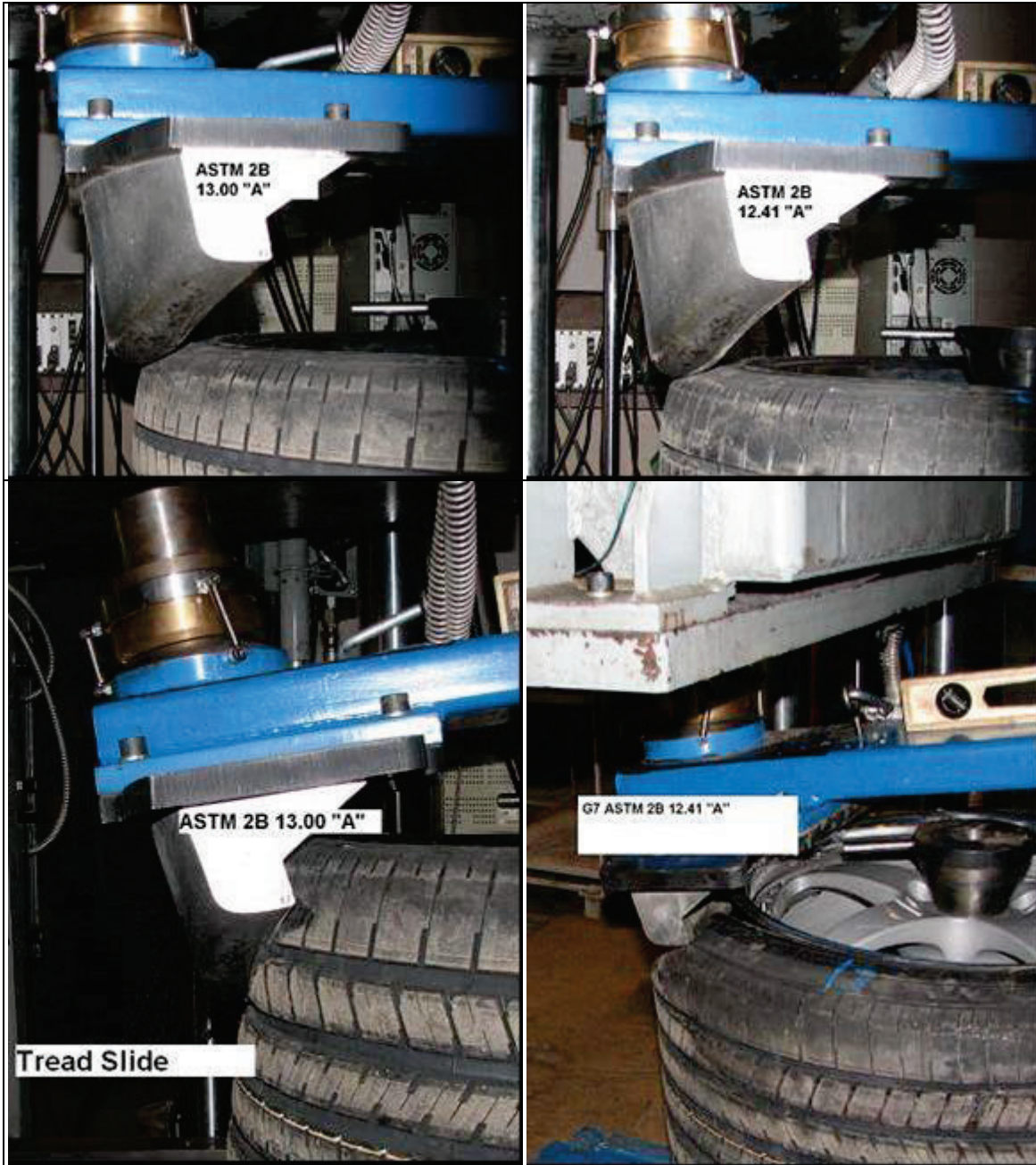
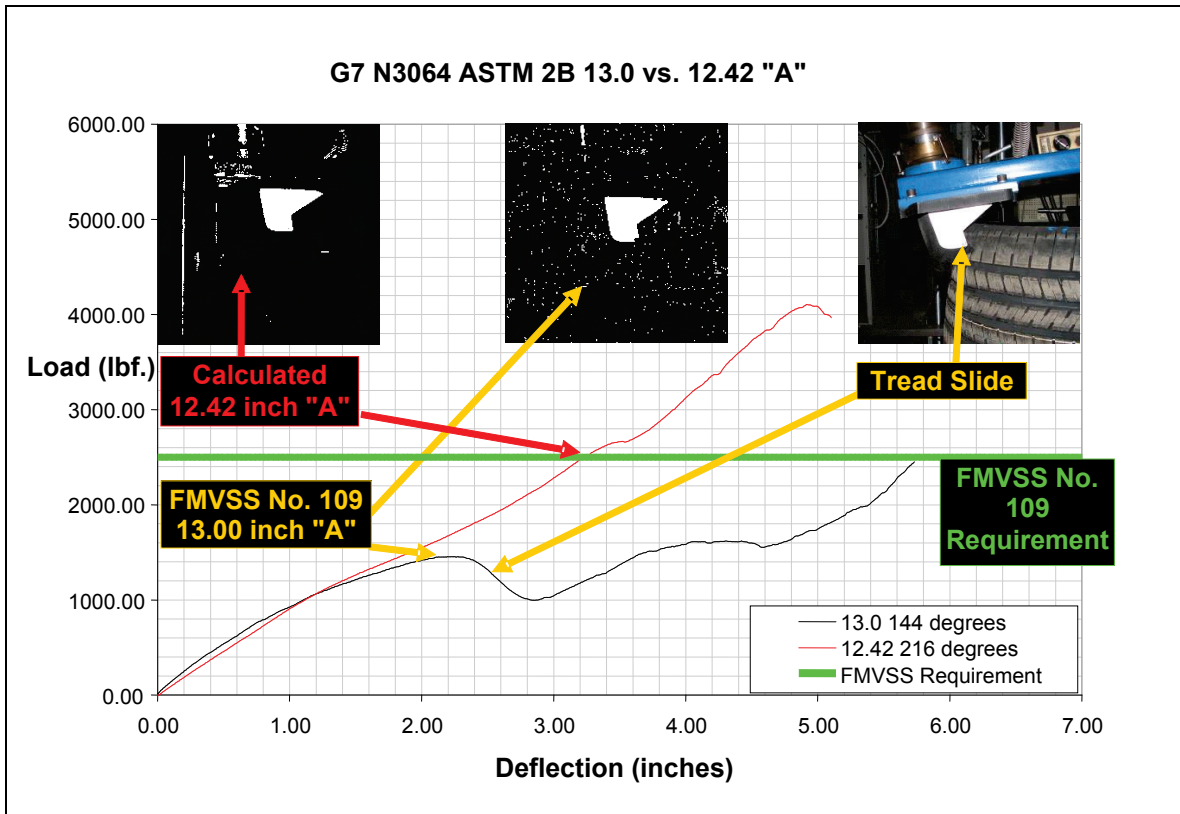
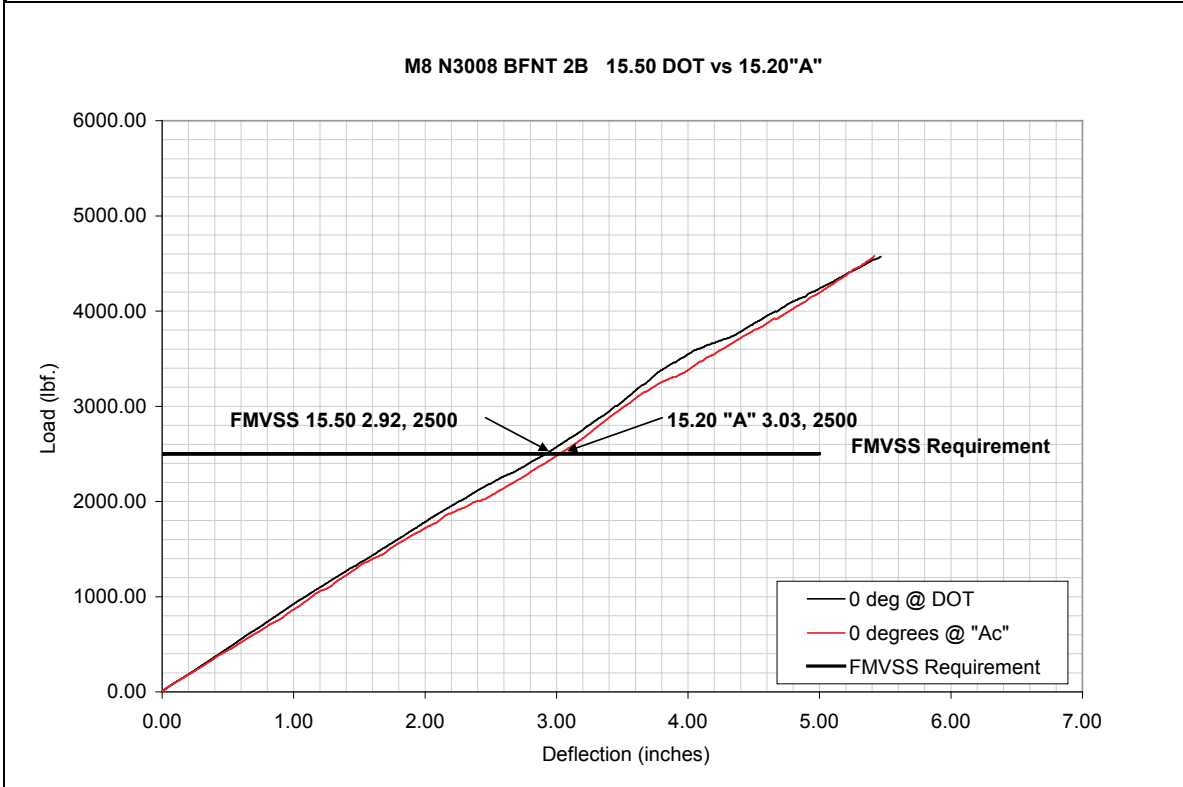
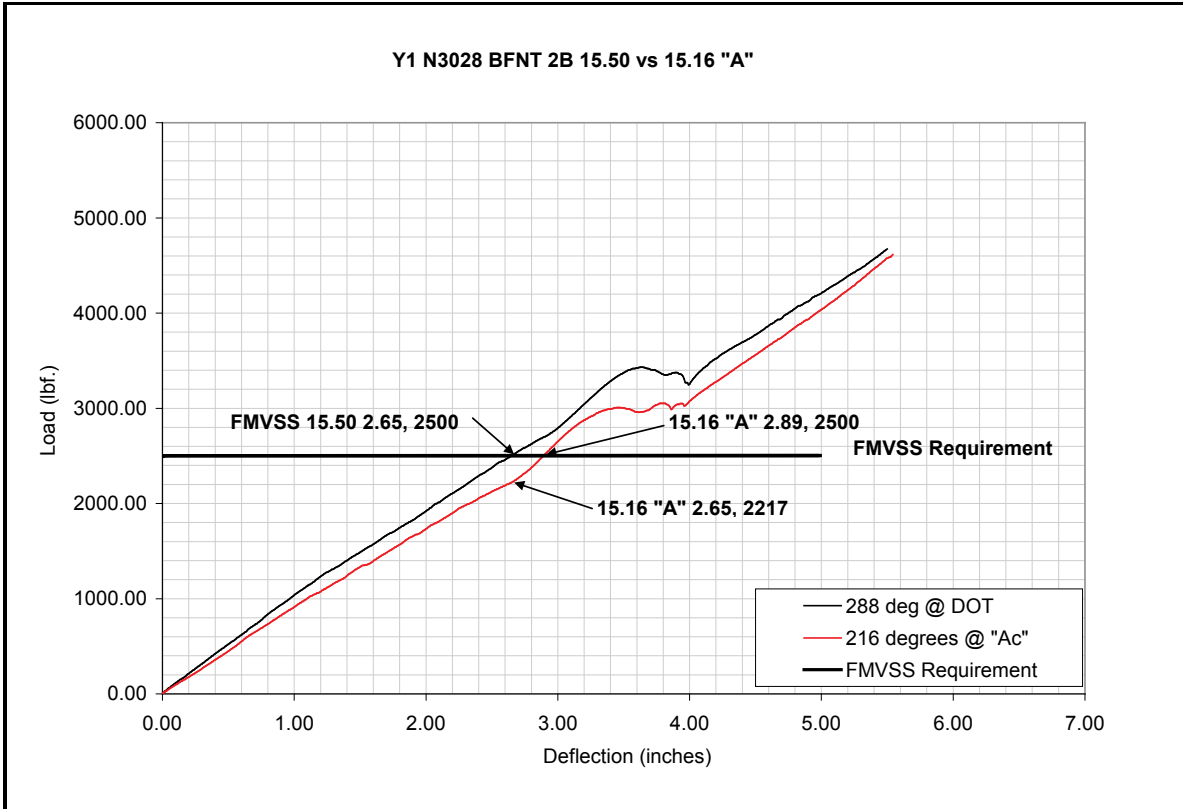


Figure 4.2. Tire Type G7 N3064 "A" Dimension Comparisons



**Figure 4.3. Tire Type G7 - 13-Inch FMVSS “A” Dimension (with Tread Slide) Versus 12.42-Inch ASTM “A” Dimension**

Another consideration when evaluating the 75-percent rule “A” Dimension was how it would affect the results of the load deflection curve, or difficulty in meeting the FMVSS minimum. Since using the lesser of the FMVSS No. 109 “A” Dimension or the calculated “A” Dimension in ASTM F2663-7a reduces the distance to the rim, the load therefore increases at a lesser rate (see Figure 4.4). The effect of pushing on the tire closer to the bead makes achieving the required minimum force level more difficult and reduces the possibility of tread slide. In all but one of the cases, the load curves for tests using the 75-percent “A” Dimension were less at a given deflection than tests using the FMVSS No. 109 “A” Dimension. The load differences ranged from -44 (greater) to 283 lbf (less). Table 4.2 contains the complete results. In addition, complete graphs can be found in Appendix 2.



**Figure 4.4. FMVSS "A" Dimension Versus ASTM "A" Dimension**

**Table 4.2. Test Results for “A” Dimensions**

<b>Tire Type</b>	<b>Tire Number</b>	<b>Block</b>	<b>Pressure (psi)</b>	<b>Pressure (kPa)</b>	<b>FMVSS No. 109 "A" @ FMVSS Minimum (inch)</b>	<b>75% Rule "A" @ FMVSS Minimum (inch)</b>	<b>Deflection Change FMVSS Minimum Force Developed (inch)</b>	<b>Force Reduction at FMVSS No. 109 "A" Dimension (lbf)</b>
M6	3004	Historical 2A	26.0	180	3.50	4.12	0.62	167
M8	3007A	ASTM 2B	26.0	180	3.78	3.85	0.07	20
M8	3007B	BFNT 2B	26.0	180	3.37	3.47	0.10	76
M8	3008A	ASTM 2B	26.0	180	3.31	3.32	0.01	7
M8	3008B	BFNT 2B	32.0	220	2.92	3.03	0.11	97
U1	3013	Historical 2A	26.0	180	4.06	4.13	0.07	22
Y1	3028A	ASTM 2B	26.0	180	3.10	3.15	0.05	58
Y1	3028B	BFNT 2B	26.0	180	2.65	2.89	0.24	283
Y1	2029A	ASTM 2B	32.0	220	2.75	2.82	0.07	78
Y1	2029B	BFNT 2B	32.0	220	2.50	2.56	0.06	61
M2	3037	Historical 2A	26.0	180	2.97	2.93	-0.04	-44
G7	3064	ASTM 2B	26.0	180	SLIDE	3.27	NA	NA
G7	3065	BFNT 2B	26.0	180	2.92	3.02	0.10	86

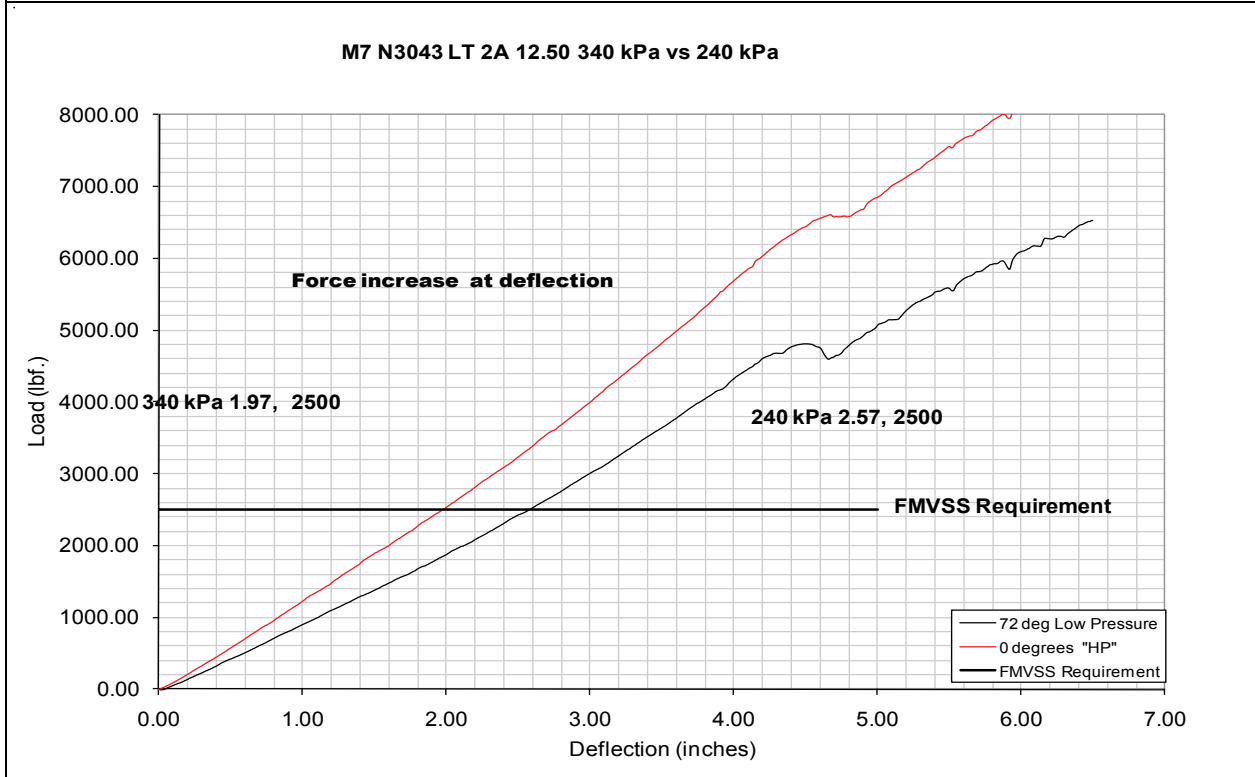
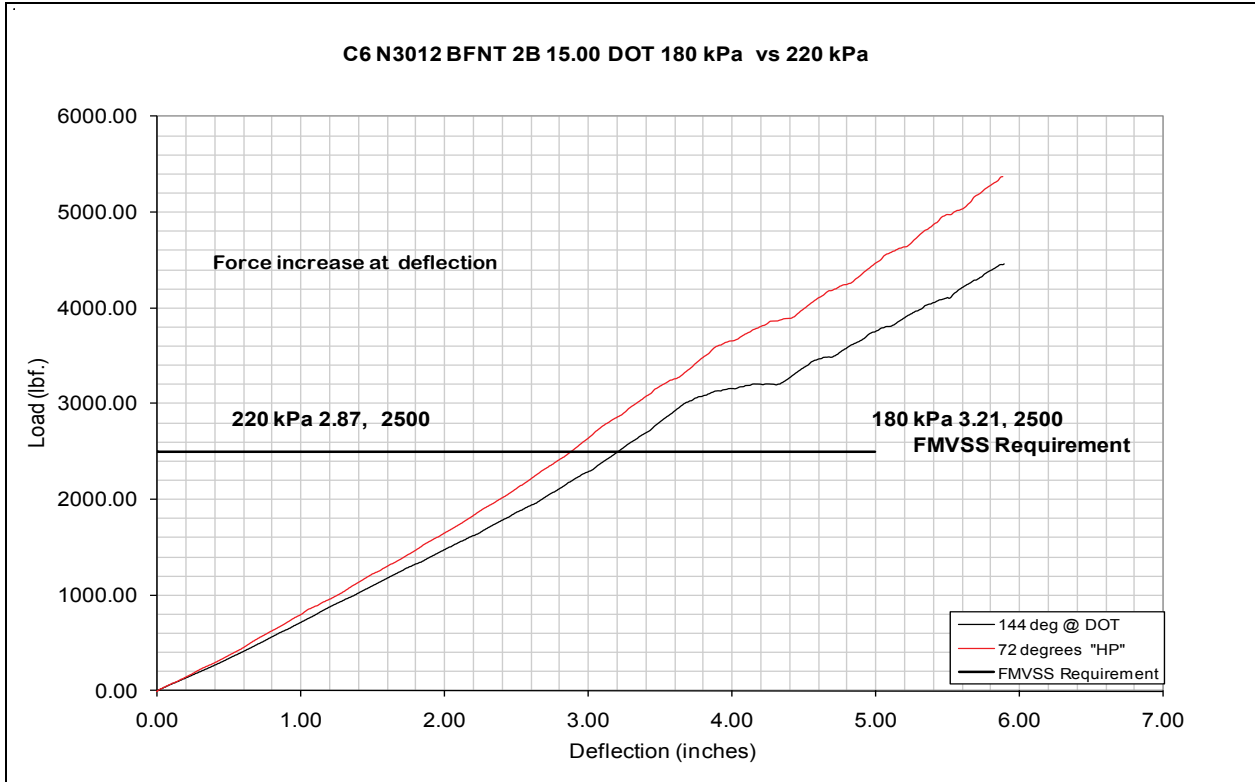
***4.2.1 Effect of Inflation Pressure on Bead Unseat Test Results***

Tests at all pressures in the test matrix produced bead unseat forces that exceeded FMVSS No. 109 minimum requirements. For a given tire tested at two pressures using the identical test setup, tests at the lower pressure unseated the tire at lower forces and required more deflection to reach the FMVSS No. 109 minimum force requirements. Table 4.3 contains the data for the eight comparisons generated in this study. In Table 4.3, the column labeled “Force Change” is the load or force difference between the lower pressure deflection at the FMVSS minimum and the same deflection for the higher pressure test. Figure 4.5 shows representative graphs of the passenger tires tested at 26 and 32 psi (180 and 220 kPa). A LT (light truck) tire tested at 35 and 50 psi (240 and 340 kPa) is also shown in the figure. Complete graphs of pressure testing are found in Appendix 3.

**Table 4.3. Test Results for Low and High Pressure**

Tire Type	Tire Number	Block	"A" Dim.	Low	High	Low Pressure Deflection @ FMVSS Minimum	High Pressure Deflection @ FMVSS Minimum	Difference in Deflection (Low - High)	Force Change	Deflection per PSI	Force per PSI
			inch	psi	psi	inch	inch	inch	lbf	inch	lbf
M7	3043	Historical 2A	12.5	35.0	50.0	2.57	1.97	0.60	842	0.040	56
T1	3022	Historical 2A	12.5	35.0	50.0	2.47	2.05	0.42	510	0.028	34
M5	3046	ASTM 2B	13.5	35.0	50.0	2.58	1.90	0.68	942	0.045	63
M5	3047	BFNT 2B	13.5	35.0	50.0	2.33	1.74	0.59	952	0.039	63
C6	3011	ASTM 2B	15.0	26.0	32.0	3.66	3.34	0.32	298	0.053	50
C6	3012	BFNT 2B	15.0	26.0	32.0	3.21	2.87	0.34	373	0.057	62
K1	3019	ASTM 2B	15.0	26.0	32.0	3.01	2.93	0.08	147	0.013	25
K1	3020	BFNT 2B	15.0	26.0	32.0	2.69	2.58	0.11	117	0.018	20





**Figure 4.5. Bead Unseat Force Versus Inflation Pressure Comparisons**

#### 4.2.2 Miscellaneous Tests

Two new tires of three tire models in Table 3.2 in the 12-18 rim code range (D1 & M9) were tested per the standard FMVSS No. 109 test conditions to evaluate the variability of the bead unseat force between two new tires of the same model. One model in the 25-30 rim code range was tested to estimate variability of the test. Maximum force data from tires shown in Table 4.4 were analyzed by one-way ANOVA (analysis of variance) to determine the level of variability for the values taken at 5 locations on the same tire, and the values obtained for two different tires of the same brand and size. Tire type K2 was also compared when tested at the 17.5 inch “A” Dimension specified in the FMVSS No. 109 and at the calculated “A” Dimension from the ASTM standard. The two different type K2 tires had different diameters; therefore the “A” Dimensions are slightly different. The difference in the mean values was caused by the random scatter of the 5 data points for each tire. The difference in the means was possibly a result of tire variation.

**Table 4.4. Tires Analyzed for Variability of Maximum Force**

Tire Type	Test Pressure, psi	Tire Number	Mean Value, lbs	Standard Deviation of Five Measurements, lbs	Notes
D1	26	3035	2536	31.0	
		3043	2557	42.5	
M9	26	3025	2461	28.4	
		3026	2484	61.2	
K2	32	3070	4590	119.3	17.5 inch “A” Dimension
		3071	4587	55.9	
		3072	4356	103.8	Calculated “A” Dimension tire 3072 (17.26”) tire 3073 (17.25”)
		3073	4771	185.3	

The results of the ANOVA analysis are shown in Table 4.5. The coefficient of variation for the testing ranged from 1.5 to 4.5 percent, indicating that the test results are very reliable. The total sums of squares is the variability among all measurements and the sums of squares of the comparisons indicate the variance that is related to each comparison. The probability that there is a difference for the comparison based on the degrees of freedom (number of samples tested) is indicated by the probability > F, where a significant difference would be indicated by a value less than 0.05. The analysis indicates that there is no significant difference between measurements taken at the five positions around each tire, or for measurements taken on two different tires of the same tire type. A similar analysis for the displacement at which the maximum force was reached indicated that there was no statistically significant difference for these values for the five measurements around a tire or for two tires of the same tire type.

**Table 4.5. One-Way ANOVA Comparisons for Maximum Force Values**

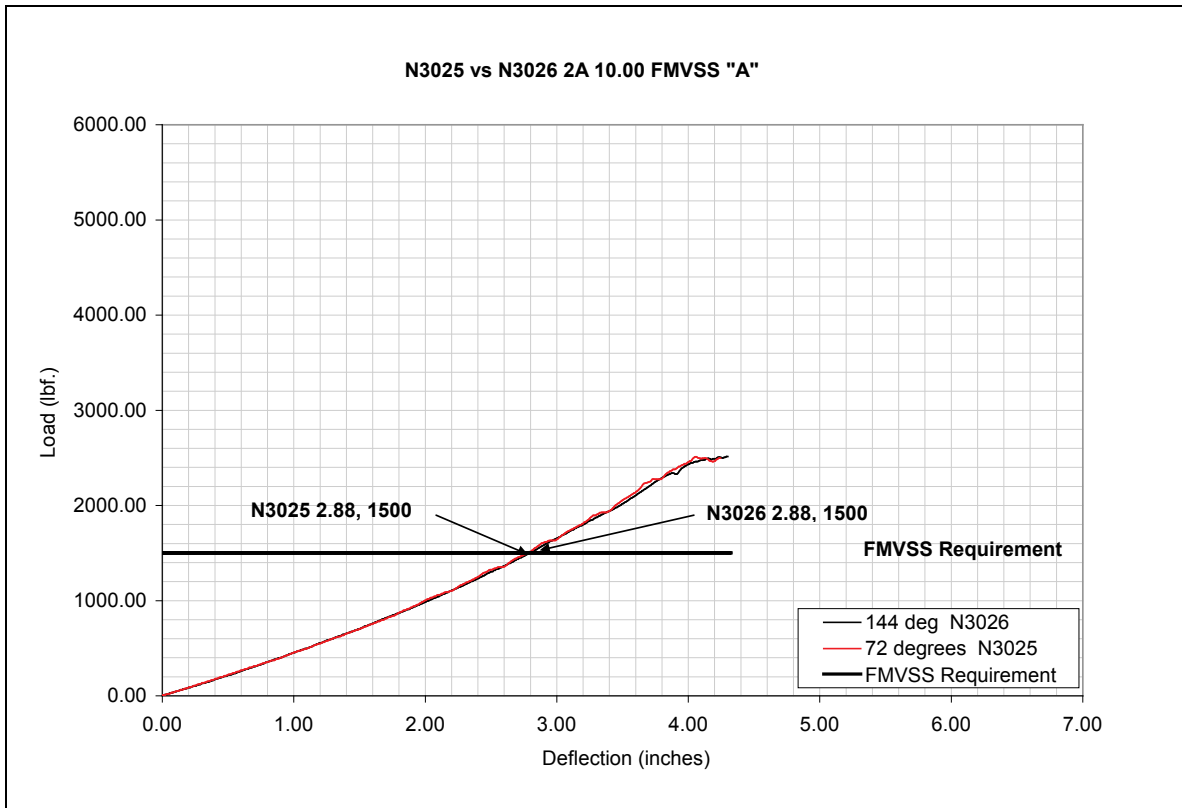
Tire Type	Coefficient of Variation, %	Total Sums of Squares	Comparison	Sums of Squares	Probability > F
D1	1.56	12163	Position on Tire	4767	0.60
			Tire Number	1109	0.45
M9	2.19	19535	Position on Tire	6464	0.71
			Tire Number	1347	0.54
K2 (FMVSS "A" Dimension)	2.18	69489	Position on Tire	29069	0.61
			Tire Number	34	0.96
K2 (Calculated "A" Dimension)	4.51	213698	Position on Tire	21950	0.96
			Tire Number	33275	0.41

Analysis of tire type K2 based on the "A" Dimension indicated that the calculated "A" Dimension produced a statistically significant different (lower) maximum force as shown in Table 4.6. This force was reached at a statistically significant different (lower) displacement as well.

**Table 4.6. Maximum Force and Displacement Versus "A" Dimension, Tire Type K2**

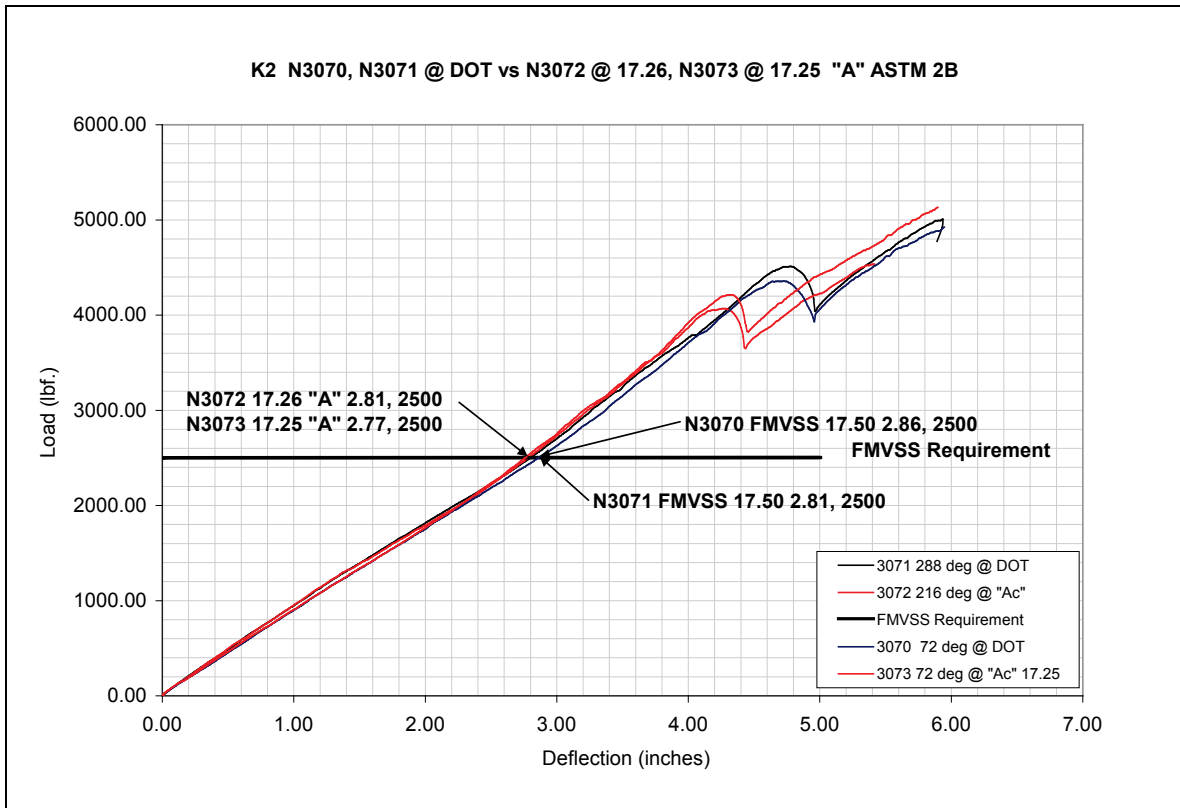
"A" Dimension, inches	Maximum Force, lbs	Probability > F	Displacement at Maximum Force, in.	Probability > F
FMVSS No. 109 (17.5)	4589	0.0001	4.32	0.0001
Calculated (17.25, 17.26)	4413		4.11	

An example of a group of tires, type "M9" (rim code 13) with tire numbers 3025 & 3026, tested with the FMVSS Historical 2A Block is shown in Figure 4.6, and complete graphs are in Appendix 4. The results from different tires of the same model were very consistent as previously shown, and all unseat forces exceeded FMVSS requirements.



**Figure 4.6. Historical 2A Block on Rim Code 13 Tire**

Another subset of the testing allowed for comparison of the consistency of test results for different tires of the same model. Four tests were completed with new tires of type “K2” (rim code 28), with tire numbers 3070, 3071, 3072, and 3073. The tests used the BFNT 2C block and the FMVSS and 75-percent rule “A” Dimensions. Since the same tire was not tested in the two different “A” Dimensions, direct comparisons cannot be drawn in these tests. However, the clearance issue, consistency between individual tires, and FMVSS minimum force requirement can be evaluated. Figure 4.7 contains the results for the four tests. The tests indicated no clearance issues were experienced with the rim code 28 tires. The results from different tires of the same model were very consistent; with all four tests exceeding FMVSS minimum force requirements before bead unseat.



**Figure 4.7. BFNT 2C Block on Rim Code 28 Tire**

### **4.3 Test Summary:**

This report contains the results from 65 tests designed to study the major variables in the FMVSS No. 109 and ASTM F2663-7a bead unseating tests. A total of 49 comparisons were possible from the 65 tests. Fourteen comparisons were completed to evaluate two test block designs against each other. Thirteen comparisons were completed to evaluate the fixed FMVSS No. 109 "A" Dimension setting and the F2663-7a calculated "A" Dimension (i.e., the 75% rule). Eight comparisons were completed to determine the effects of pressure on the bead unseating test results. Six comparisons were run to check tire consistency and operation of FMVSS No. 109 test block Historical 2A. Eight comparisons were completed to evaluate tire consistency and a new block for rim codes 13 and 28.

## **5.0 CONCLUSIONS**

### **5.1 ASTM 2B and BFNT 2B Blocks**

The BFNT blocks do reduce the stringency of the test as they contact more tire surface area than the ASTM 2B. However, ASTM determined that the contact of the BFNT blocks is more like the original contact of the original FMVSS No. 109 block and eliminated use of the ASTM 2B block in the F2663-07a standard.

All tests with BFNT blocks exceeded the FMVSS No. 109 minimum force requirements. Neither BFNT block contacted the rim during tests before exceeding the FMVSS requirement. As no clearance issues were noted during the testing, the newly designed blocks BFNT 2B (rim codes 19 to 24) and BFNT 2C (rim codes 25 to 30) allowed bead unseating test.

### **5.2 “A” Dimensions**

In a total of 13 comparisons between the new ASTM 75-percent rule and the FMVSS No. 109 “A” dimensions for positioning the block on the sidewall generally produced lower unseat force results using the ASTM method, meaning it is more severe. Furthermore, occurrences of the test block sliding across the tread when testing using the ASTM method did not occur.

### **5.3 Pressures**

All passenger tires exceeded the FMVSS No. 109 requirements at all test pressures evaluated. The results at the lower pressures used in this testing for LT tires suggests that all of the LT tires would pass the minimum performance requirements in the FMVSS No. 109 bead unseat test at the higher pressures recently specified in the FMVSS No. 139. As expected, the results of tests at two tire inflation pressures indicated that tire bead unseating force was sensitive to inflation pressure, with lower unseating forces recorded at lower pressures.

### **5.4 Test Equipment Observations**

During the development of FMVSS no. 109, Bead Unseat Test, a pass/fail condition was used to record test results. However, the equipment used during this testing continuously recorded the test load. Adding equipment to monitor the pressure continuously during the test could provide more accurate information on the load at the point of unseat. This was and is feasible because sensors and data acquisition technology have advanced significantly since the enactment of FMVSS No. 109 in 1967.

## **6.0 SUMMARY**

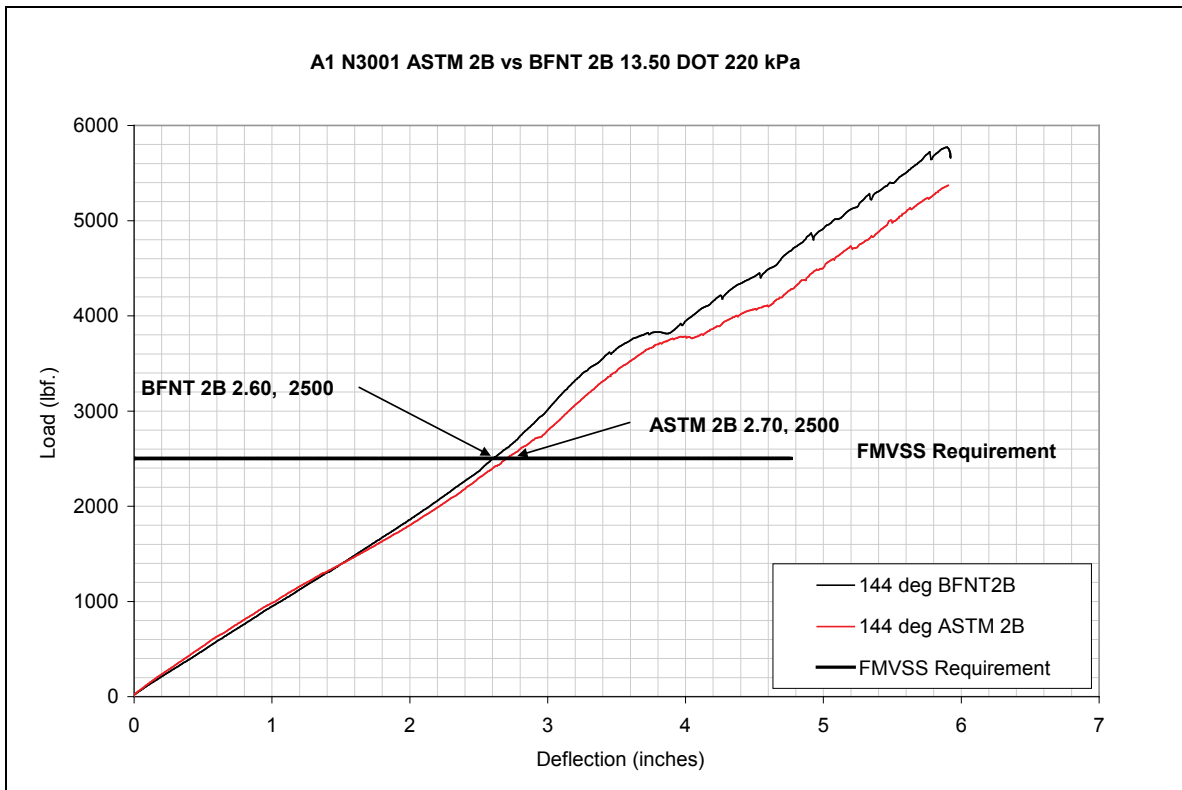
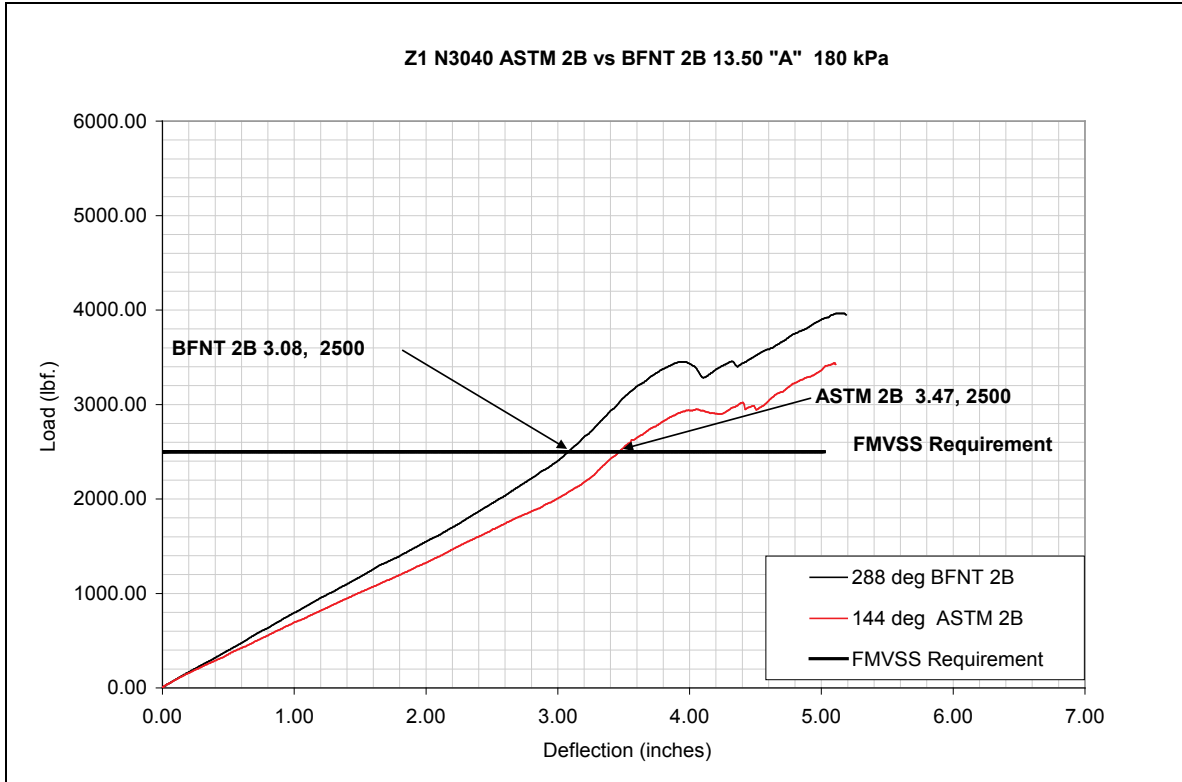
The results indicated that the test equipment and procedures in ASTM F2663-07a allowed testing tires of larger rim codes and/or low profiles. This was accomplished using the ASTM (“BFNT”) 2B and 2C blocks for the new, larger rim codes, retaining the current block for the smaller rim codes. Use of the ASTM standard’s provision to calculate the “A” Dimension and compare it to the FMVSS No. 109 “A” Dimension, using the lesser of the two for the test, also facilitated the testing tires of larger rim codes and/or low profiles.

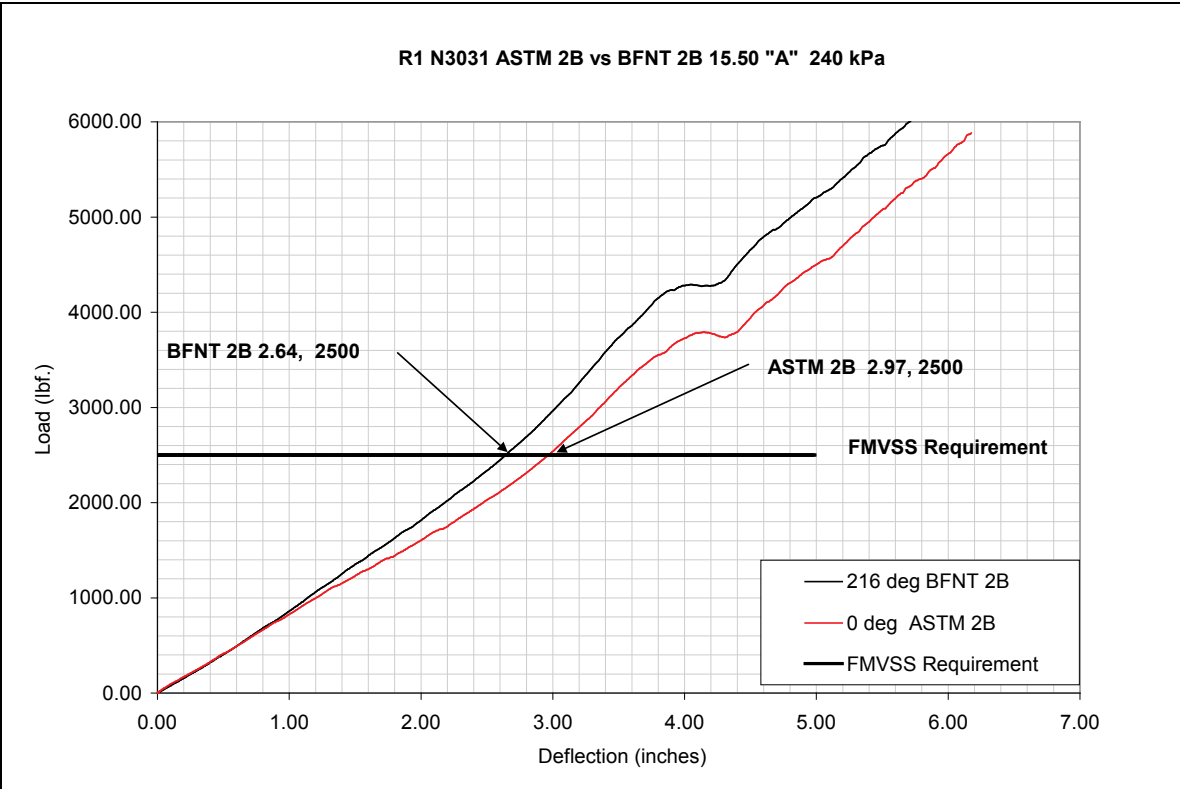
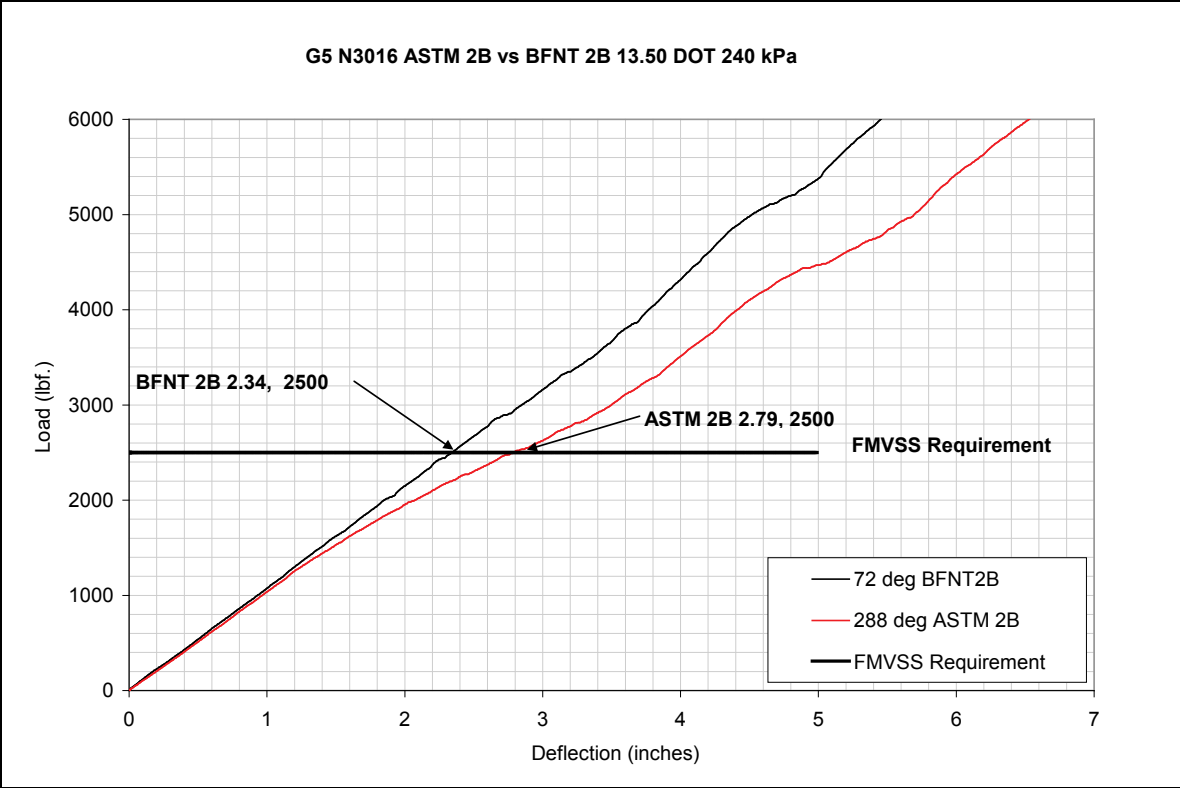
## **BIBLIOGRAPHY**

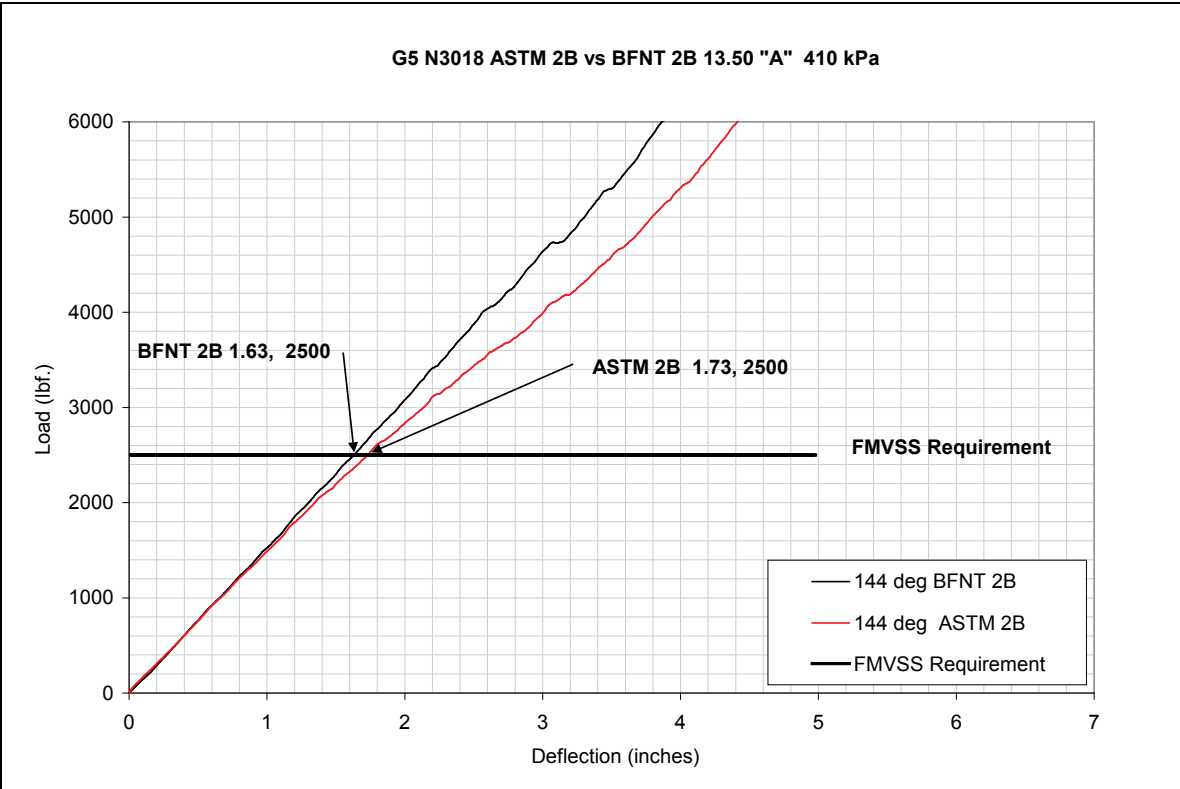
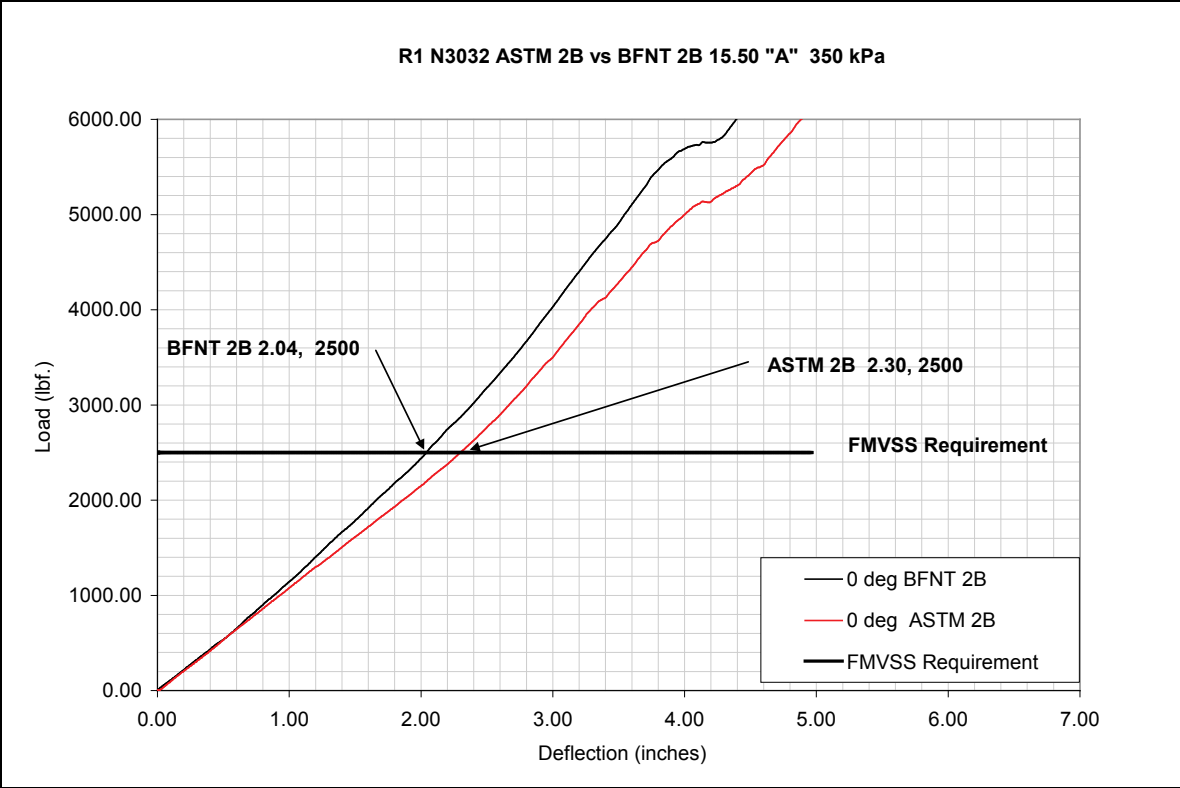
1. USDOT-NHTSA. (2002, March). CFR 49 Part 571; Federal Motor Vehicle Safety Standards; Tires; Proposed Rule. March 5, 2002. Vols. Docket No. NHTSA-00-8011-0019.
2. Edington, G. (2009, September). Tech Service: Bead Unseat Testing. *RubberWorld Magazine*, pp. 17-20.
3. Risteen, W. H. (1967). *Report on the Development of the Initial Federal Motor Vehicle Safety Standards Issued January 31, 1967*. Washington, DC : United States Department of Commerce, National Traffic Safety Agency.

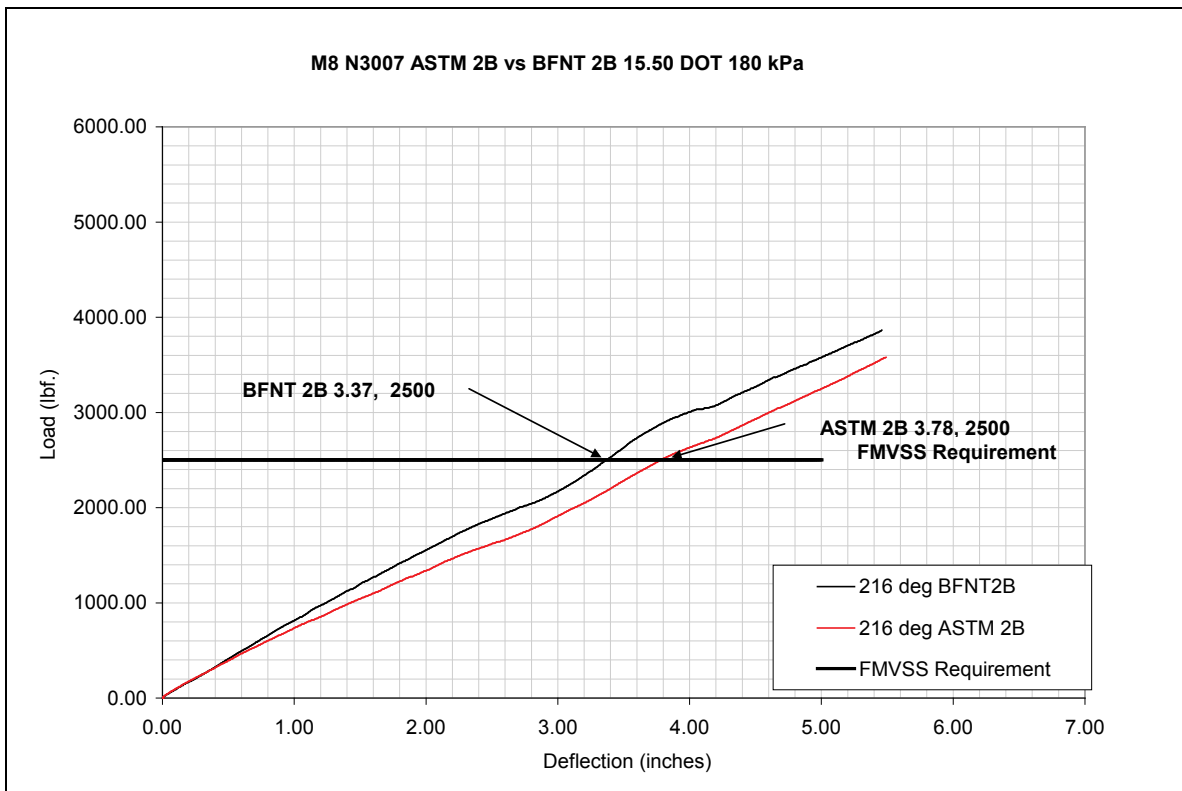
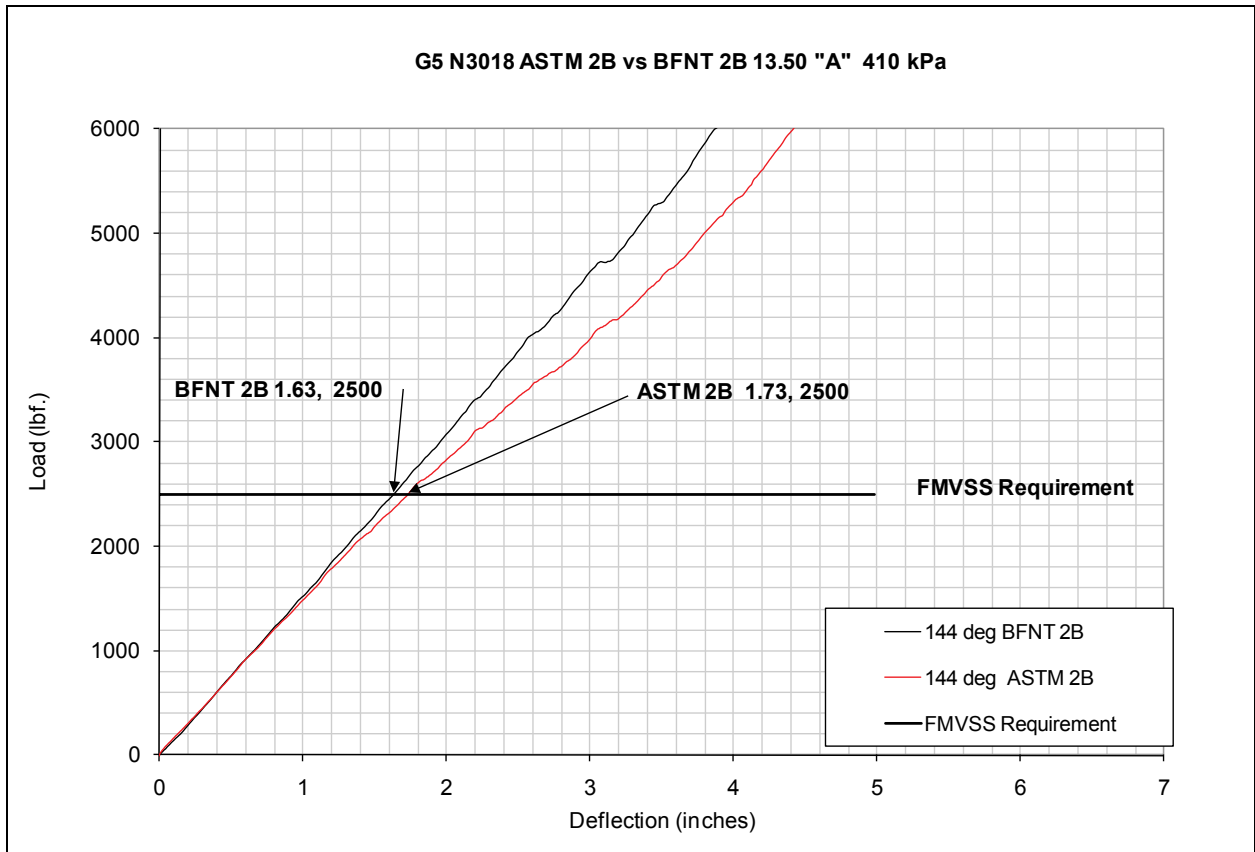


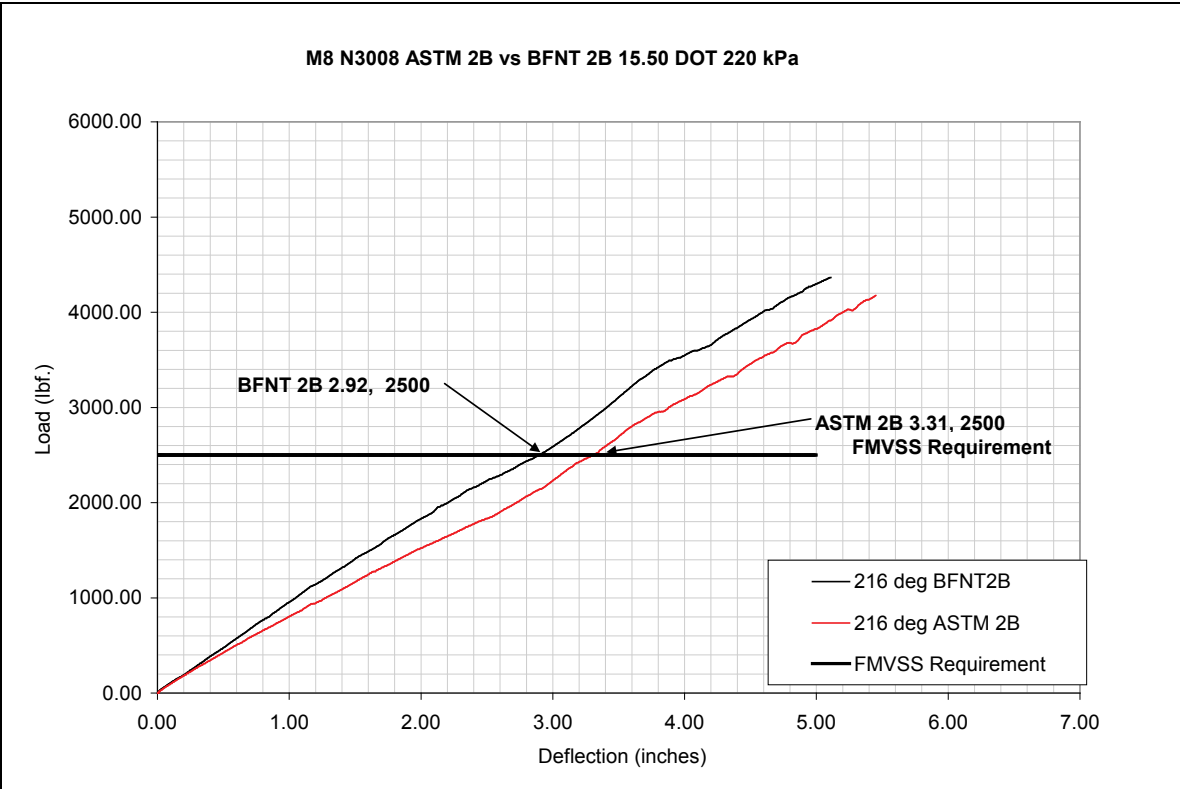
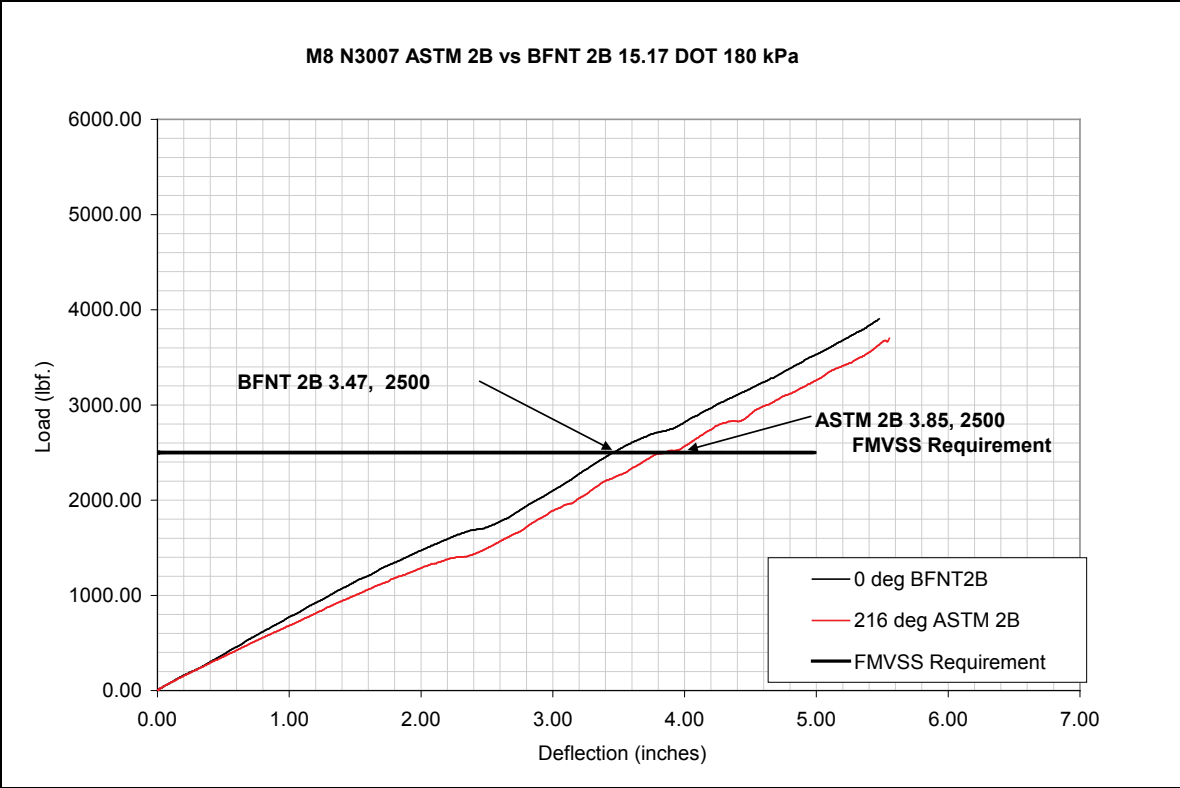
# Appendix A. ASTM 2B Versus BFNT 2B

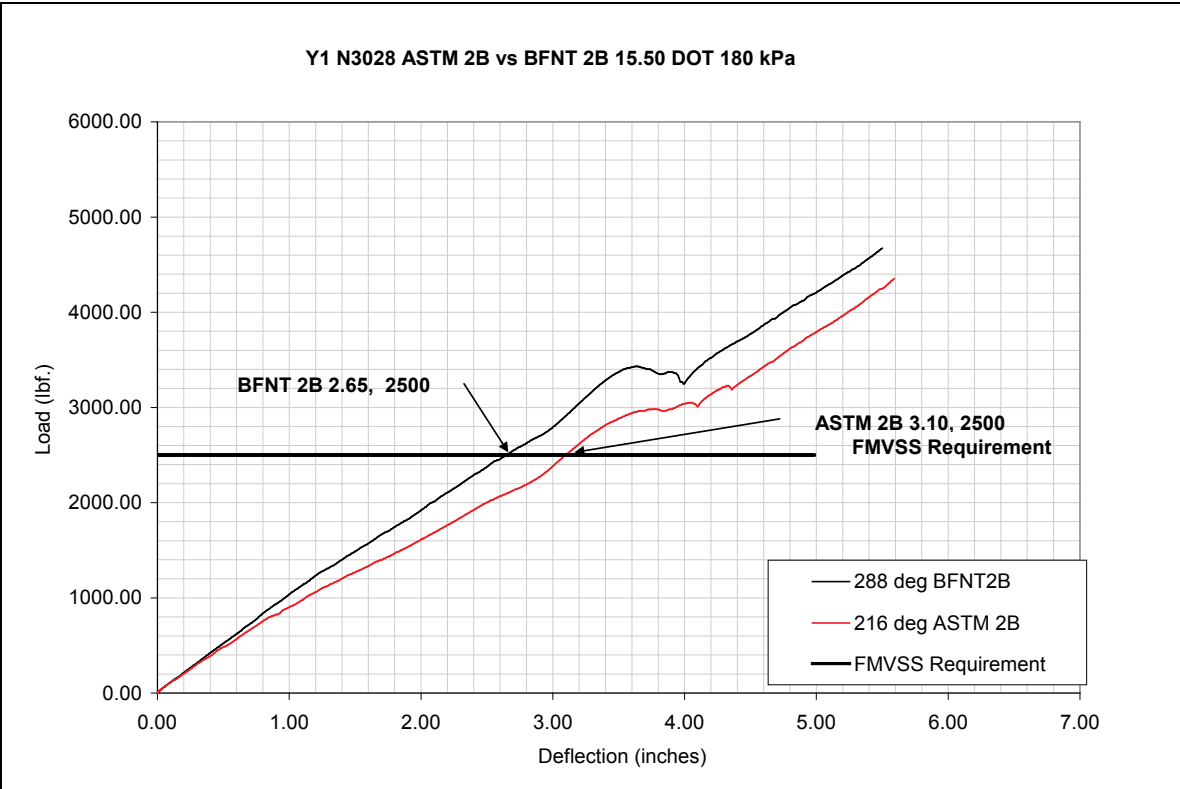
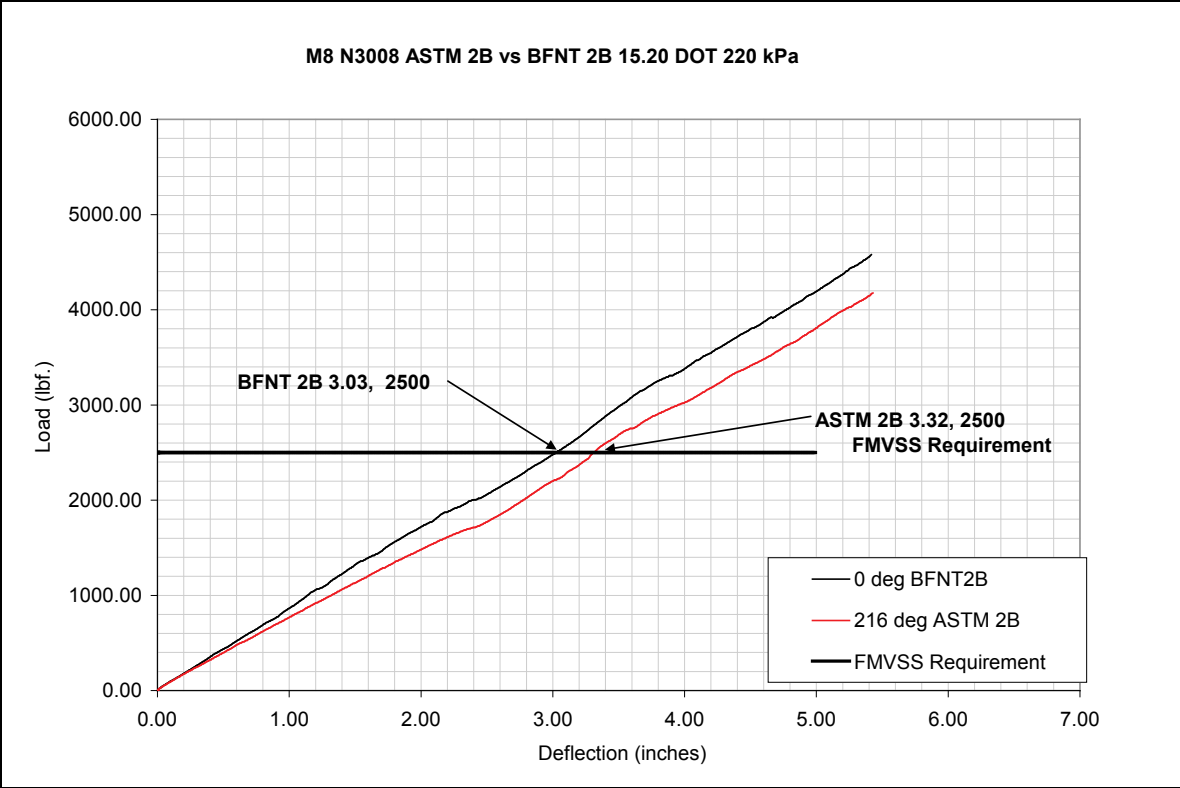


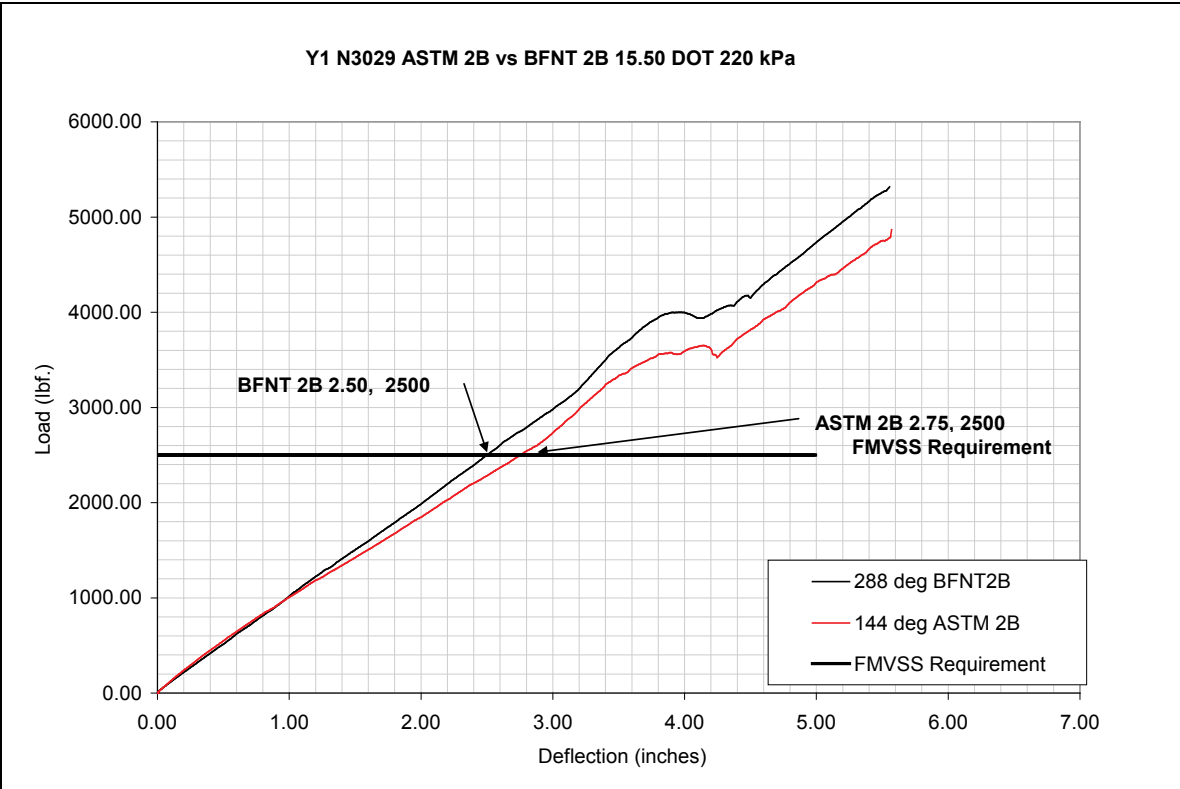
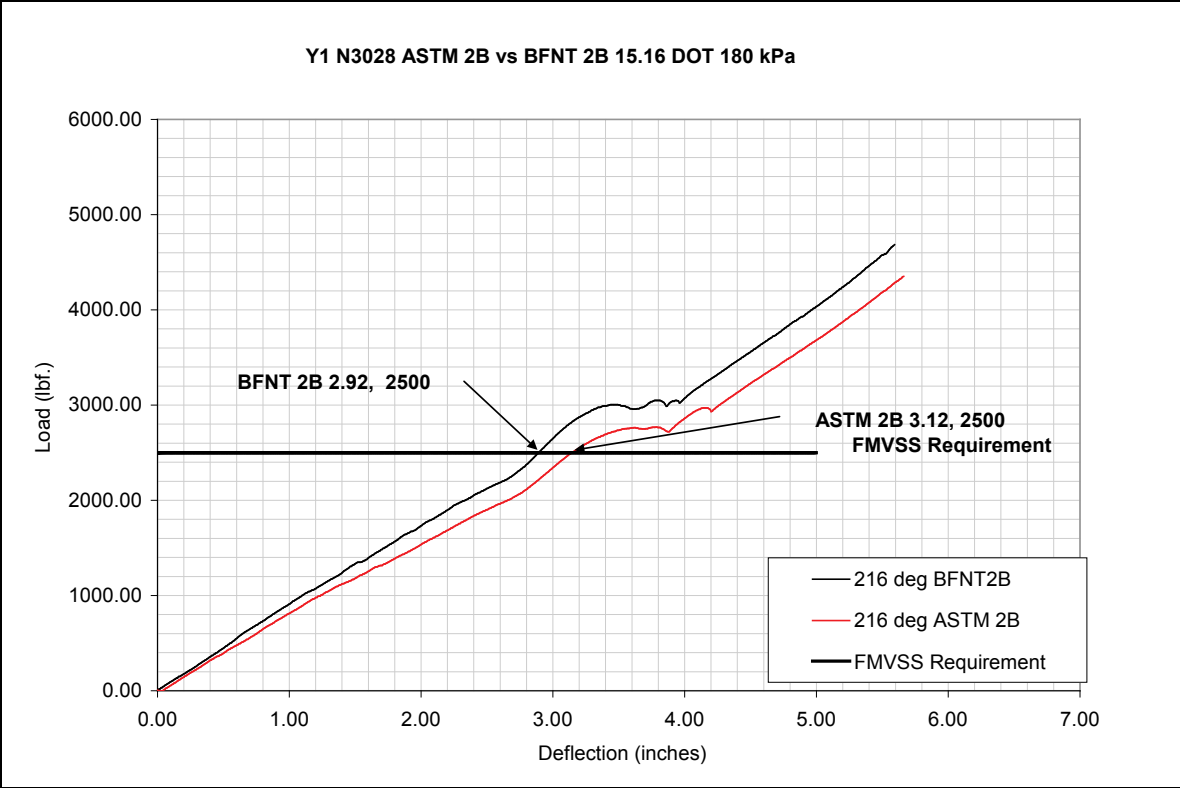




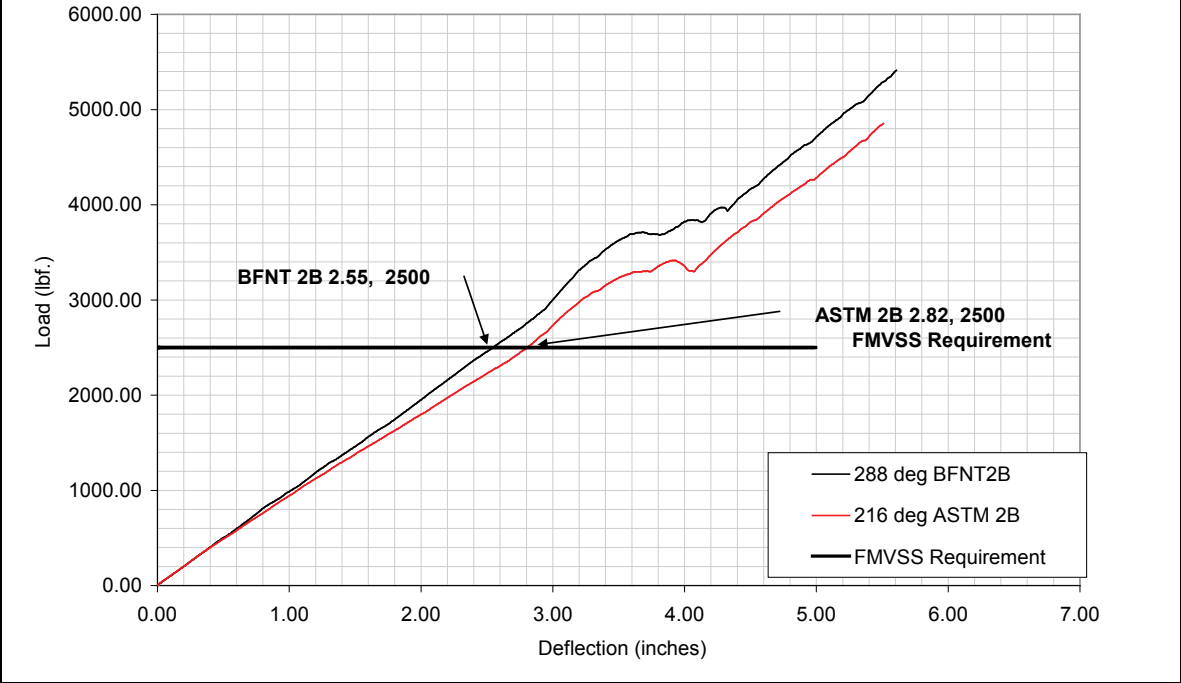






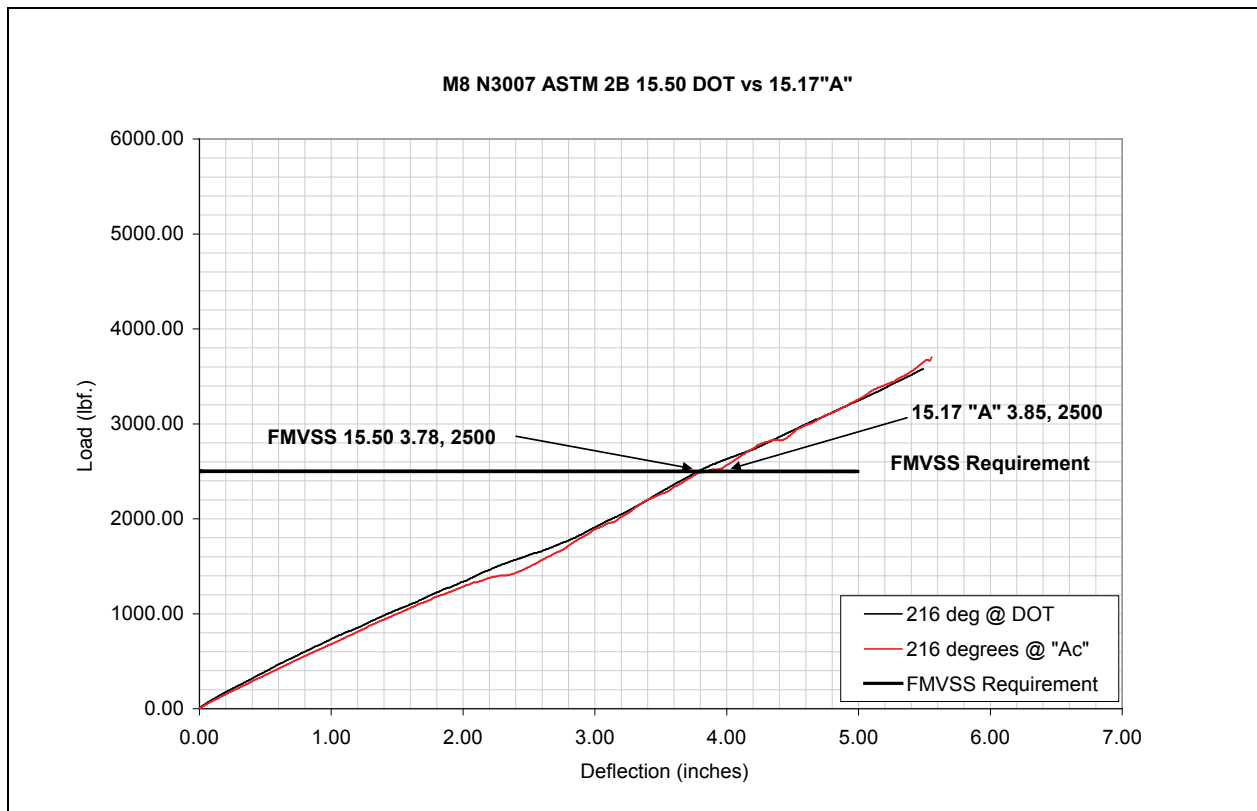
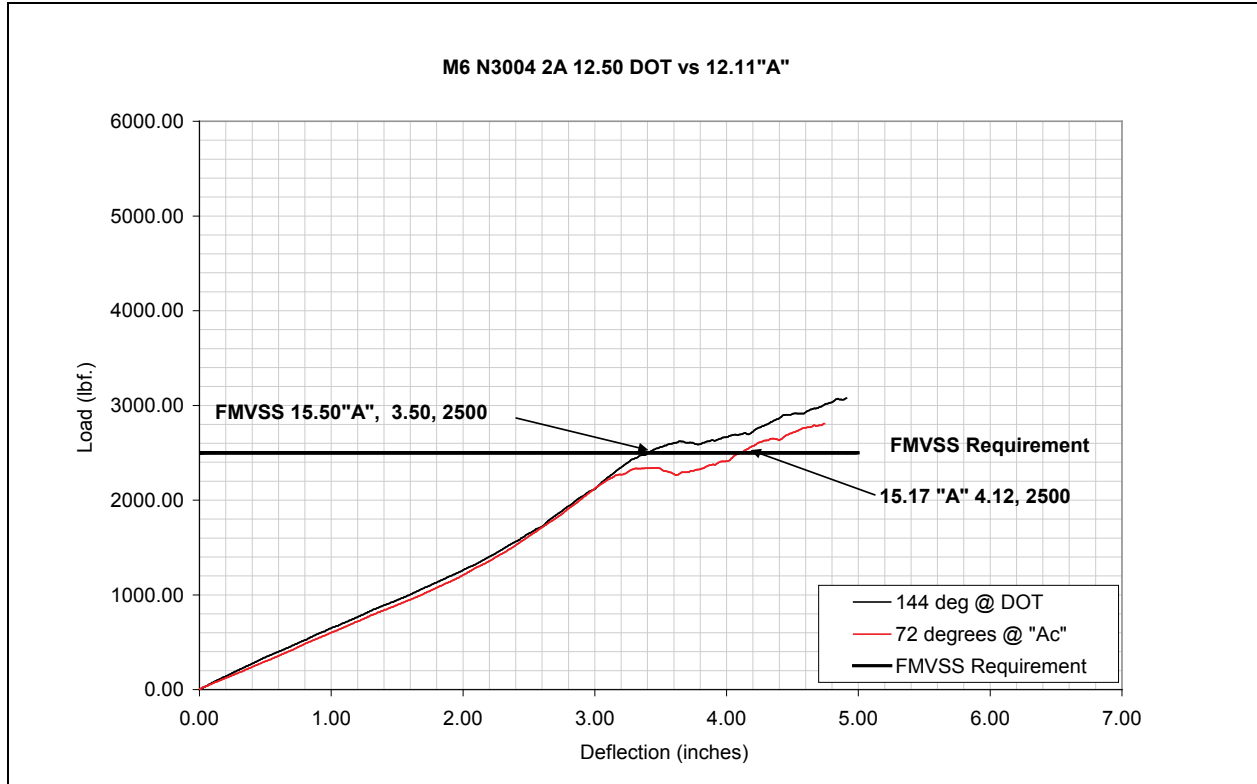


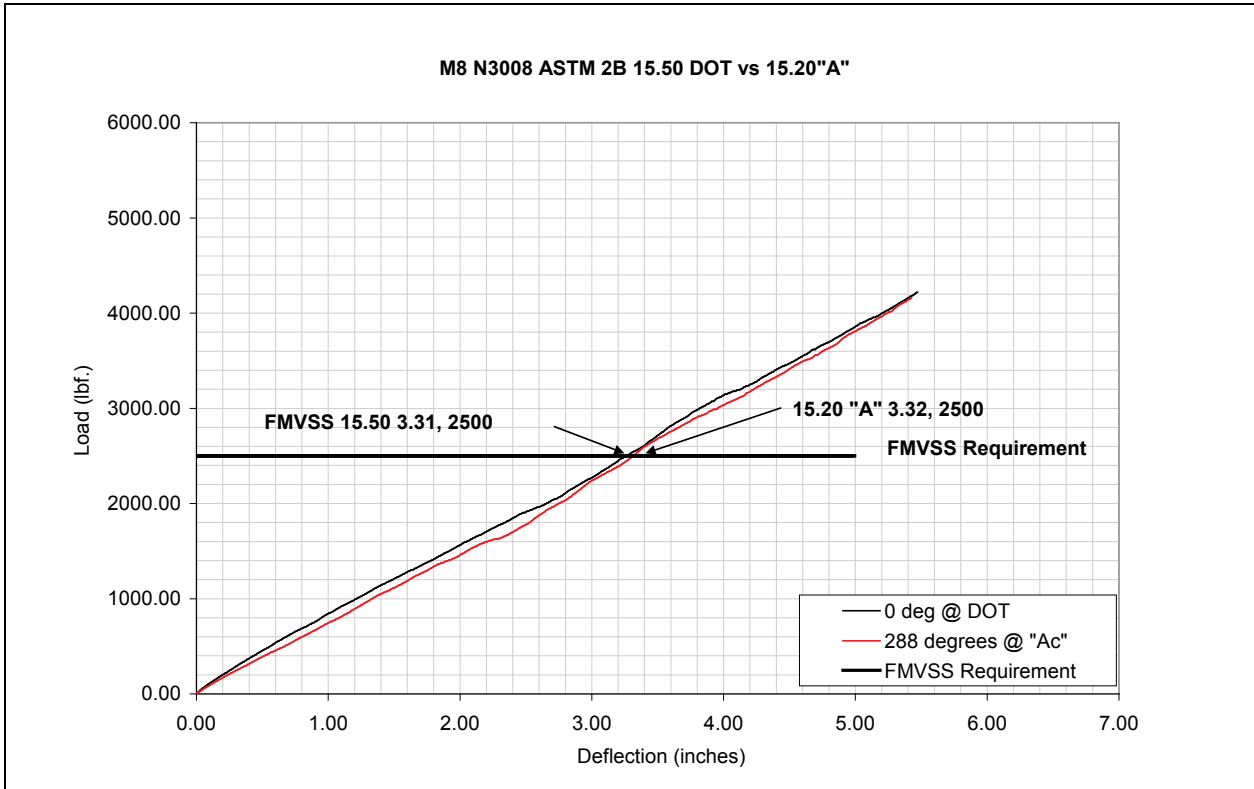
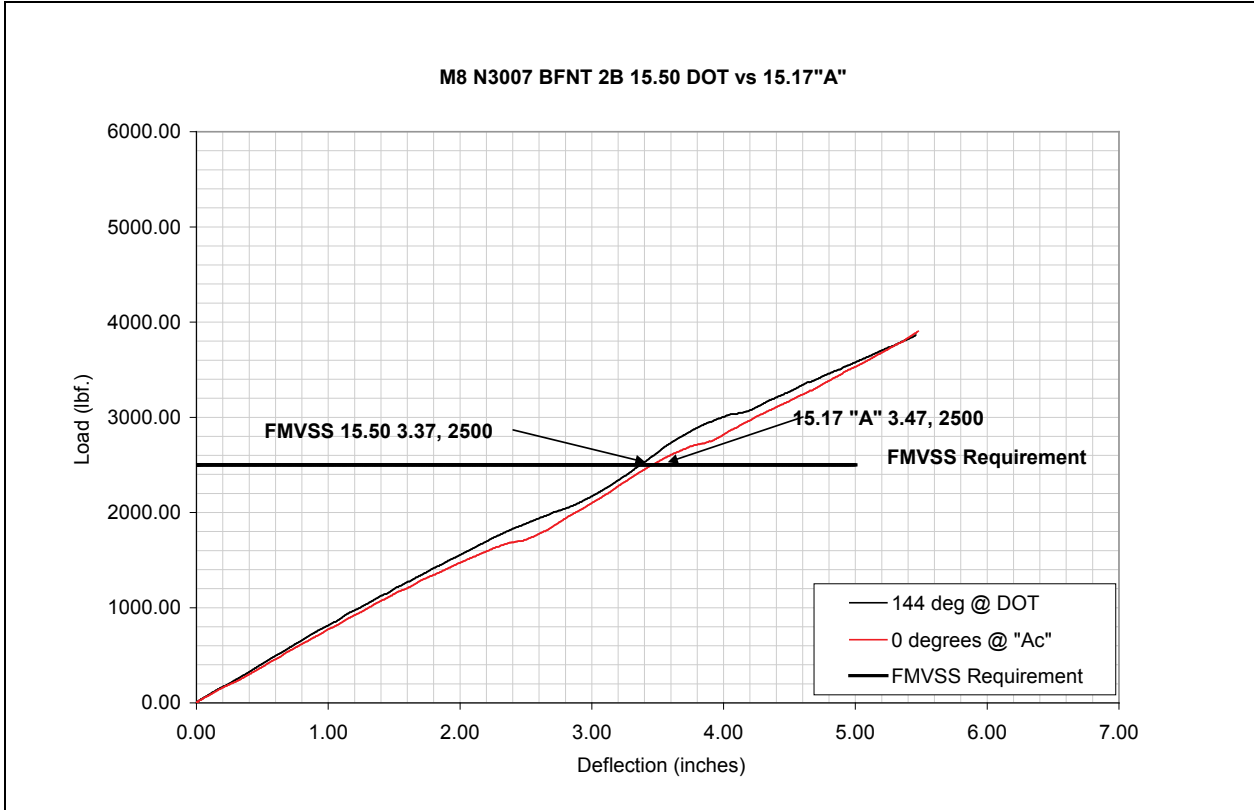
Y1 N3029 ASTM 2B vs BFNT 2B 15.20 DOT 220 kPa

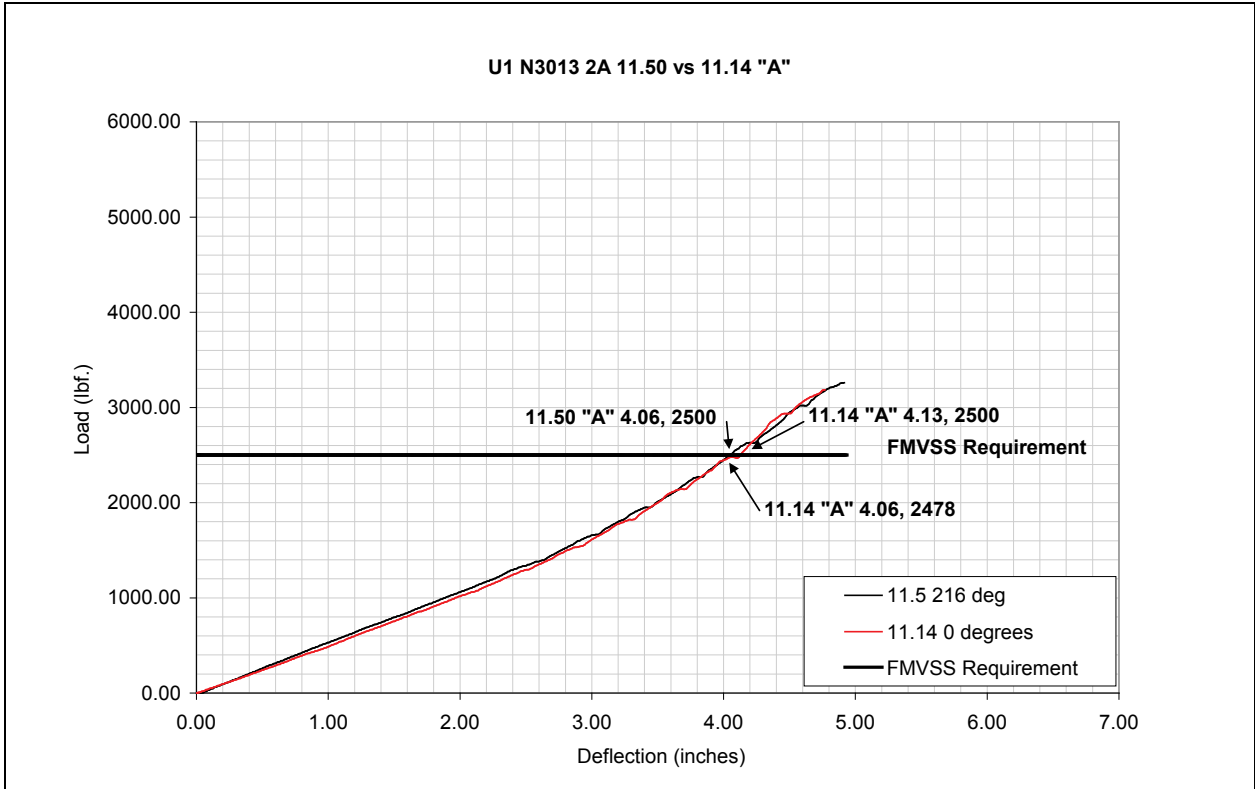
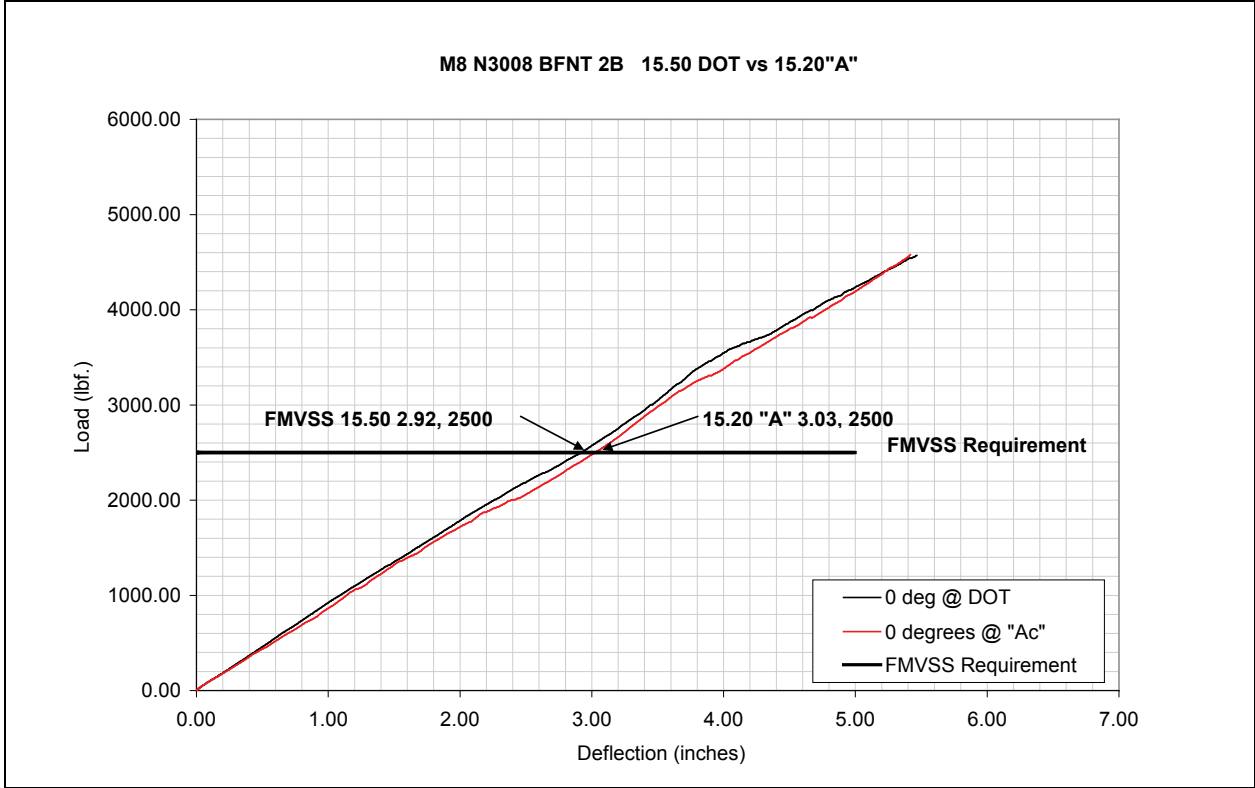


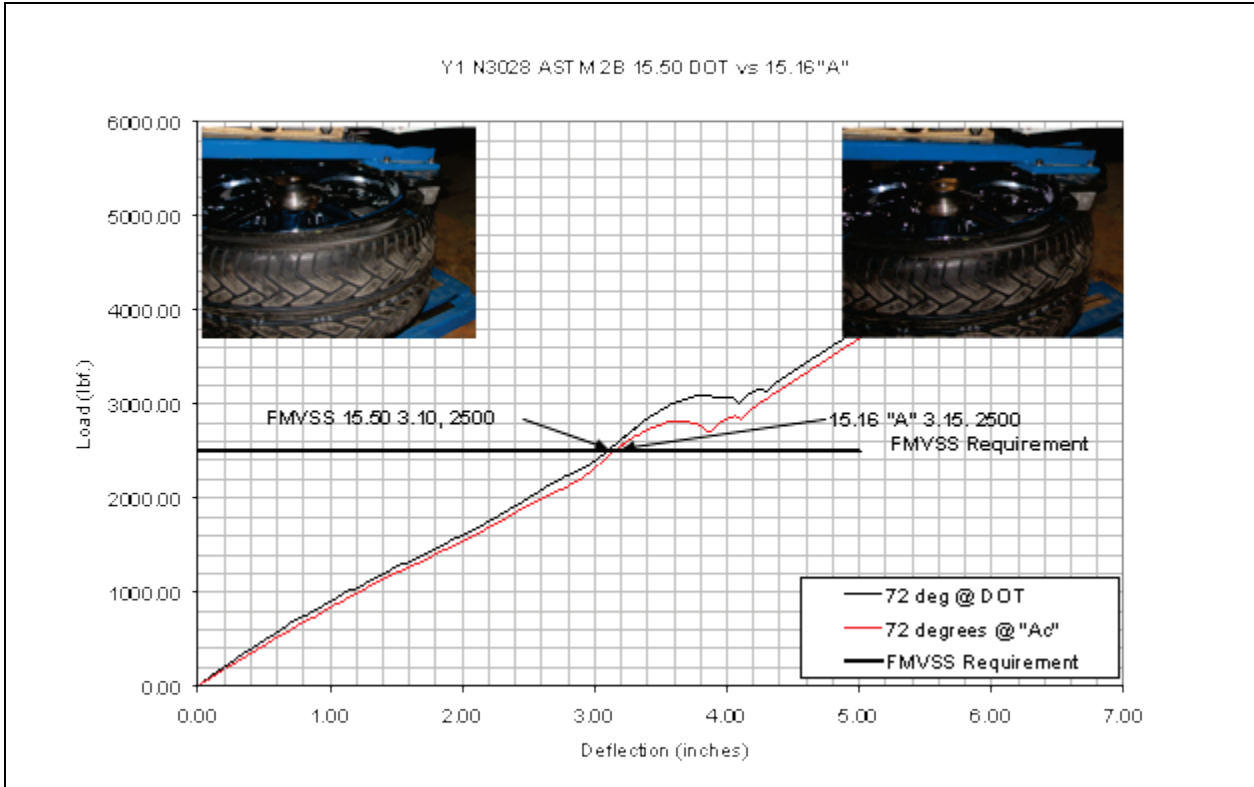
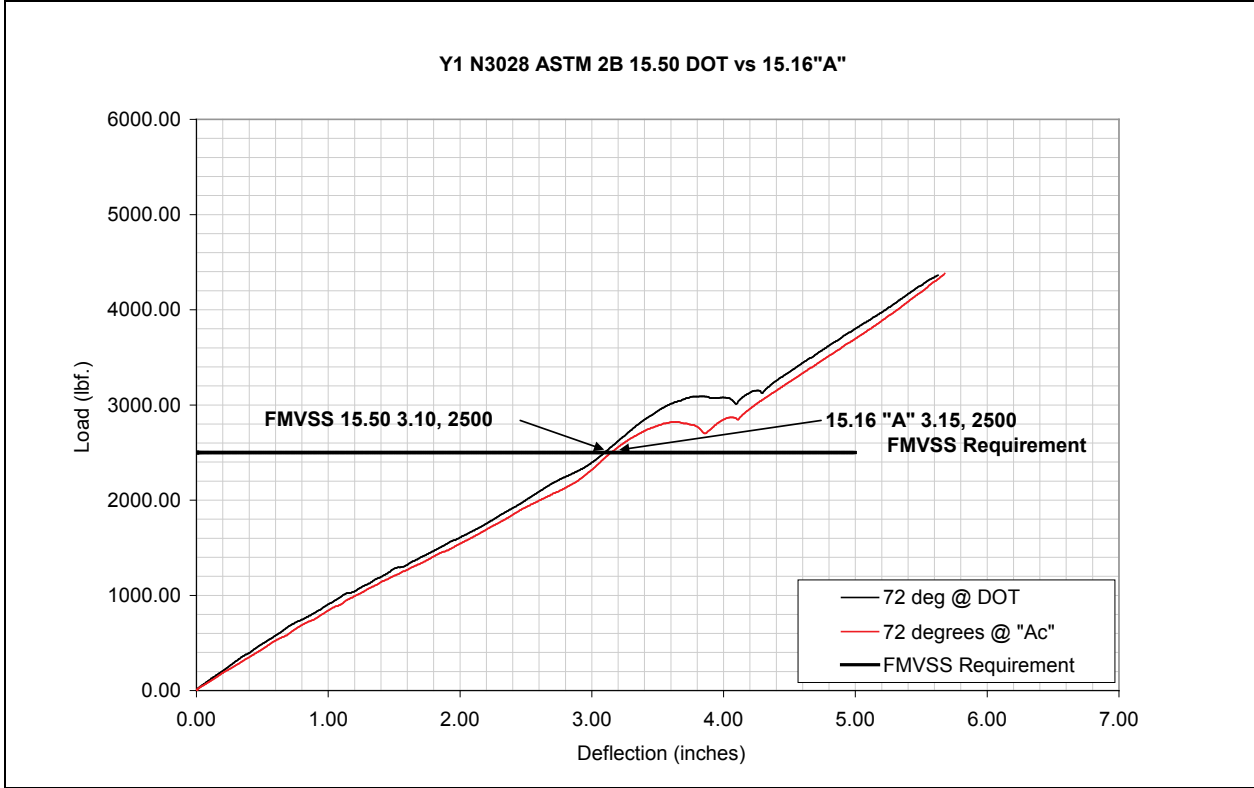


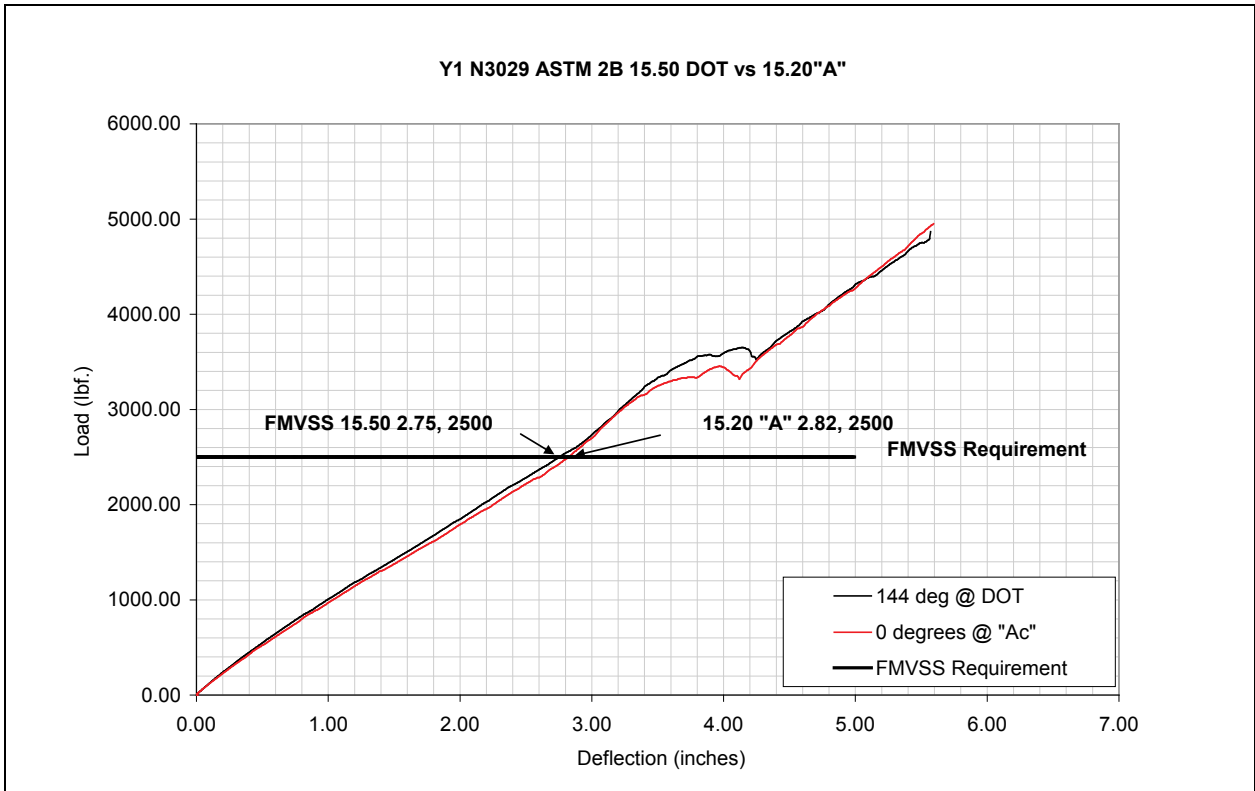
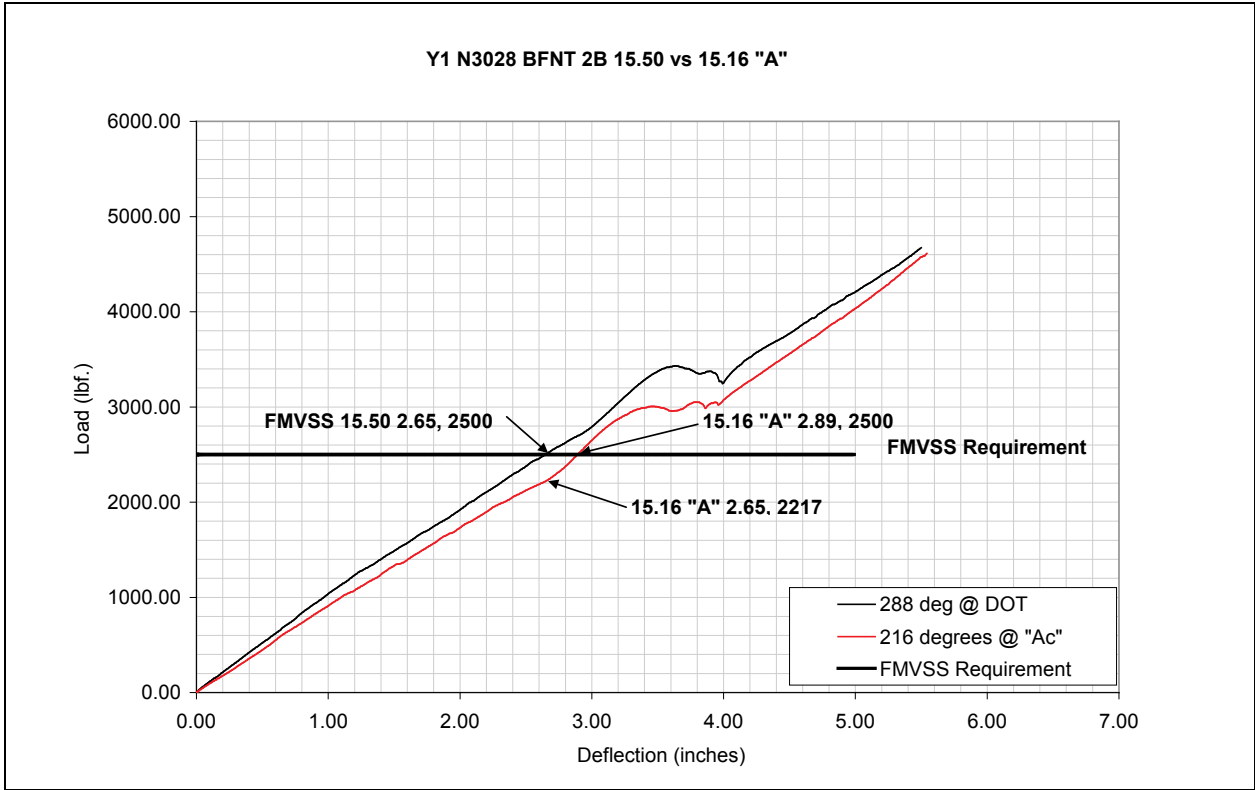
## Appendix B. DOT "A" Versus 75-Percent Rule

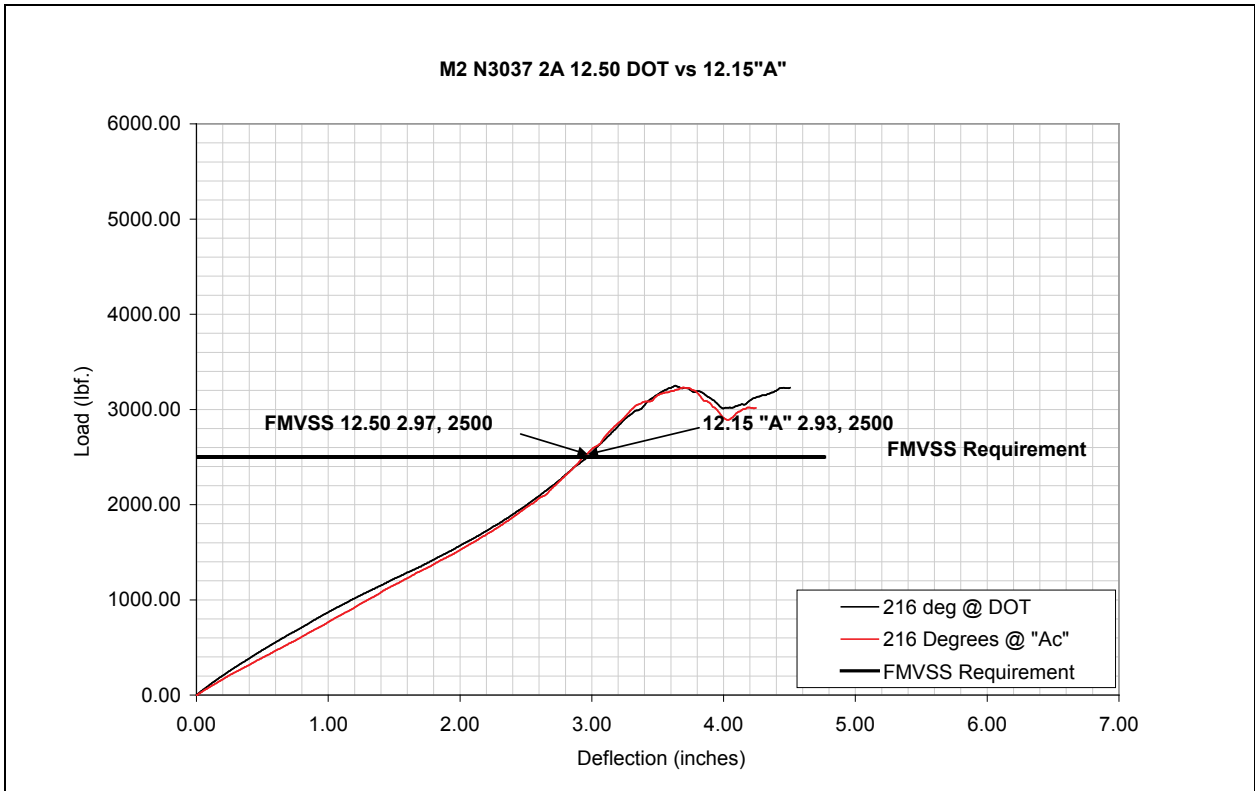
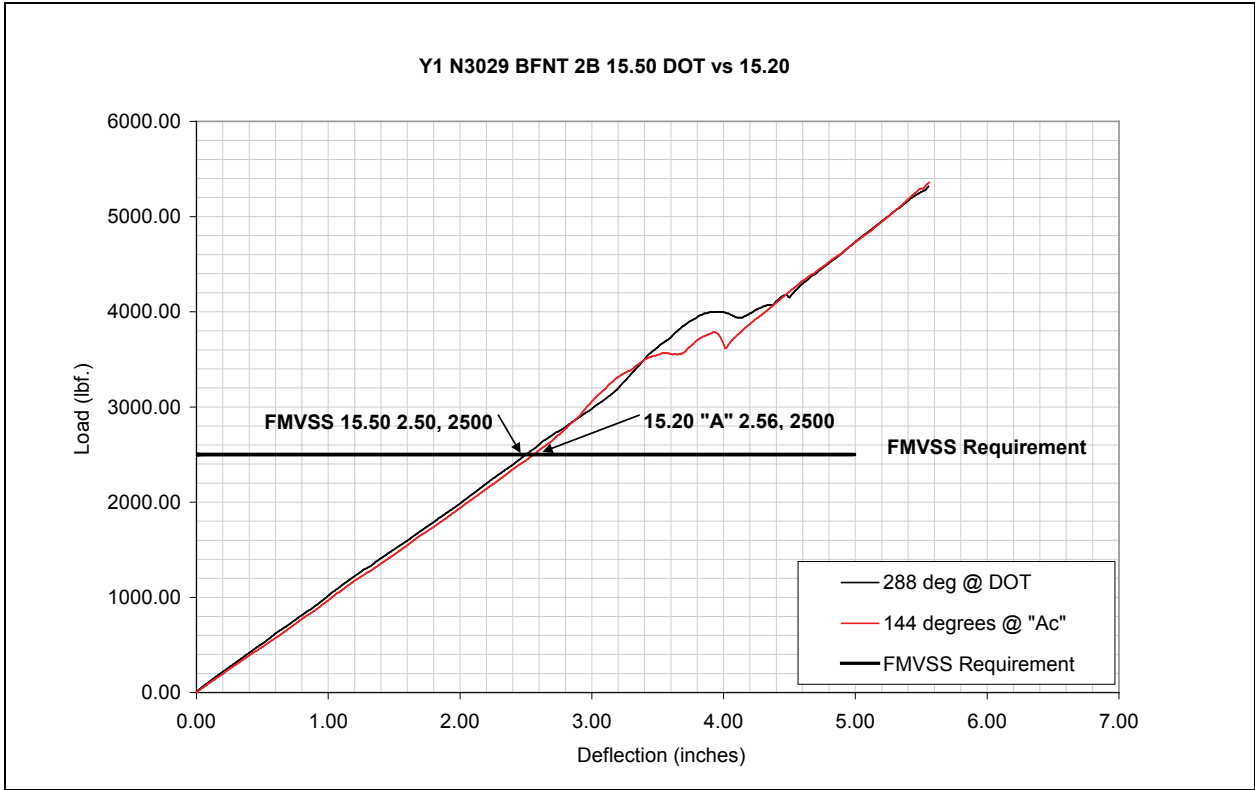


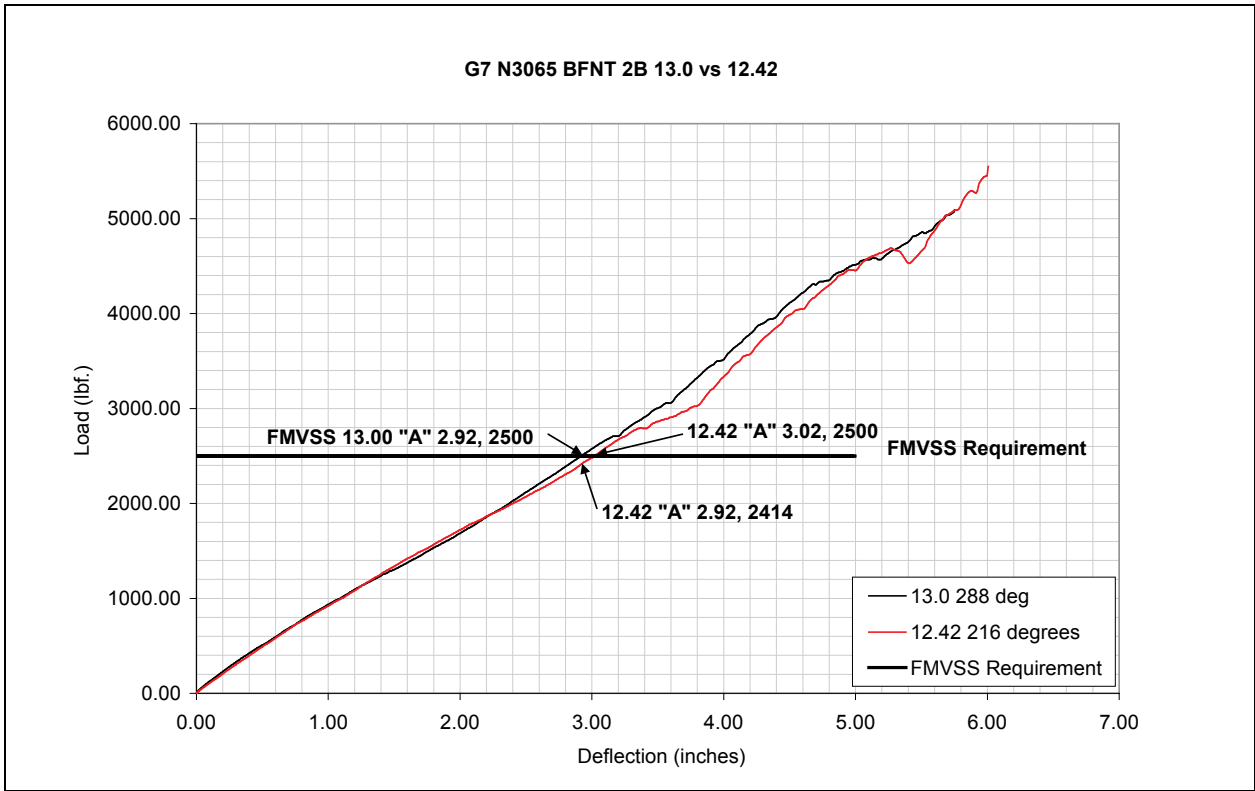
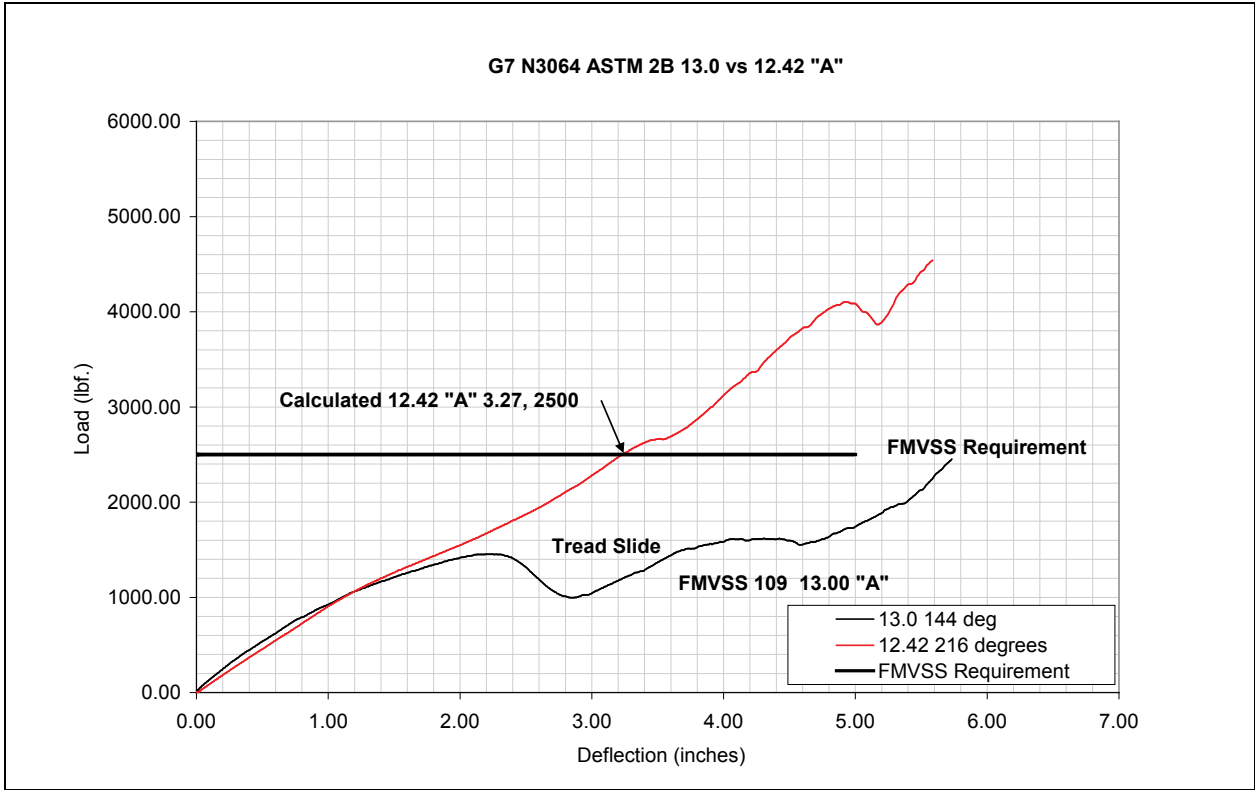




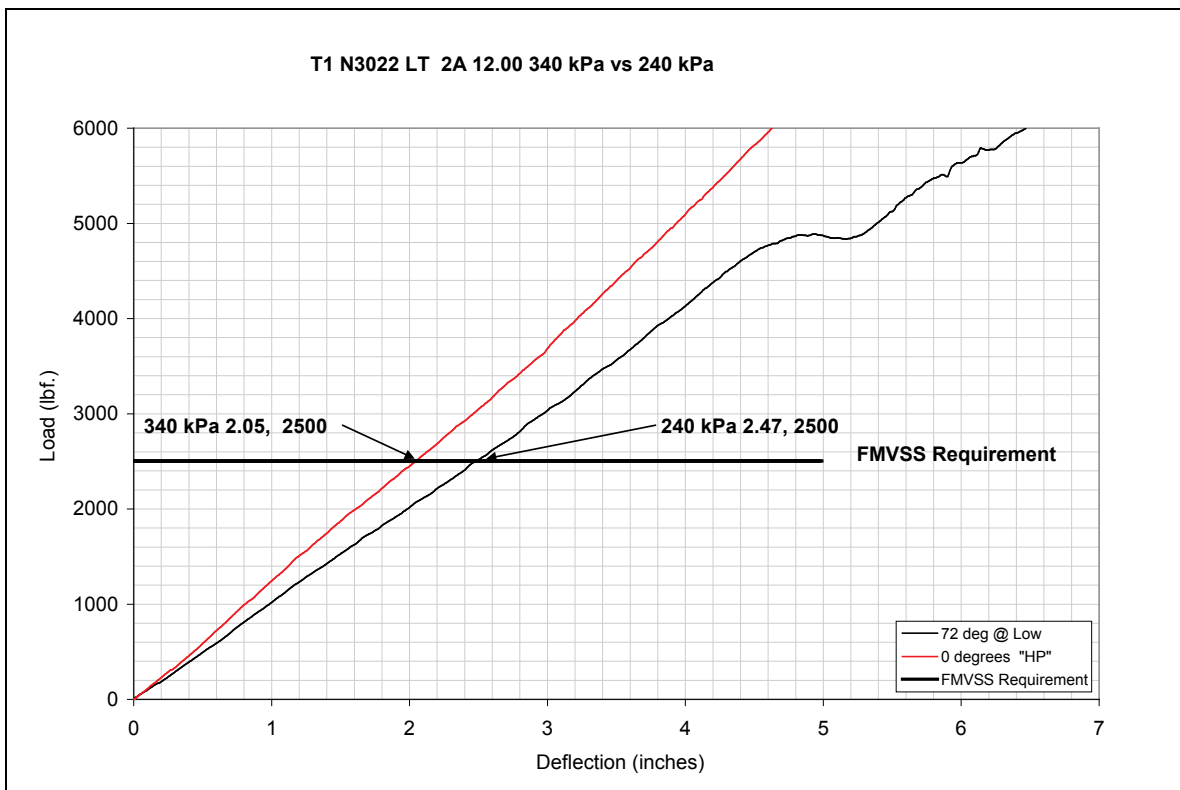
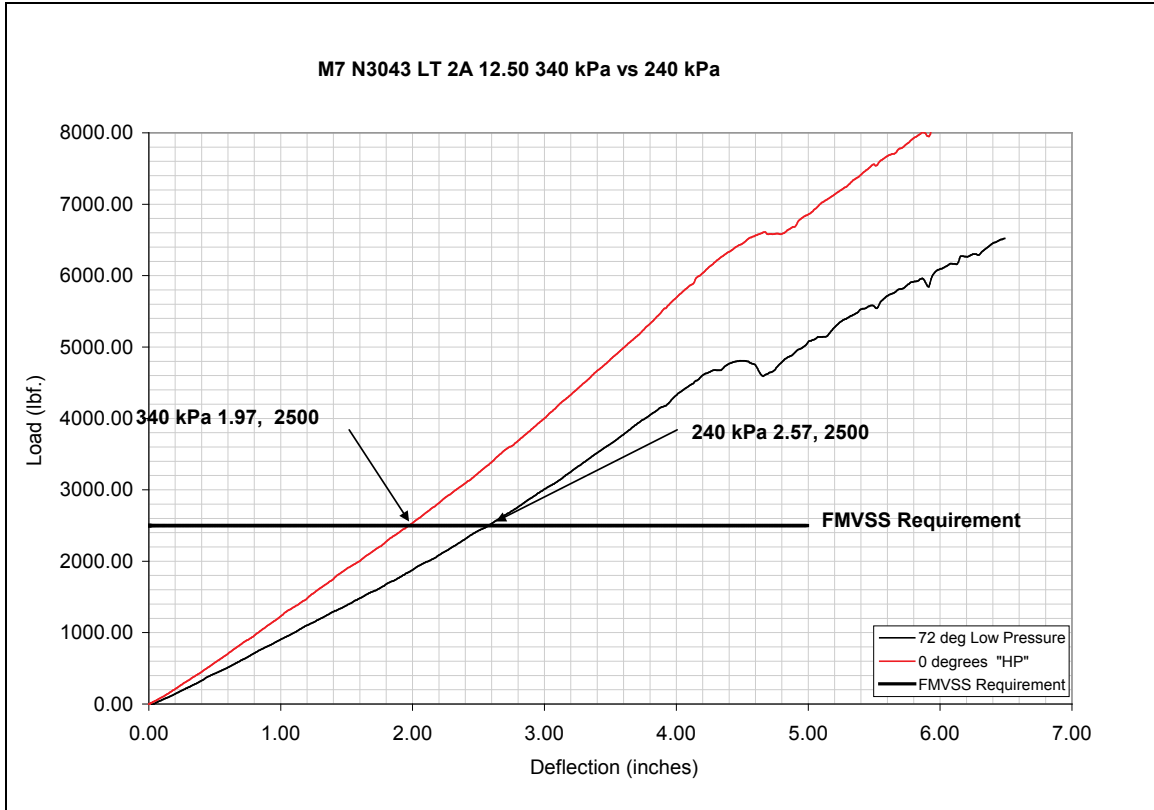




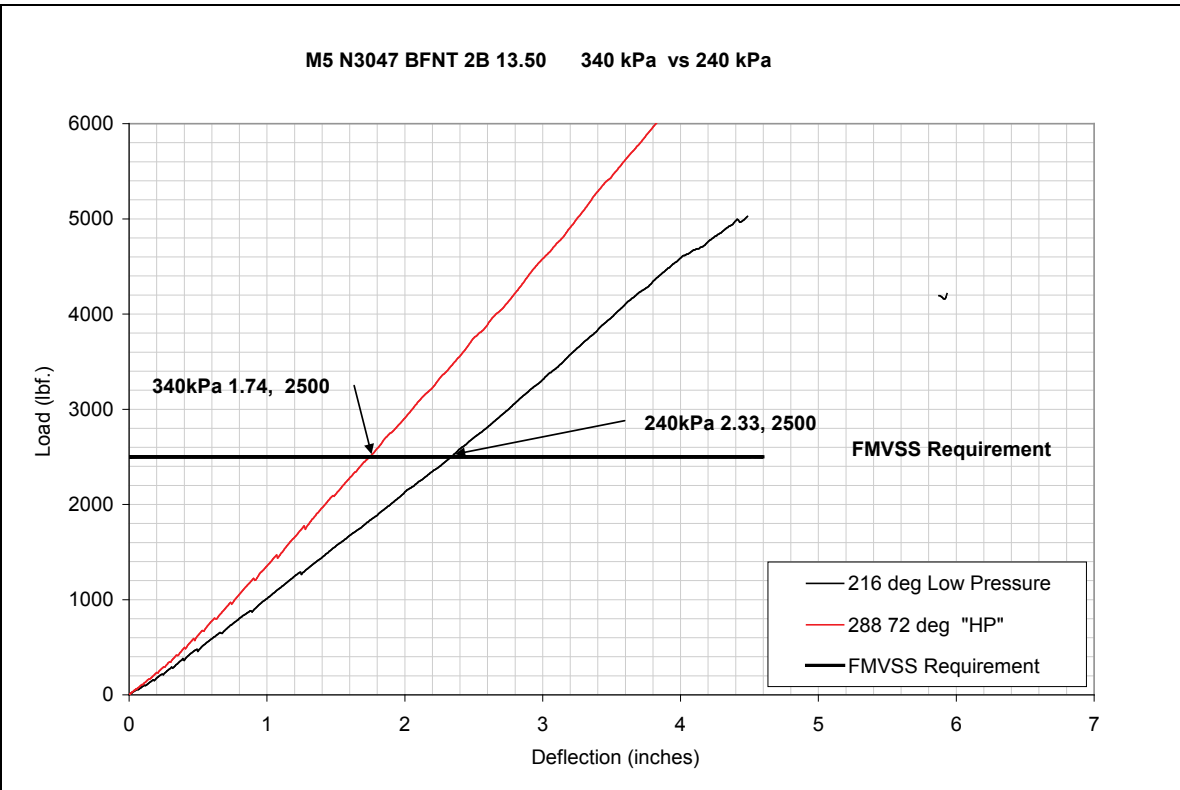
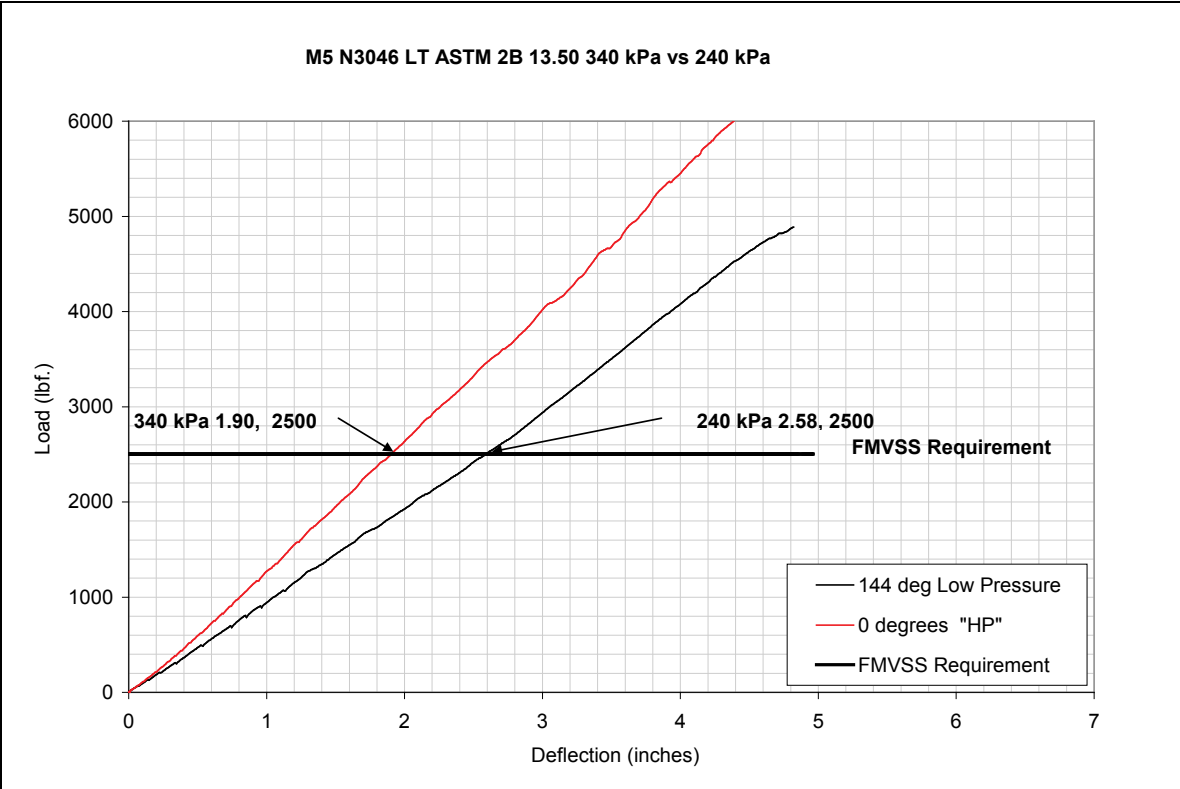


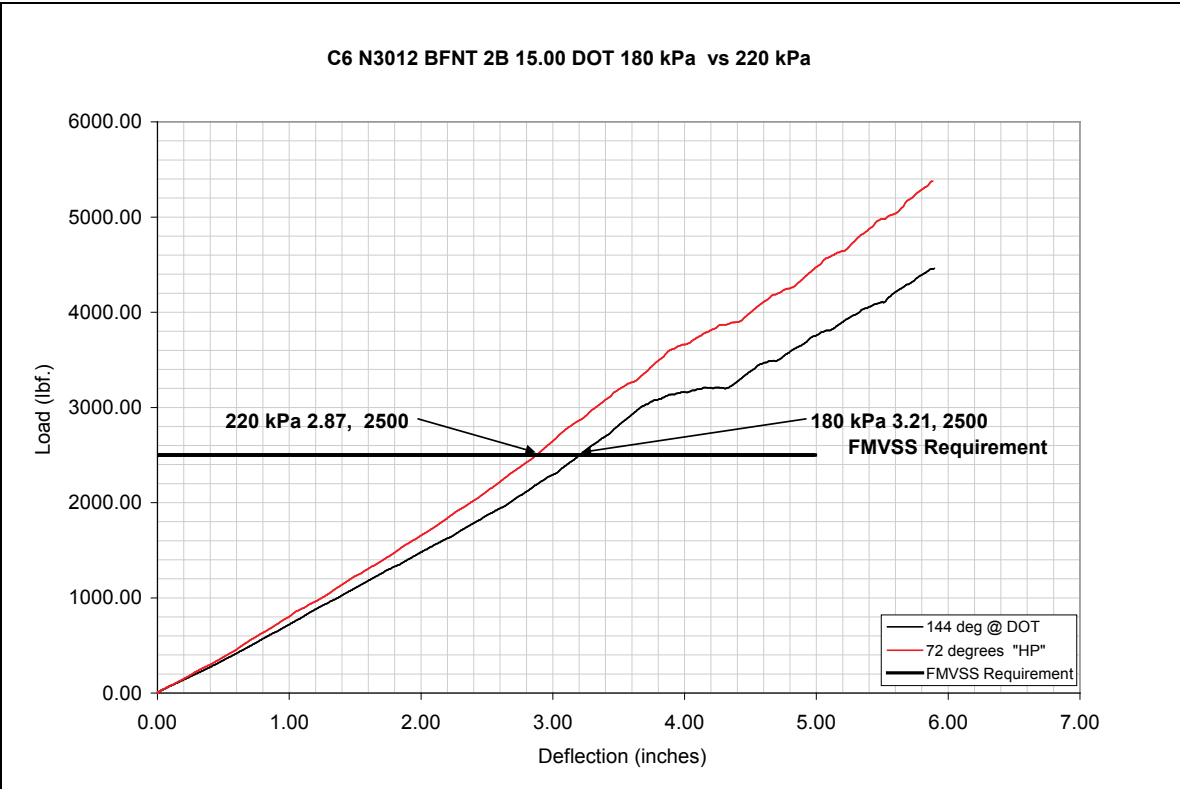
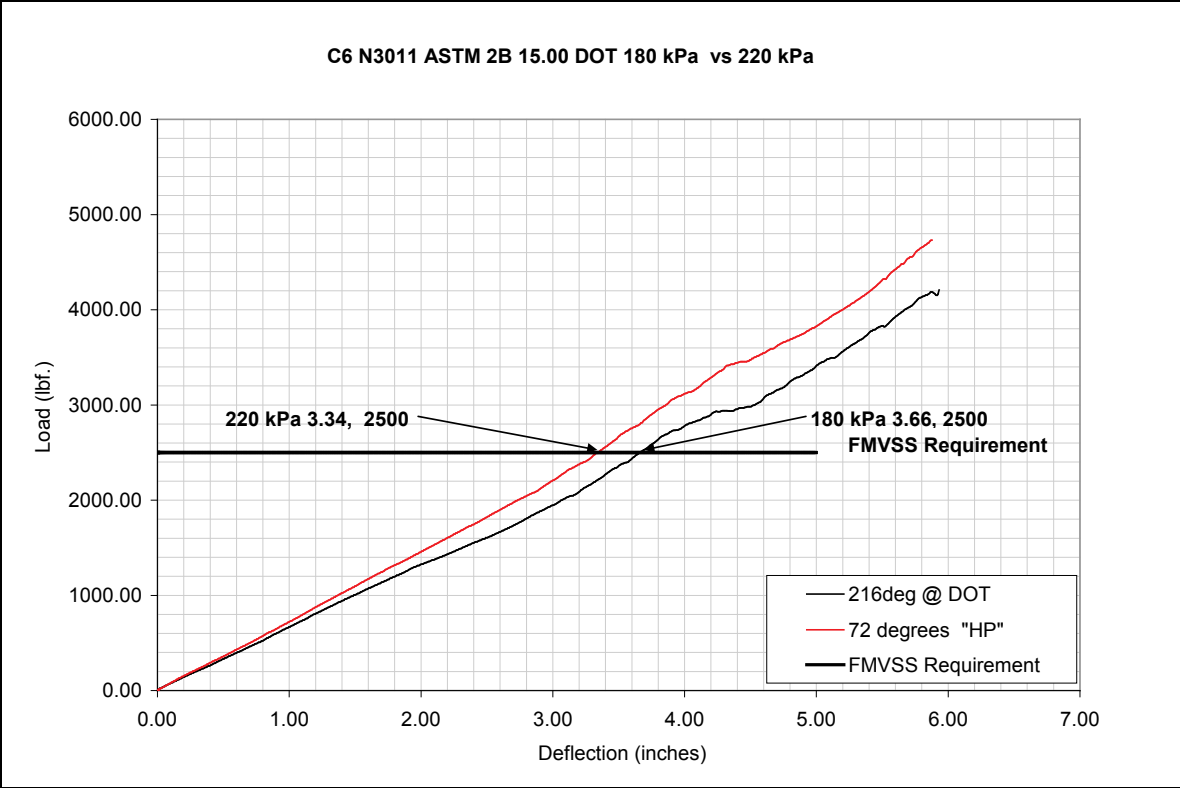


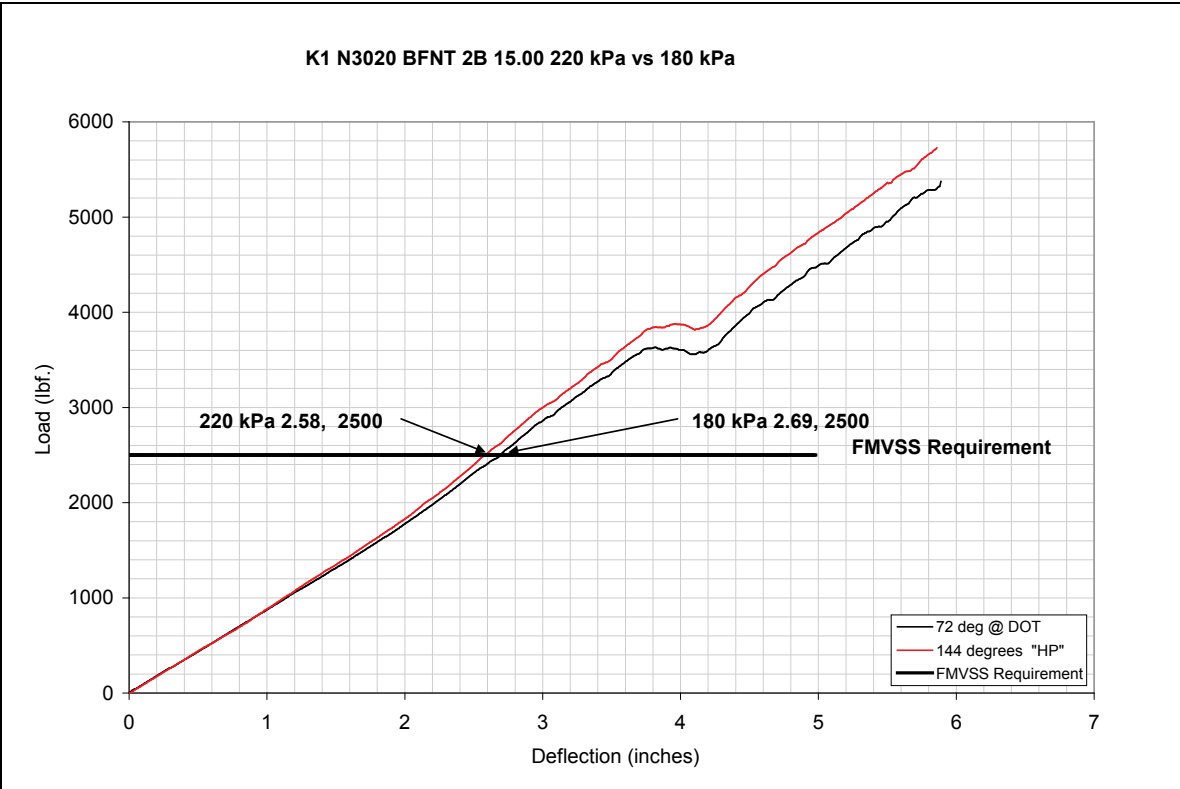
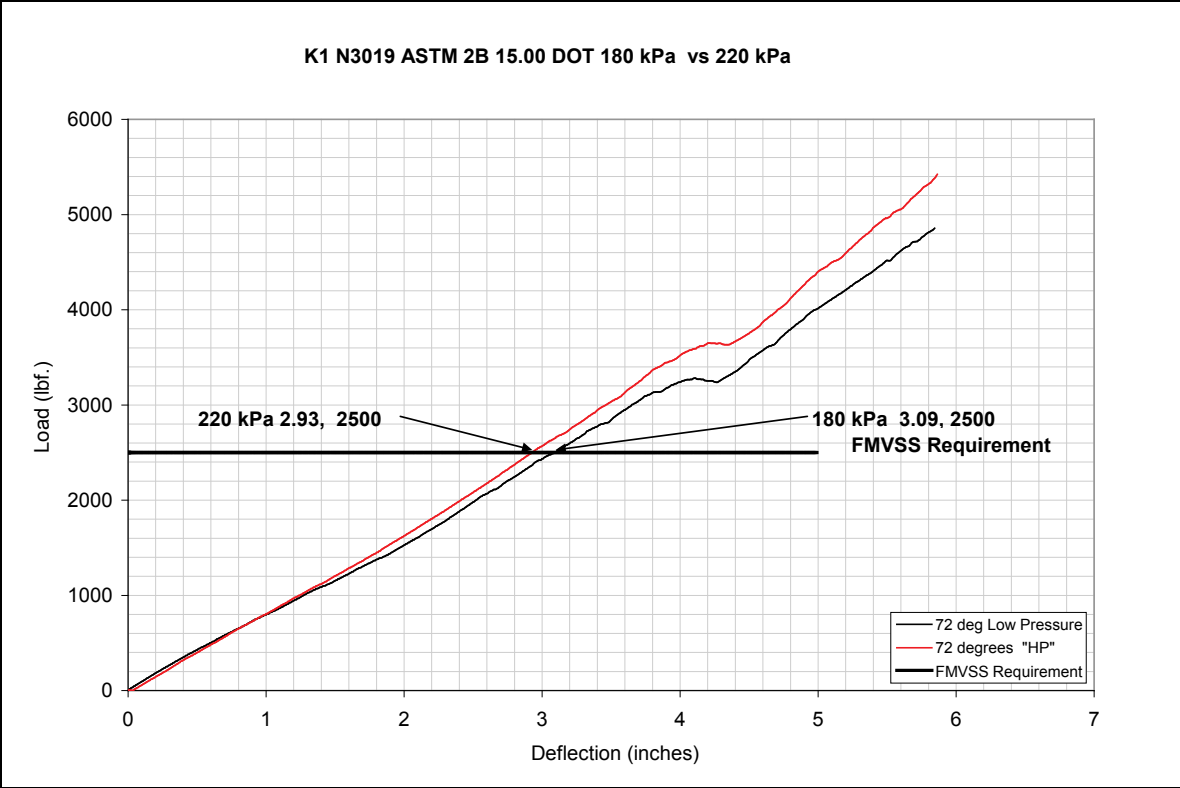
## Appendix C. Pressure Comparisons



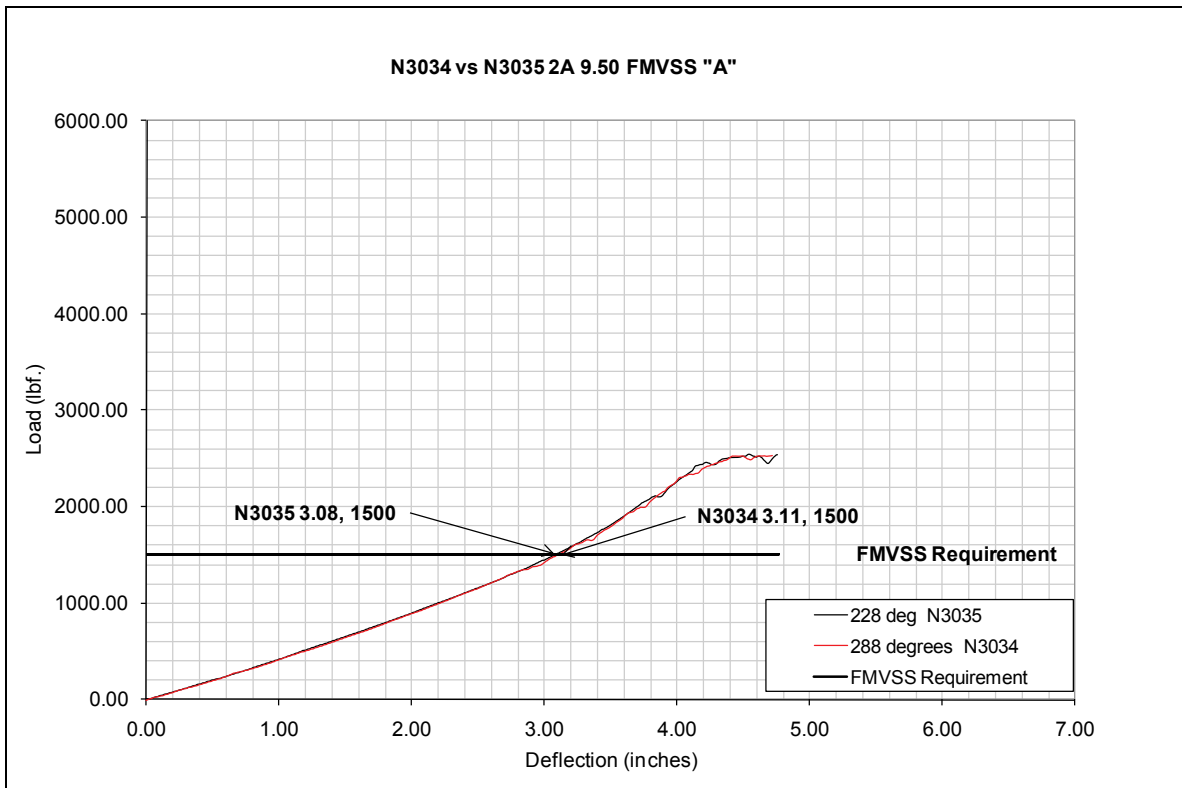
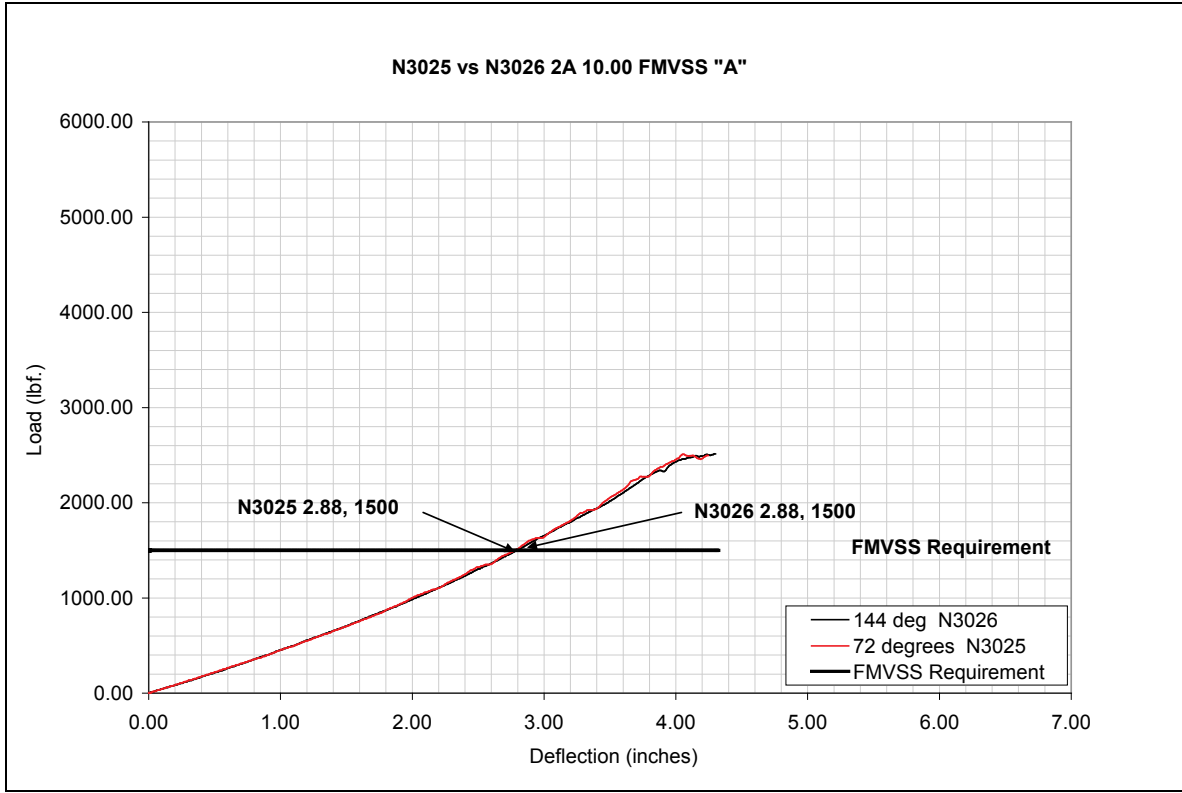


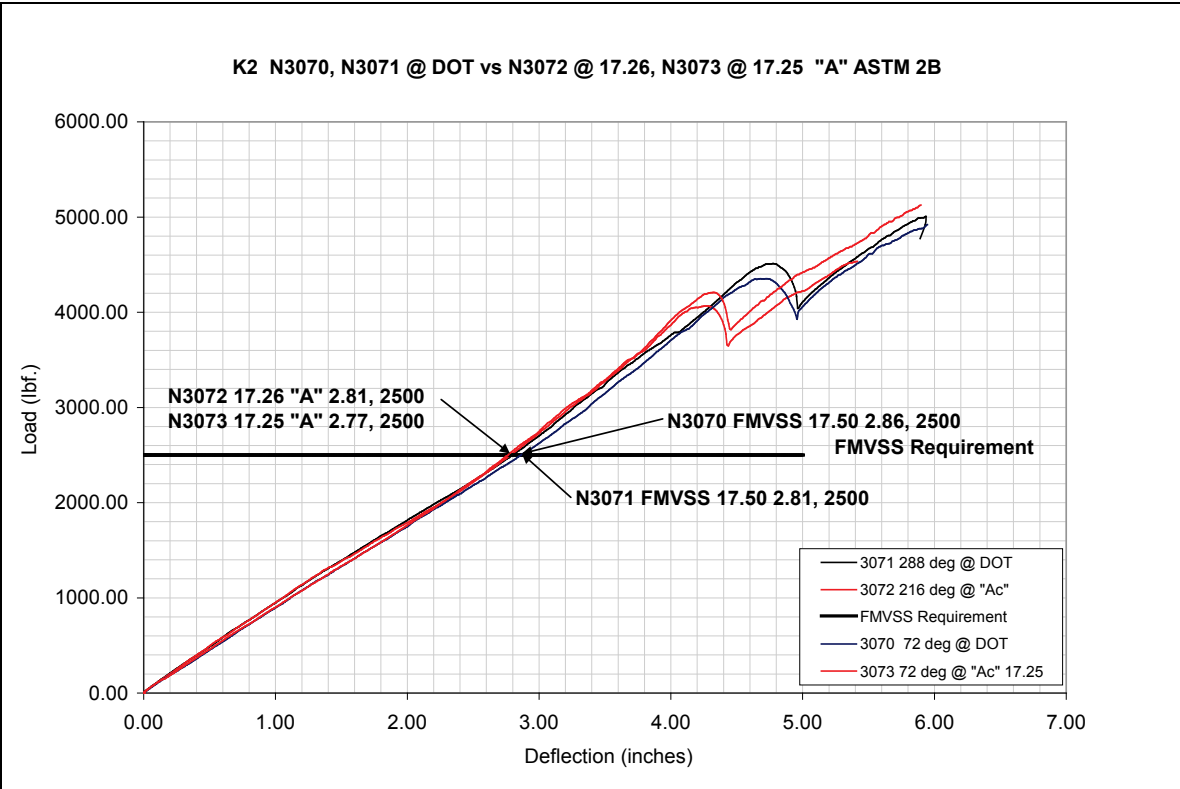
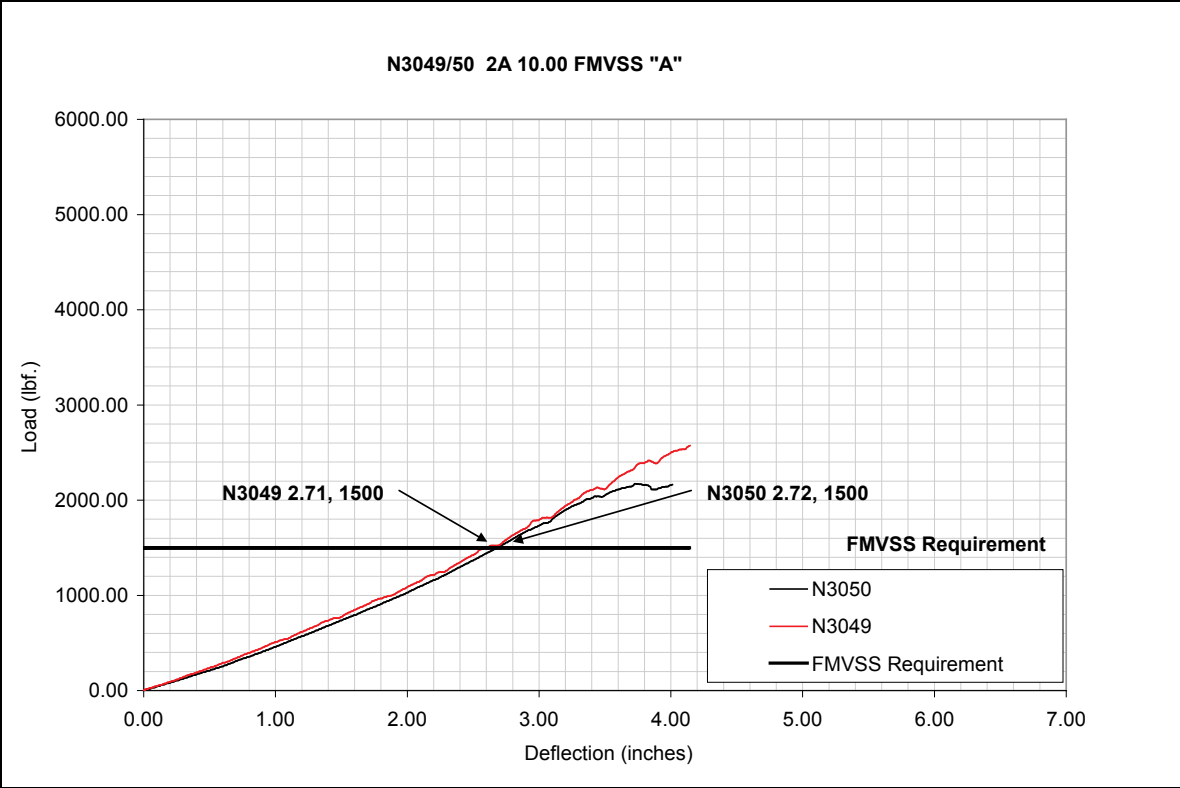






## Appendix D. Tire-to-Tire Comparisons





DOT HS 811 735  
April 2013



U.S. Department  
of Transportation  
**National Highway  
Traffic Safety  
Administration**



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