MESILLA VALLEY TRANSPORTATION SOLUTIONS
CERTIFIED
Fuel Economy Experts

TEST REPORT

MVT SOLUTIONS CERTIFIED™ FUEL ECONOMY TEST

MARCH 2020

MICHELIN: X ONE TIRES + ENERGY GUARD AERODYNAMICS

17.01	1.07	12.62%
gal/1000 miles	MPG	

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1.0: INTRODUCTION

Mesilla Valley Transportation Solutions ("MVTS" or "MVT Solutions") certifies the fuel savings described in this report. **Note:** this report was designed for carriers and providing information relevant to their needs. Therefore, the format varies from traditional fuel economy and technical reports. The Report Summary provides the reader a quick synopsis of the fuel savings. Following the Summary is the body of the report and further details on the subjects. This fuel economy test was performed using MVTS proprietary fuel economy test methods. These test methods were developed from race car engineering and advanced vehicle test methods, which the Mesilla Valley Transportation ("fleet" or "MVT") has relied on since 2012 to identify substantial fuel savings. The MVTS methods provide highly accurate and reliable answers on real-world fuel savings in comparison to other test methods, which enables carriers to make the best decisions for their company. Contact MVTS with any questions regarding the product or test. As part of an MVTS Certified™ test, MVTS supports product inquiries, which we encourage carriers to utilize. **Note:** blue text indicates a link to the topic. Click to follow. Alt + ← returns the reader to the initial location.

2.0: TEST SUMMARY

Michelin North America offers a unique combination of fuel saving technologies by providing both tires and trailer aerodynamic solutions. As a means of quantifying the fuel savings of these technologies, both separately and combined, MVTS conducted tests on behalf of Michelin. Therefore, there were two (2) parts to this fuel economy test; Part I; Wide Based Single (WBS) tires and Part II; trailer aerodynamics in the form of the Michelin Energy Guard system. These were tested individually but also combined to provide both the individual and total combined fuel savings. The **combined fuel savings of the Michelin X One tire package and Michelin Energy Guard system was 17.01 gal/1000 miles (12.62%, 1.07 MPG)**. Separately, the **Michelin X One tire package saved 6.70 gal/1000 miles (5.35%, 0.41 MPG)** and the **Michelin Energy Guard system saved 10.31 gal/1000 miles (7.65%, 0.62 MPG).** The X One tires were compared to a Bridgestone Greatec WBS package. Both packages included Steer tires of their respective brands. All tires tested were EPA SmartWay approved and considered direct brand comparisons. All tires had a 500 miles break-in procedure using the same vehicle and load as was used for the fuel economy tests. The Energy Guard system was compared to a trailer with no aerodynamic devices. Testing was conducted on a 9-mile test track at 65 miles per hour and a Gross Vehicle Weight (GVW) of 72,000 lbs.

Table 1: Results Summary

	Fuel Economy Improvement		
	Gal/1000 miles	MPG	Percent
Michelin X Ones vs. Bridgestone Greatec	**6.70**	0.41	5.35%
Michelin Energy Guard	**10.31**	0.62	7.65%
Combined: Michelin X Ones + Energy Guard	**17.01**	1.07	12.62%

2.1: PART I: TIRE TEST

More information on the tire test can be found in a separate report at www.m-v-t-s.com.

Table 2: Tire Test Sets

	Michelin	
	Model	**Size**
Steer	LRG X Line Energy Z	275/80R22.5
Drive	LRL X One Line Energy D	445/50R22.5
Trailer	LRL X One Line Energy T	445/50R22.5
	Bridgestone	
	Model	**Size**
Steer	LRG R284 Ecopia	295/75R22.5
Drive	LRL Greatec M835A Ecopia	445/50R22.5
Trailer	LRL BS Greatec R197 Ecopia	445/50R22.5

The tire test was conducted on behalf of Michelin Tires North America; however, all work was conducted independently by MVT Solutions. This included tire sourcing, purchasing, mounting, break-in miles, and testing. MVT Solutions is an unbiased, independent third-party testing organization and does not receive any commission from the sale of tested products.

Note: Fuel savings from tires is directly related to GVW; if vehicle weight increases, the fuel savings value will also increase.

2.2: PART II: AERODYNAMIC TEST

The fuel savings of the **Michelin Energy Guard was 10.31 gal/1000 miles (7.65%, 0.62 MPG)**, which was conducted with WBS tires. The Energy Guard fuel savings were very similar to the 2019 MVTS Certified™ test results of 10.00 gal/1000 miles, adding further support that both the test and products are consistent and reliable.

2.3: COMBINED FUEL SAVINGS

Combining the fuel savings of the Michelin X One package and the Michelin Energy Guard aerodynamics provided a total fuel savings of 17.01 gal/1000 miles (12.62%). This value was obtained by comparing the combination of the X Ones and Energy Guard to the Baseline, which had Bridgestone Greatec WBS and no trailer aerodynamics.

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3.0: TIRE TEST PROCEDURE

Fuel economy testing of tires varies to other technologies since tire performance changes over time, both long term and short term. During a fuel economy test, fuel economy can change due to temperatures and pressure of the tires. Many extra steps were taken during the tire tests to ensure accuracy and consistency including tire preparation, tire pressure management and monitoring.

3.1: TIRES TESTED

All tires were purchased new for this test and received 500 break-in miles prior to testing. All Drive and Trailer tires were the same size at 445/50R22.5. Steer tires were 295/75R22.5 for the Bridgestone tires and Michelin Steers were 275/80R22.5.

All tires were SmartWay approved, and each company's fuel-efficient offerings in the WBS category; therefore, the tire packages tested are considered direct and fair competitors.

Table 3: Test Tire Info

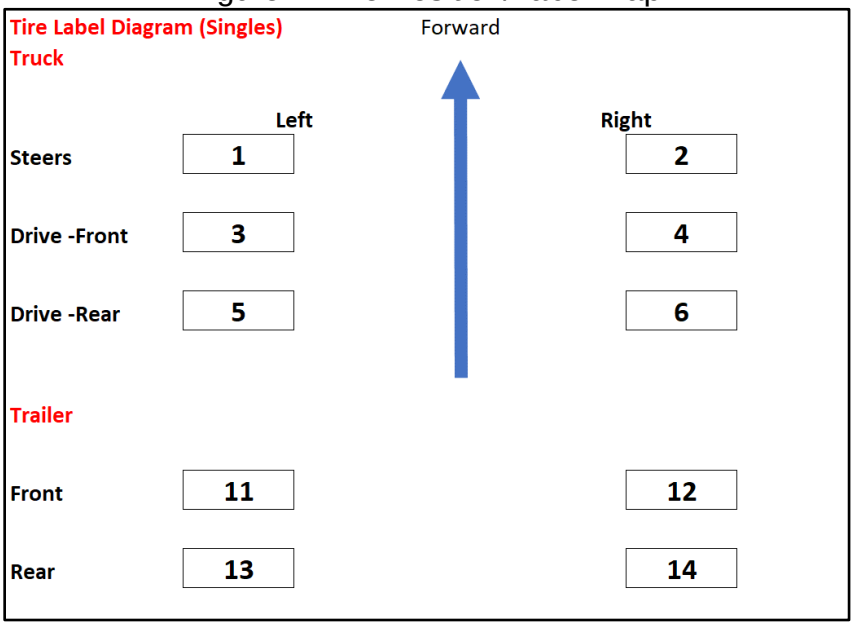
Michelin				
	Model	**Size**	**Rev/Mile**	**Tread Depth (32nds)**
Steer	LRG X Line Energy Z	275/80R22.5		19
Drive	LRL X One Line Energy D	445/50R22.5	517	24
Trailer	LRL X One Line Energy T	445/50R22.5		13
Bridgestone				
	Model	**Size**	**Rev/Mile**	**Tread Depth (32nds)**
Steer	LRG R284 Ecopia	295/75R22.5		18
Drive	LRL Greatec M835A Ecopia	445/50R22.5	524	23
Trailer	LRL Greatec R197 Ecopia	445/50R22.5		11
Veh. B: Compare Vehicle: Michelin Duals				
	Model	**Size**	**Rev/Mile**	**Tread Depth (32nds)**
Steer	LRG X Line Energy Z	275/80R22.5		19
Drive	LRL XDA Energy + (duals)	275/80R22.5	512	22
Trailer	LRG X Line Energy T (duals)	275/80R22.5		12

All tires were tested on the same truck and trailer, termed the 'Test' vehicle (Veh. A), in sequential test runs. A second vehicle, the 'Compare' vehicle, remained unchanged throughout testing and is denoted as 'Veh. B: Compare Vehicle' in the table above. The Compare vehicle utilized a Michelin dual tire package, which was spec on the MVT vehicles used for testing at the time (MVT has a mixture of dual and WBS). Using fuel efficient dual tires on the Compare vehicle during a WBS test did not impede the test validity in any way, as the tire pressure comparison will show. Results will also show there was a significant difference in the WBS brands, which negates any challenge that could

be raised about the difference in duals versus WBS on the vehicles. The Test and Compare vehicles will be discussed in more detail in the sections below.

Tires were installed in the same positions for the break-in miles and fuel economy tests, as labelled in the figure below.

Figure 1: Tire Position/Label Map



Note: Tire images shown below may include footprints and/or dirt. It was decided not to clean the tires with any water or chemicals prior to testing. Footprints were caused by MVTS technicians walking on the tires while checking pressures and dirt was contracted during break-in miles as the vehicle was parked in a secure dirt yard during break-in mile operations.

Figure 2: Michelin Steer (Position 1)

Figure 3: Michelin Drive (Position 4 & 6)

Figure 4: Michelin Trailer (Position 11 & 13)

Figure 5: Bridgestone Steer (Position 1)

Figure 6: Bridgestone Drive (Position 6)

Figure 7: Bridgestone Trailer (Position 7 & 9)

3.2: TIRE SOURCING & MOUNTING

All test tires were purchased through regular supply chains, which were sourced independently by MVT Solutions through Border Tire in Las Cruces, NM. This ensured tire manufacturers were not involved in sourcing or supplying the tires.

Border Tire mounted and balanced all Steer tires. Drive and Trailer tires were mounted in the MVT shop with a single technician. Since it is common practice in the trucking industry, Steer tires were balanced, Drives and Trailer tires were not.

Table 4: Wheels and Balancing

	Wheels	Balanced?
Steer	Aluminum	Yes
Drive	Aluminum	No
Trailer	Aluminum	No

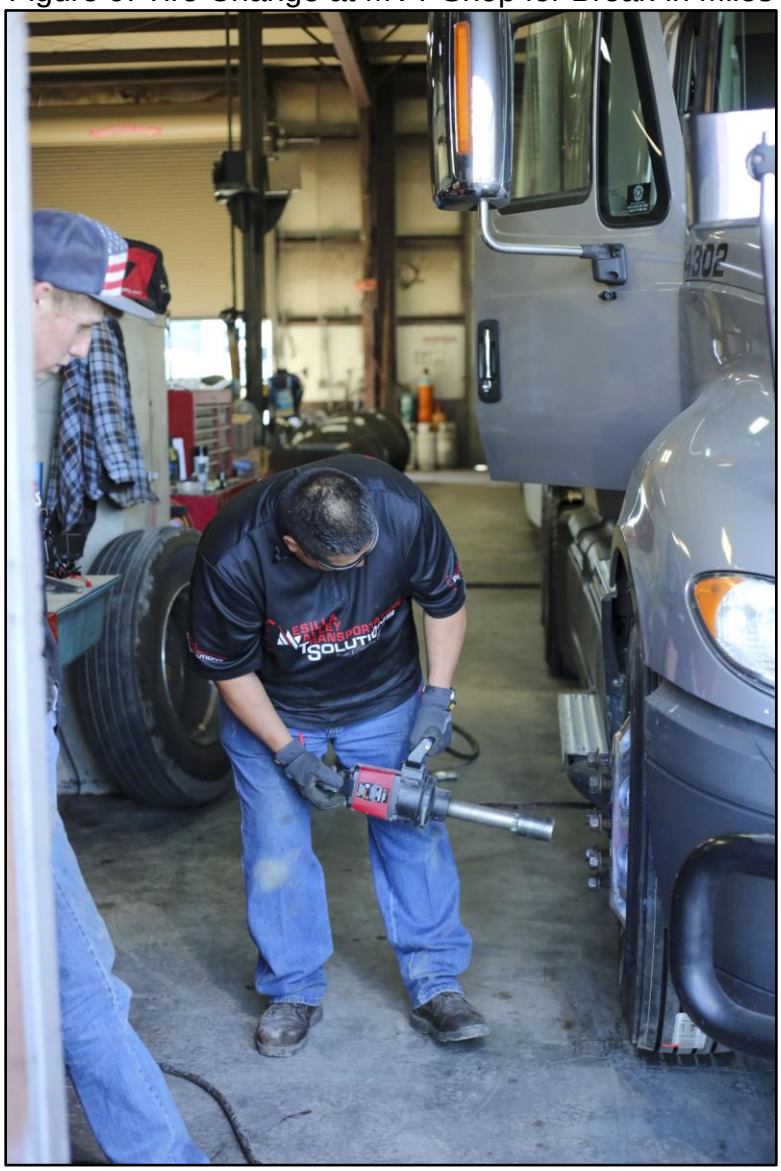
3.3: TIRE BREAK-IN

All tires received a break-in distance of 500.3 miles in the weeks prior to testing. A distance of 500 miles was chosen due to industry standard expectations for tire consistency[1] and break-in. All break-in miles used the same truck, trailer, driver, route, and load to ensure consistency.

Figure 8: Test and Break-in Ballast (72,000 lbs. GWV)

[1] J1321 Revised FEB2012 Page 13 of 50 4.2.2 Vehicle Type and Configuration

Figure 9: Tire Change at MVT Shop for Break-in Miles



All tires were inflated to 100 psi cold pressure. Each set remained in the MVT shop overnight prior to conducting break-in miles the following day. After installation, tire pressures were again verified to be at 100 psi. All tires were labelled to its position on the vehicle to ensure consistency when reinstalled during the actual fuel economy test.

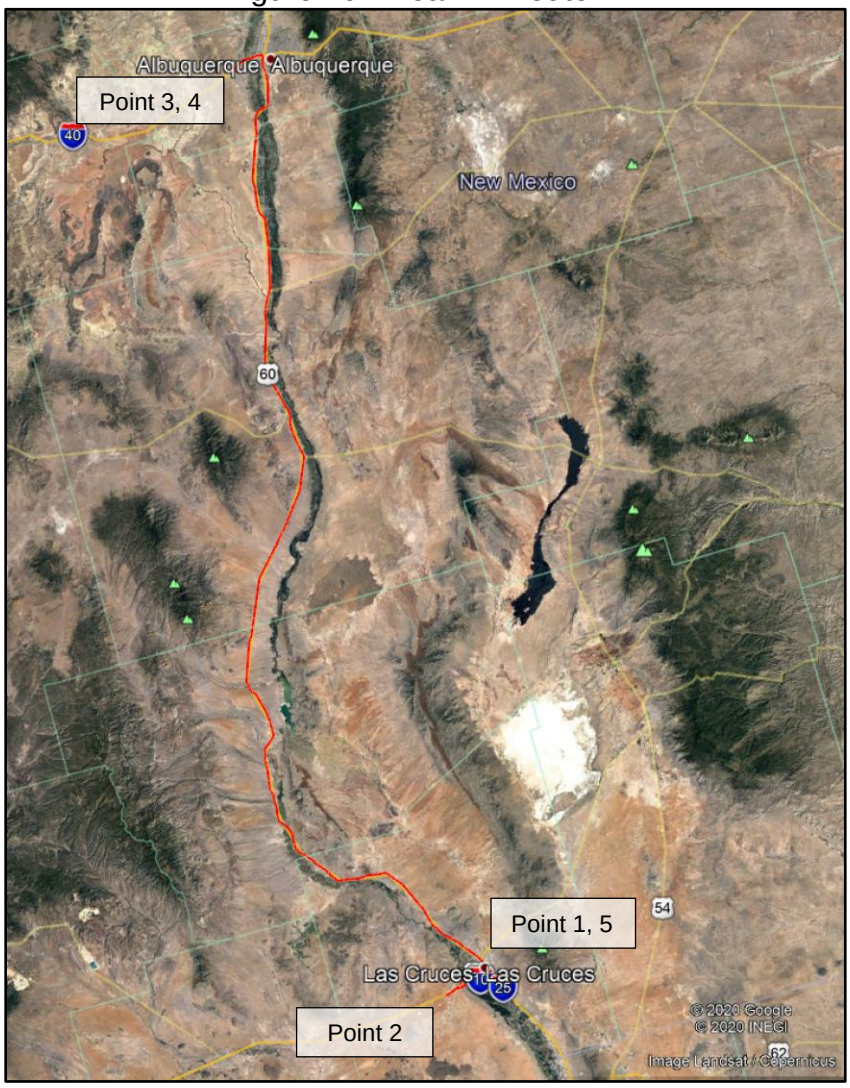
3.3a: Break-in Route

Break-in miles followed a route from Las Cruces, NM to Albuquerque, NM. This included a variety of terrain types, which allowed the tires to heat cycle. The numbers below correlate with those found in the route map of Figure 10.

1. Start of route: MVT shop, 3530 W. Picacho Ave., Las Cruces, NM
2. To Loves Truck stop, 8993 Robert Larson Blvd, Las Cruces, NM (**6.3 miles**)
3. To 66 Casino, Route 66 Casino Hotel, 14500 Central Ave SW, Rio Puerco, Albuquerque, NM 87121 (**250 miles**)
4. Stop for 30 minutes to allow tires cool
5. Return to 3530 W. Picacho Ave., Las Cruces, NM (**244 miles**)
6. Total Distance **500.3 miles**

Upon completion of the break-in miles, the truck and trailer were parked overnight in the MVT yard. In the morning, the break-in process was repeated for the next set of tires.

Figure 10: Break-in Route



Data was collected during the break-in process using MVT Solutions data acquisition system and included:

- Air speed, direction, temperature
- Road temperature
- Left-front Drive tire temperature
- GPS speed, position, direction, time
- Fuel consumption by flow meter

Figure 11: Test Vehicle Leaving MVT Shop for Break-in Miles

3.4: TEST RUN TIRE PREPARATION

For the fuel economy test, all test tires were placed in the shop at the test track and laid flat on the floor overnight. Tire pressures were set to 105.0 psi cold the night prior to testing. Although the test pressure would be 100.0 psi cold for the test, a higher pressure was set the night before testing to ensure air would not be added prior to testing since the tires would cool overnight and pressures would decrease.

At 5am of the test day, all tire pressures were set to 100.0 psi. This time was chosen to ensure complete darkness and no affect from sunlight on any tires. This included the tires mounted on the Compare vehicle, which remained on that vehicle and parked outside of the shop overnight.

Each vehicle had a its own corresponding digital tire pressure gauge, which remained with that vehicle throughout the test. These gauges were brand new and accurate to 0.5 psi.

Figure 12: MVTS employee checking tire pressure

Tire pressures were not adjusted after 5am the morning of the test runs, they were only checked to verify and record pressure values.

Tires on Vehicle B, the Compare vehicle with dual tires, were not changed during testing. Vehicle A, the Test vehicle, had its tires changed for each corresponding test.

3.5: TIRE FUEL ECONOMY TEST PROCEDURE

Testing was conducted in Pecos, Texas on the 9-mile test track. Test speed was 65 mph. Wheel revolution counts were changed in accordance with the Drive tire revolutions per mile for each tire set tested.

The test procedure was as follows:

A) Complete five (5) warm-up laps to allow tire pressures and temperatures to stabilize
B) Stop on test track to record tire pressures
C) Complete 12 laps (108 miles) –where data is used for test results
D) End test run. Record tire pressures (18 total laps)

Table 5: Warm-up and Test Laps

Lap #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Check Pressures	Warm-up Laps					Stop. Check Pressure. Accelerate.	Test Laps 1-12												End Test. Pit. Check Pressures.

Note: Lap 6 was used to accelerate the vehicles to 65 mph and was not part of the test results data. Tire pressure values are shown in the Tire Details and Pressures section and the comparisons are summarized in the Test Results section.

3.6: TEST VEHICLES

Test vehicles were 2015 International LT's with Cummins ISX 15-Liter engines and Eaton 10-Speed Automated Manual Transmissions (AMT). Trailers were 53' Hyundai dry vans. Gross Vehicle Weight (GVW) was 72,000 lbs. Both trucks were equipped with Ex-Guard grill guards, which were previously tested and showed no influence on fuel economy. The Compare vehicle remained unchanged throughout all tests. The Test vehicle configuration was changed between test runs with the installation of the Michelin X One tires and the Michelin Energy Guard system. The Compare vehicle used dual tires, whereas the Test vehicle used Wide Based Single (WBS) tires since they were the tested product. Vehicle info can be found in the Appendix.

Vehicles were thoroughly inspected and received regular maintenance prior to testing. It should also be noted, for the reader's piece of mind, Mesilla Valley Transportation (MVT) and MVT Solutions are 100% confident in the reliable condition of the test vehicles. MVT fleet uses the same vehicle data and test procedures for their own internal purchase decisions.

Figure 13: Test Vehicles

Figure 14: Test Trailers

4.0: AERODYNAMICS TEST PROCEDURE

The aerodynamic test procedure was more simplified when compared to the tire test and followed the standard MVTS Certified test procedure. The aerodynamic tests used the same two (2) vehicles as the tire test. The vehicles ran simultaneously at 65 mph on the 9-mile circle track near Pecos, Texas. The Baseline run was 14 laps (126 miles) and the Test run was 12 laps (108 miles). **Note:** The difference in test run length did not affect MVTS results since the laps are analyzed individually and not as a total fuel used value. Extra laps of the Baseline were to improve accuracy of the test due to wind conditions. The vehicles were 1-minute apart, avoiding any aerodynamic influence on either vehicle during testing. The 'Test' vehicle had modifications made during the test (*i.e.* Michelin Energy Guard installed).

The test procedure may appear similar to the SAE J1321 method traditionally used in the trucking industry; however, the MVTS methods are a much more advanced and precise form of on-road and track testing. The vehicles are equipped with sensors and data recording systems that collect data on fuel consumption, aerodynamics, rolling resistance, driver behavior and many other variables that affect fuel consumption. The data is analyzed using MVTS proprietary methods, which provide very accurate answers on fuel savings. Additionally, the test results can be scientifically translated to a carrier's real-world daily operations and long-term savings, which is a feature unique to these methods. Overall, the MVTS test methods are a much more advanced and reliable tool for predicting fuel savings than the trucking industry has used previously.

4.1: MICHELIN ENERGY GUARD KIT

The Michelin Energy Guard kit has several components: trailer end fairings top (A) and sides (B), wake reducer (C), mud flaps (D) and trailer skirts (E) (Figure 15 - Figure 18).

Figure 15: End Fairings (Top)

Figure 16: End Fairings (Side) and Wake Reducer

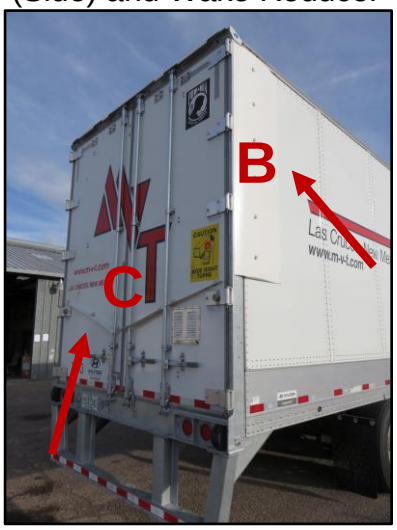


Figure 17: Mud Flaps

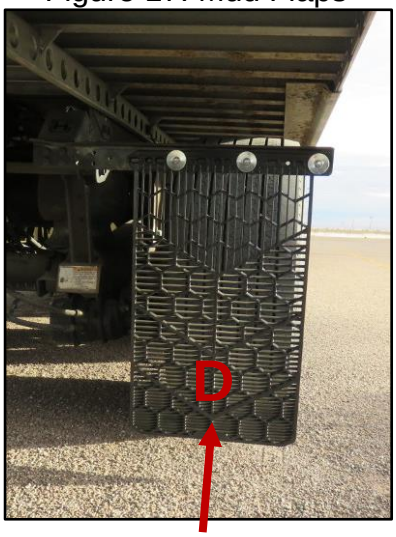


Figure 18: Trailer Skirts

5.0: VEHICLE FUEL ECONOMY TEST EQUIPMENT

MVT Solutions fuel economy testing utilizes a data acquisition system and sensors specifically for this testing. This style of testing is derived from race car engineering where reliable sensor data is critical to understanding vehicle modifications.

MVTS test sensors include:

- Data acquisition system (records sensor data)
- Fuel flow meter (accurate to 0.2%)
- Fuel temperature sensor
- Tire temperature sensor (infrared, mounted on left-front drive tire)
- Ground/road temperature sensor (infrared, mounted ahead of left-front drive tire)
- Wind speed air pressure sensor (truck hood)
- Wind direction sensor (truck hood)
- Ambient air temperature sensor (truck hood)
- Ambient air pressure sensor (truck cab)
- High Precision GPS (latitude, longitude, altitude, time)

Click this link to see a video of MVTS sensors and testing: How We Test

Figure 19: Aerodynamic Sensors

Figure 20: Data Acquisition System

Figure 21: Fuel Flow Meter

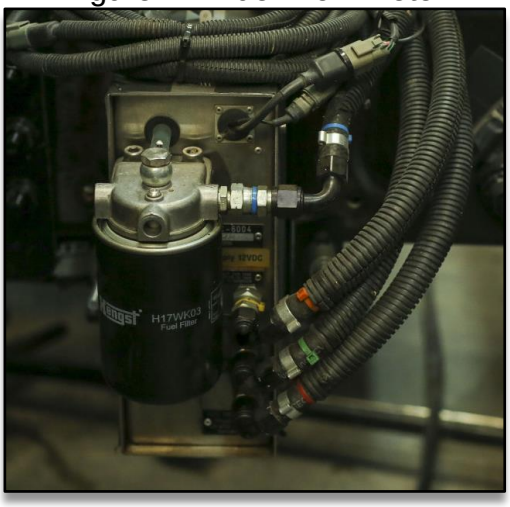
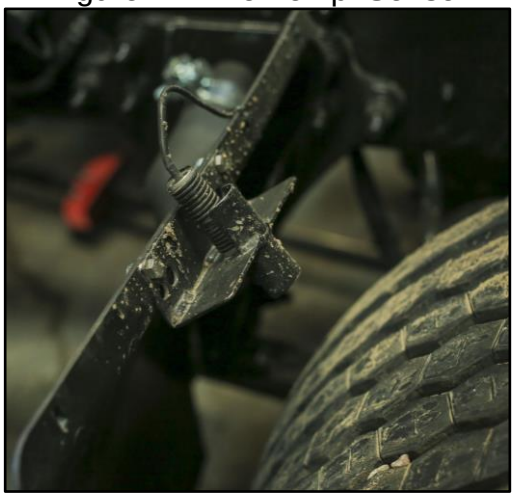


Figure 22: Tire Temp. Sensor



6.0: TEST RESULTS

The tire test was conducted on March 11, 2020. The aerodynamic test was conducted the following day on the morning of March 12, 2020. The fuel savings found with the combination of Michelin X One tires (compared to Bridgestone Greatec package) and Michelin Energy Guard trailer aerodynamic package totalled 17.01 gal/1000 miles (12.62%, 1.07 MPG). This included 6.70 gal/1000 miles due to the tires (5.35%, 0.41 MPG), and 10.31 gal/1000 miles (7.65%, 0.62 MPG) from the aerodynamic savings. A total of 17.01 gal/1000 miles may be surprising to some readers; however, it does not surprise MVTS. After conducting nearly 400 fuel economy tests to date, MVTS has experienced savings of this magnitude many times. Tires and trailer aerodynamics are two of the biggest areas for improvement. In the case of Michelin, the company has fuel saving technologies in both categories and the combination of these accumulates to a very large improvement in fuel economy.

Table 6: Test Runs

	Run Name
	March 11, 2020
Day 1 Run 1	Bridgestone Greatec
Day 1 Run 2	Michelin X One
	March 12, 2020
Day 2 Run 1	Michelin Energy Guard
Day 2 Run 2	Baseline (i.e. Michelin Energy Guard Removed)

Table 7: Fuel Economy Improvement Summary

	Fuel Economy Improvement		
	Gal/1000 miles	MPG	Percent
Michelin X Ones vs. Bridgestone Greatec	**6.70**	0.41	5.35%
Accuracy	**+/-0.49**	+/-0.03	+/-0.39
Michelin Energy Guard	**10.31**	0.62	7.65%
Accuracy	**+/-0.62**	+/-0.03	+/-0.46
Combined: Michelin X Ones + Energy Guard	**17.01**	1.07	12.62%
Accuracy	**+/-0.47**	+/-0.03	+/-0.35

Figure 23: Test Results (gal/1000 miles)

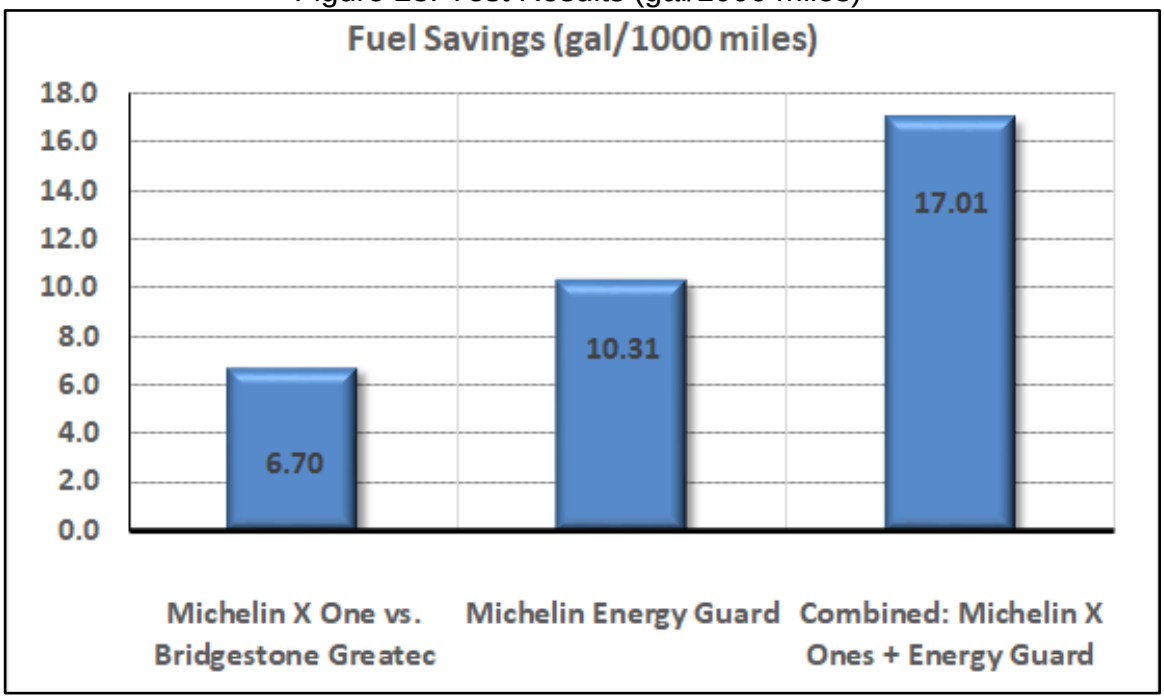
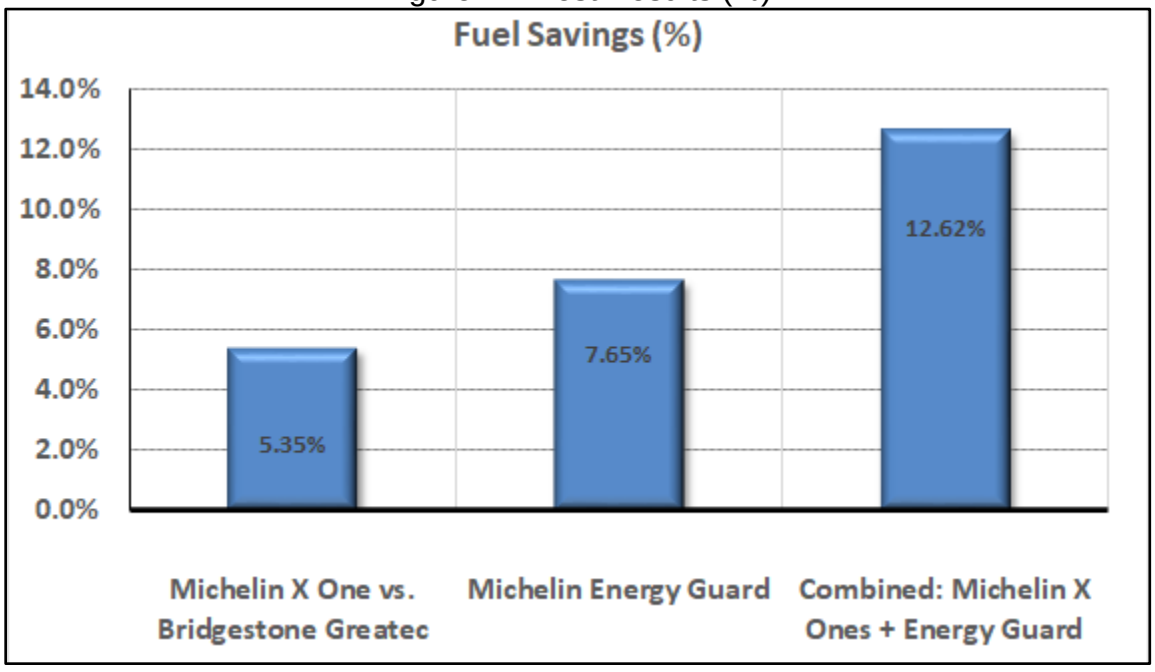


Figure 24: Test Results (%)



6.1: TIRES

Compared to the Michelin X One tire package, the Bridgestone Greatec package used 6.70 gal/1000 miles (5.35%) more fuel. The reader should be aware that since Steer tires were part of each brand of tire package, they had some impact on the overall fuel economy results; however, the impact of Steer tires is generally small compared to the Drive and Trailer axles. This is due mainly to the lower load on the Steer axle. Secondly, the test was conducted as a complete brand package (*i.e.* all wheel positions) since that is how most fleets spec their equipment. Overall, the affect of the Steer tires was considered minimal and the focus of the test and results was placed on the WBS tires of the Drive and Trailer axles.

Tire pressures were monitored closely during the testing. They were checked before the test, after the warm-up laps and at the conclusion of the test. This provided a comparison of the tire pressures on the Compare and Test vehicles. It also provided a comparison of the pressure changes during the test (*i.e.* pressure growth) on the Compare and Test vehicles. This was important to ensure the Test vehicle did not experience significant differences in pressure growth between brand comparisons, which could affect results.

Table 8 shows the average difference in tire pressures during the Bridgestone test with the Compare and Test vehicles, which was also used to calculate the change in pressure growth (*i.e.* start vs. end pressures). The Test vehicle had lower tire pressures than the Compare vehicle, with an average difference of -6.1 psi. The minimum difference was -7.8 psi and the maximum was -3.0 psi. These are considerable differences between the two vehicles; however, a similar offset occurred in the Michelin X One test with values of -4.2 psi, -5.8 psi, and -2.5 psi respectively (Table 10). The difference in the average values between the two tests was only 1.9 psi (-6.1 – (-4.2)) and can be considered very comparable. Therefore, the conditions of the tires between the Michelin X One and Bridgestone Greatec tires can be considered reliable. The offset in tire pressures between the Compare and Test vehicles was due to the Compare vehicle tires conducting multiple runs throughout the day, while the Test vehicle had its tires changed each time and therefore experienced different temperature and pressure changes.

Table 9 shows that the Average Pressure Growth Variance for the Bridgestone test was -1.6 psi during the Bridgestone test. This indicates there was a difference of 1.6 psi between the tire pressure change on the Compare and Test vehicles. Table 11 shows the tire growth average was -1.0 psi for the Michelin test. Therefore, the two tire brands experienced a difference of only -0.6 psi (-1.6 – (-1.0)). These values are very close in magnitude and indicate the tire pressure growth was consistent between the Michelin and Bridgestone tests.

Overall, tire pressures and pressure growth were consistent and reliable between the tire test sets. The raw values can be found in the Appendix.

Table 8: Bridgestone Test Tire Pressures Comparison (Compare – Test Vehicle)

Average Tire Pressure Comparison				
(Compare Vehicle - Test Vehicle)				
-3.0		Steers (psi)		-3.8
-6.3		Drives-Front (psi)		-7.5
-7.5		Drives-Rear (psi)		-7.8
-4.1		Trailer-Front (psi)		-7.5
-6.5		Trailer-Rear (psi)		-7.5
-6.1		Average Pressure Variance (psi)		
-7.8		Minimum Pressure Variance (psi)		
-3.0		Maximum Pressure Variance (psi)		

Table 9: Bridgestone Tire Test Pressure Growth

Tire Pressure Growth Comparison				
(End Pressure - Start Pressure) of (Compare Vehicle - Test Vehicle)				
-1.0		Steers (psi)		-0.5
-1.0		Drives-Front (psi)		-2.5
-2.0		Drives-Rear (psi)		-2.5
-2.0		Trailer-Front (psi)		-1.0
-1.5		Trailer-Rear (psi)		-1.5
-1.6		Average Pressure Variance (psi)		
-2.5		Minimum Pressure Variance (psi)		
-0.5		Maximum Pressure Variance (psi)		

Table 10: Michelin Test Tire Pressures Comparison (Compare – Test Vehicle)

Average Tire Pressure Comparison				
(Compare Vehicle - Test Vehicle)				
-2.5		Steers (psi)		-2.5
-4.1		Drives-Front (psi)		-5.1
-4.0		Drives-Rear (psi)		-4.9
-5.1		Trailer-Front (psi)		-5.8
-3.9		Trailer-Rear (psi)		-4.5
-4.2		Average Pressure Variance (psi)		
-5.8		Minimum Pressure Variance (psi)		
-2.5		Maximum Pressure Variance (psi)		

Table 11: Michelin Tire Test Pressure Growth

Tire Pressure Growth Comparison				
(End Pressure - Start Pressure) of (Compare Vehicle - Test Vehicle)				
0.0		Steers (psi)		0.0
-0.5		Drives-Front (psi)		-1.5
0.0		Drives-Rear (psi)		-1.5
-2.0		Trailer-Front (psi)		-1.5
-1.5		Trailer-Rear (psi)		-1.5
-1.0		Average Pressure Variance (psi)		
-2.0		Minimum Pressure Variance (psi)		
0.0		Maximum Pressure Variance (psi)		

6.2: TRAILER AERODYNAMICS RESULTS (ENERGY GUARD)

The Michelin Energy Guard showed fuel savings of 10.31 gal/1000 miles (7.65%, 0.62 MPG) when compared to a trailer with no aerodynamic technologies installed. This result is very similar to the 2019 MVTS Certified test of the Energy Guard, which was 10.00 gal/1000 miles, a difference of only 0.31 gal/1000 miles. As a comparison, 0.31 gal/1000 miles is approximately equivalent to a tractor fender mirror or two (2) clicks of the truck heater fan. These are very small values and indicate the consistent of the aerodynamic package.

The percent fuel saved values varied from 2019 to 2020, at 8.75% and 7.65 respectively, a difference of 1.1%. This may appear like a testing discrepancy or error; however, it is not. The 1.1% difference is an example of the error that occurs when measuring fuel savings as a percent. This is explained in the next section.

6.2a: WHY MEASURING FUEL SAVED AS A PERCENT CREATES ERRORS

The gallons per 1000 miles test result varied by only 0.31, whereas the percent fuel saved differed by 1.1%. The difference in values was not due to the amount of fuel saved, it was due to the MPG (miles-per-gallon) of the truck. This a problem with measuring or reporting fuel savings as a percent; when the MPG of the vehicle varies, the percent Fuel Saved values also varies. This creates inconsistent results, such as that experienced with 2019 versus 2020 Michelin Energy Guard tests. This may sound abnormal to the reader; however, it highlights the problem with measuring fuel saved as a percent value. It is also why MVTS and the Mesilla Valley fleet use units of gal/1000 miles instead.

Percent is affected by MPG since percent is calculated in combination with *total* fuel saved. Therefore, the more fuel a truck is consuming during a test period (i.e. the lower its MPG), the lower the percent fuel saved value. The formula is:

$$Equation\ 1:\ \ Fuel\ Saved\ (\%) = \frac{(Fuel\ Saved)}{(Total\ Fuel\ Used)}$$

Where *Total Fuel Used* is directly related to the truck MPG. Therefore, a truck getting a higher MPG, and therefore useing less *Total Fuel,* results in a higher percent test value. This is demonstrated in the examples below.

EXAMPLE 1: 2019 Energy Guard test @ 8.75 MPG, 10.00 gallons saved in 1000 miles

$$Fuel\ Saved\ (\%) = \frac{\left(10.00\frac{gal}{1000}miles\right)}{(114.3\ gal)}$$

$$= 8.75\%$$

Where 114.3 gal is how much fuel a truck consumes in 1000 miles at 8.75 MPG (1000 / 8.75 = 114.3).

EXAMPLE 2: If the 2020 test also saved 10.00 gallon in 1000 miles @7.42 MPG

$$Fuel\ Saved\ (\%) = \frac{\left(10.00\,\frac{gal}{1000}\,miles\right)}{(134.8\ gal)}$$

$$= 7.42\%$$

Therefore, despite both trucks saving the exact same amount of fuel at 10.00 gal/1000 miles, the percent Fuel Saved would be 8.75% and 7.42% when experiencing 8.75 MPG and 7.42 MPG respectively. Therefore, it is the MPG of the truck that is changing the percent test result, not the actual fuel being saved.

The difference in MPG of the 2019 versus 2020 trucks was due to load; the 2019 truck had a GVW of 45,000 lbs. and the 2020 vehicle was 72,000 lbs. The heavier load resulted in more Total Fuel Used (*i.e.* lower MPG). The lower MPG created a lower percent value, despite the actual Fuel Saved value being nearly identical. The reader should be aware that any variable affecting MPG affects the percent Fuel Saved (%) value including driver behavior, idle time, terrain, traffic, or rolling resistance of the tires. These factors affect fleets every day, which is one of the reasons percent fuel savings values change daily as well. Combined, this is why measuring fuel savings as a percent is unreliable. It is also why fleets should use units of gallons per 1000 miles since they are not affected by these variables.

6.3: UNITS OF MEASUREMENT

The reader may not be familiar with units of gal/1000 miles (gallons per 1000 miles) since it is not traditionally used in the trucking industry. The following paragraphs briefly explain the reasons for these units and how they help carriers better calculate fuel savings.

Units of gal/1000 miles more reliably calculate fuel savings when compared to other units such as miles-per-gallon (MPG) or percent (%). Those units are prone to error from changing variables such as vehicle baseline fuel economy, load, driver behavior, and duty cycle. For example, a vehicle achieving 9 MPG with a highly aerodynamic configuration will save the same gal/1000 miles as a vehicle achieving 6 MPG. However, the percent fuel savings will be different since that is based on the baseline fuel economy and the 6 MPG vehicle will use more fuel, which will make the percent savings value lower.

Units of gal/1000 miles are also more reliable for a fleet's real-world savings due to this unit not being affected by vehicle speed. The fuel savings from tires are nearly the same at 20 mph as they are at 65 mph (*i.e.* savings are nearly linear with speed). Therefore, it is important to use units of gal/1000 miles. To convert from MPG to gal/1000 miles, simply use 1000 divided by MPG (ex. 1000 / 7.15 MPG = 139.9 gal/1000 miles).

6.4: WEATHER CONDITIONS SUMMARY

On the first day of testing, temperatures ranged from 63.0°F to 83.0°F. Winds ranged from 0 mph to 12 mph. On the second day of testing, temperatures ranged from 60.0°F to 79.0°F. Winds ranged from 3 mph to 10 mph. It should be noted that the MVTS test methods account for these variables and their effects on fuel savings. Therefore, the range in climate conditions did not impede the test results shown in this report. Complete weather data can be found in the Appendix.

6.5: MEASUREMENT ACCURACY

The accuracy of fuel economy measurements is critical in determining the trustworthiness of test results. Historically, this has been a major difficulty in the trucking industry with fuel economy testing, which has led to confusion and misleading results. The MVTS test methods overcome this issue by achieving better accuracy, which is one of the ways it provides more reliable test results.

Accuracy for all the tests was calculated using a 95% confidence interval, a common standard for testing measurement. 95% confidence interval indicates that if the test were repeated 100 times, values would fall within the range in 95 out of the 100 tests (*i.e.* the reader would be 95% confident the value would be within that range).

Figure 25 below shows the statistical bell curves of the Michelin X One tires versus Bridgestone Greatec. The Baseline test (Michelin X Ones) and the Bridgestone Greatec test clearly show two separate bell curves, indicating the test had valid accuracy and the results were reliable. The graph shows the arrow pointing to the right illustrating more fuel used for the Bridgestone tires, meaning the baseline tire (Michelin X Ones) by comparison, saved fuel. The distance between the peaks of the bell curves is the test

result average, which was 6.70 gal/1000 miles. Minimum and maximum values were calculated as the test result plus or minus the accuracy values (6.70 +/- 0.49), which were 7.19 and 6.21 gal/1000 miles.

Figure 25: Michelin X Ones vs. Bridgestone Greatec Fuel Consumption Bell Curve

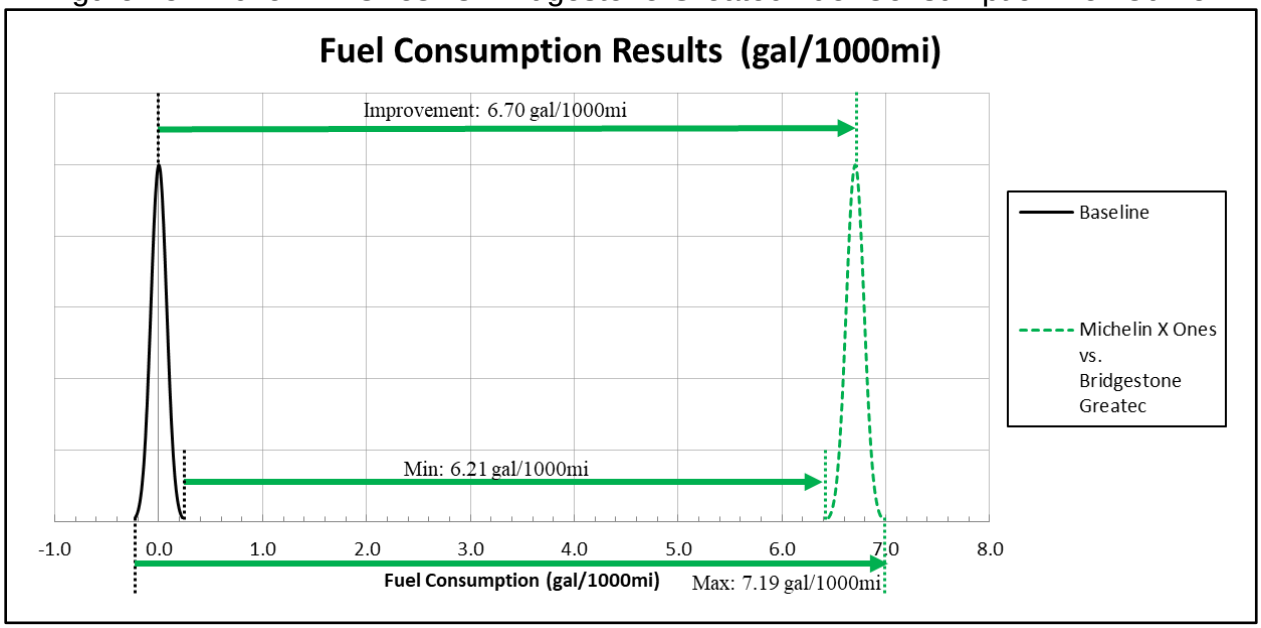


Figure 26 below illustrates the statistical bell curves of the Michelin Energy Guard. The average value was 10.31 gal/1000 miles saved, as indicated by the arrow pointing to the right. Once again, the minimum and maximums are the test result plus or minus the accuracy vales (10.31 +/- 0.62), which were 10.93 and 9.69 gal/1000 miles.

Figure 26: Michelin Energy Guard Fuel Consumption Bell Curve

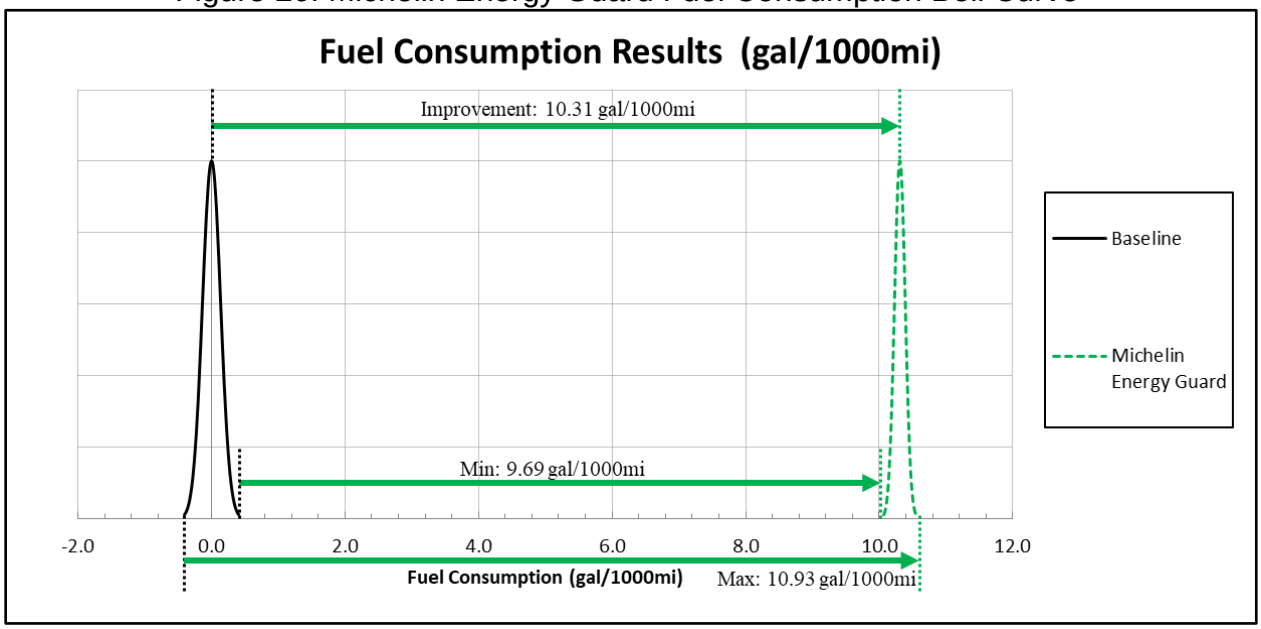
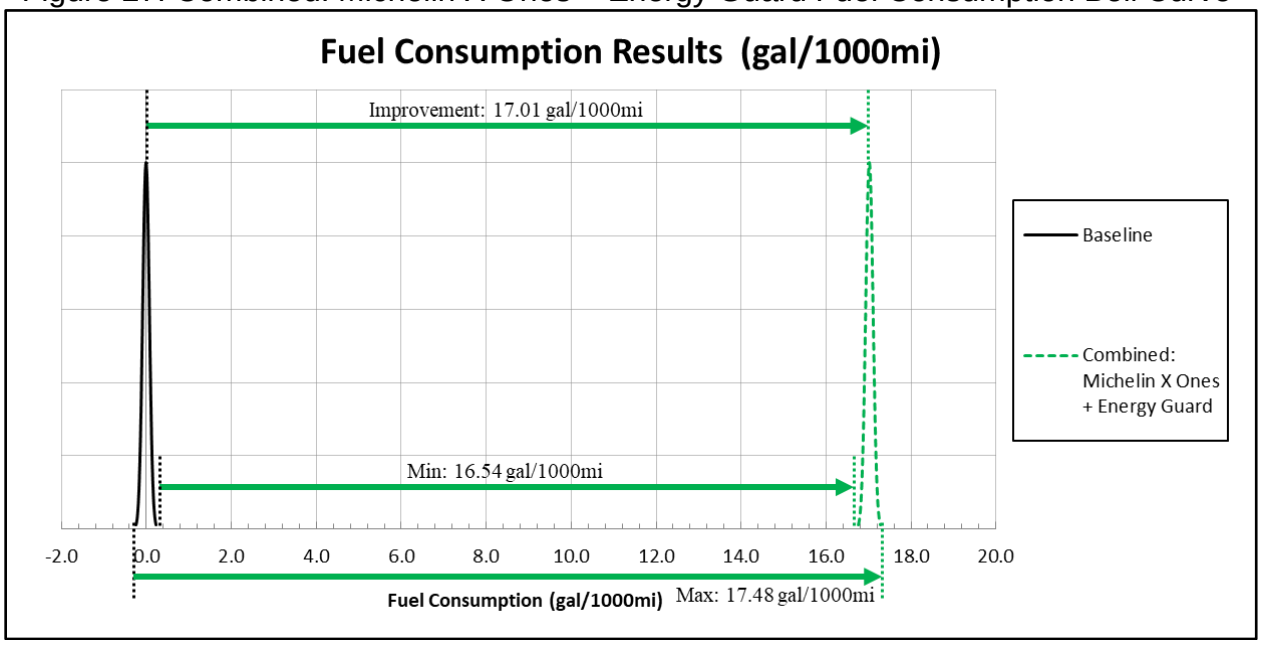


Figure 27 below illustrates the statistical bell curves of the combined result from the Michelin X Ones and the Energy Guard. The savings was 17.01 gal/1000 miles. Once again, the minimum and maximums are the test result plus or minus the accuracy vales (17.01 +/- 0.47), which were 17.48 and 16.54 gal/1000 miles.

Figure 27: Combined: Michelin X Ones + Energy Guard Fuel Consumption Bell Curve



7.0: SAVINGS CALCULATIONS (TIRES)

Below is a brief outline of how to use the test results to calculate savings. For more detail or assistance contact MVT Solutions.

7.1: FUEL SAVINGS CALCULATIONS

Fuel savings resulting from this test can be calculated as follows:

$$Fuel\ Savings\ (gal/year) = (Test\ result)\ x\ \frac{(Thousands\ of\ miles\ travelled\ per\ year)}{1000}$$

Test result must be in units of gal/1000 miles (*i.e.* not percent or MPG)

Example: Michelin WBS package fuel savings versus Bridgestone WBS package and 125,000 miles travelled annually:

$$Fuel\ Savings = (6.70\ gal/1000\ miles)x\frac{(125{,}000\ miles/year)}{1000} = 837.50\ gal/year$$

Therefore, the Michelin X One package would save 837.50 gallons of fuel per year for this vehicle travelling 125,000 miles.

7.2: FINANCIAL SAVINGS CALCULATIONS

Financial calculations can be made by multiplying the fuel saved by the fuel price:

$$Savings\ (\$/year) = (Fuel\ Savings)\ x\ (Price\ of\ fuel)$$

Example: Using the example above and U.S. average retail price of diesel fuel in 2019, $3.056[2] /gal

$Savings\ (\$/year) = \left(837.50\frac{gal}{year}\right)\ x\ \left(\frac{\$3.056}{gal}\right) = \$2{,}559.40\ /year$ in fuel savings

Therefore, the Michelin X One package would save $2,559.40 per year in fuel for the vehicle travelling 125,000 miles at 72,000 lbs.

[2] Source: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_NUS_DPG&f=W

7.3: TECHNOLOGY PAYBACK AND RETURN-ON-INVESTMENT

Buyers of fuel economy technologies are highly interested in saving money. For a technology supplier to be successful, their technology must save their potential customers money and many fleets consider the number of months required for the technology to pay for itself as a buying qualification, which is referred to as 'payback' in trucking or sometimes ROI.

$$Payback\ (months) = \frac{(Product\ cost)}{(Savings\ (\$/year)}\ x\ (12\ months/year)$$

Where the 'Product cost' in the case of tires is the difference between the two brands. MVTS advises fleets to ensure they are comparing prices based on fleet size and not retail or a mixture of both.

Example @$600 'Price cost': Using example pricing with the Michelin WBS package costing $600 more than the Bridgestone WBS package:

$$Payback\ (months) = \frac{(Product\ Cost)}{(Savings\ (\$/year)}\ x\ (12\ months/year)$$

$$Payback\ (months) = \frac{(\$600)}{(\$2{,}559.40\ /year)}\ x\ \left(12\frac{months}{year}\right) = 2.8\ months$$

Therefore, with a difference of $600 per vehicle set, the Michelin X One tire package would pay for itself (*i.e.* payback or ROI) in 2.8 months. This is extremely fast by comparison to add-on technologies.

Example @$1000 'Product cost':

$$Payback\ (months) = \frac{(\$1000)}{(\$2{,}559.40\ /year)}\ x\ \left(12\frac{months}{year}\right) = 4.7\ months$$

Therefore, with a $1000 per vehicle set difference in pricing, the Michelin X One tire package would pay for itself (*i.e.* payback or ROI) in 4.7 months. This is still very fast by comparison to add-on technologies.

Note: Payback examples utilize an estimated 125,000 miles of usage for each brand. Tire wear and miles achieved may be required for the fleet.

7.4: TECHNOLOGY PROFIT

Since saving money is the end goal, calculating profit is another important factor. **Note**: these calculations will consider fuel and purchase price only and not maintenance, or tire life. An assumption will be made for this example that both brands have equal tire life.

$$Profit\ (\$) = (Savings) - (Cost)$$

Example @$600 'Product cost': Using annual values from above.

$Profit\ (\$) = (\$2{,}559.40) - (\$600)$ = $1,959.40 saved per year, per vehicle.

If this were translated to a 1000-truck fleet, the profits would be $1.96M annual.

Therefore, the Michelin X One package could add $1,959.40 in profit per vehicle with 125,000 miles in travel. For a fleet of 1000 vehicles, this would equate to $1.96M.

Example @$1000 'Product cost': Using annual values from above.

$Profit\ (\$) = (\$2{,}559.40) - (\$1000)$ = $1,559.40 saved per year, per vehicle

If this were translated to a 1000-truck fleet, the profits would be $1.56M annual.

Therefore, the Michelin X One package could add $1,559.40 in profit per vehicle with 125,000 miles in travel. For a fleet of 1000 vehicles, this would equate to $1.56M.

Note: The profit calculations do not account for total cost-per-mile (CPM) that may include tire wear etc. The non-fuel economy related CPM items can be evaluated within the fleet and may vary between fleets.

7.5: FUEL SAVINGS FOR DIFFERENT GVW

The MVTS test was conducted at 72,000 lbs. GVW. A fleet that operates at different GVW can still calculate their fuel savings from MVTS test results. Units of gal/1000 miles must be used.

$$Fleet\ Fuel\ Savings = \frac{(Fleet\ GVW)}{(Test\ GVW)}\ x\ (MVTS\ Test\ Result)$$

Example: Fleet GVW = 47,500 lbs., comparing Bridgestone to Michelin WBS

$$Fleet\ Fuel\ Savings = \frac{(47{,}500)}{(72{,}000)}\ x\ \left(6.70\ \frac{gal}{1000} miles\right) = \mathbf{4.42}\ \frac{\boldsymbol{gal}}{\mathbf{1000}}\ \boldsymbol{miles}$$

Therefore, the fleet with an average GVW of 47,500 lbs. would see savings of 4.42 gal/1000 miles instead of 6.70 gal/1000 miles for the Michelin X One package versus the Bridgestone Greatec package.

Note: There can be some variation based on individual axle weights. Calculating based on each axle type (Steer, Drive, Trailer) is ideal; however, this requires tests conducted for each axle type individually, which was out of the scope of this test.

8.0: SAVINGS CALCULATIONS (AERODYNAMICS)

Below is a brief outline of how to use the test results to calculate savings. For more detail or assistance contact MVT Solutions.

8.1: FUEL SAVINGS CALCULATIONS

Fuel savings resulting from this test can be calculated as follows:

$$Fuel\ Savings\ (gal/year) = (Test\ result)\ x\ \frac{(Thousands\ of\ miles\ travelled\ per\ year)}{1000}$$

Test result must be in units of gal/1000 miles (*i.e.* not percent or MPG)

Example: Michelin Energy Guard system and 125,000 miles travelled annually:

$$Fuel\ Savings = (10.31\ gal/1000\ miles)x\ \frac{(125{,}000\ miles/year)}{1000} = 1{,}288.8\ gal/year$$

Therefore, the Michelin X One package would save 1288.8 gallons of fuel per year for this vehicle travelling 125,000 miles.

8.2: FINANCIAL SAVINGS CALCULATIONS

Financial calculations can be made by multiplying the fuel saved by the fuel price:

$$Savings\ (\$/year) = (Fuel\ Savings)\ x\ (Price\ of\ fuel)$$

Example: Using the example above and U.S. average retail price of diesel fuel in 2019, $3.056[3] /gal

$Savings\ (\$/year) = \left(1288.8\frac{gal}{year}\right)\ x\ \left(\frac{\$3.056}{gal}\right) = \$3{,}938.57\ /year$ in fuel savings

Therefore, the Michelin Energy Guard system would save $3,938.57 per year in fuel for the vehicle travelling 125,000 miles.

[3] Source: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_NUS_DPG&f=W

8.3: TECHNOLOGY PAYBACK AND RETURN-ON-INVESTMENT

Buyers of fuel economy technologies are most interested in saving money. For a technology supplier to be successful, their technology must save their potential customers money and many fleets consider the number of months required for the technology to pay for itself as a buying qualification, which is referred to as 'payback' in trucking or sometimes ROI.

Note: the product cost used is for example purposes only. Contact your trailer OEM or a Michelin representative to acquire your fleet's purchase price.

$$Payback\ (months) = \frac{(Product\ cost)}{(Savings\ (\$/year)}\ x\ (12\ months/year)$$

Example @$2000 price and 2:1 trailer ratio:

$$Payback\ (months) = \frac{(Product\ Cost)}{(Savings\ (\$/year)}\ x\ (12\ months/year)$$

$$Payback\ (months) = \frac{(\$2000\ x\ 2)}{(\$3{,}938.57\ /year)}\ x\ \left(12\frac{months}{year}\right) = 12.2\ months$$

Note: Product cost is multiplied by 2 to factor in the trailer ratio. Therefore, with a $2,000 price, 2 trailers per truck, the Michelin Energy Guard system would pay for itself (i.e. payback or ROI) in 12.2 months.

8.4: TECHNOLOGY PROFIT

Since saving money is the end goal, calculating profit is another important factor. Maintenance has not been included in this example.

$$Profit\ (\$) = (Savings)\ x\ (Years\ of\ use) - (Cost)$$

Example @$2,000 purchase cost and 2:1 trailer ratio, 5 year trailer life: Using annual values from above.

$Profit\ (\$) = (\$3{,}938.57)\ x\ (5) - (\$2{,}000\ x\ 2)$ = $15,692.85 saved in 5 years, per power unit.

If this were translated to a 1000-truck fleet, the profits would be $15.69M in 5 years.

Therefore, the Michelin Energy Guard could add $15,962.85 in profit per power unit with 125,000 miles in travel. For a fleet of 1000 vehicles, this would equate to $15.69M.

9.0: CONCLUSION

The combined Michelin package of X One tires and Energy Guard trailer aerodynamics produced fuel savings of 17.01 gal/1000 miles (12.62%, 1.07 MPG). These are substantial savings that may surprise the reader, and many fleet operators. However, these savings are not surprising to MVTS since we have conducted nearly 400 fuel economy tests to date and know the magnitude of savings that exist from tires and trailer aerodynamic solutions.

Of the combined savings, the Michelin X One tire package had a fuel economy advantage over the Bridgestone Greatec package of 6.70 gal/1000 miles (5.35%, 0.41 MPG). These values also include the Steer tires of the respective brands, which were not tested independently due to the Steer tires having minor impact on fuel economy due to smaller relative axle loads and the tendency of most fleets utilizing a single brand of tire in all wheel positions.

Tires were tested in new condition, following a 500-mile break-in period. Therefore, the difference in fuel consumption tested will be their highest value for their tire life. As tire tread depths decrease with miles driven, the difference in fuel consumption can also be expected to decrease. To quantify this decrease would require further testing as the tires wear, which was out of the scope of this test. The Mesilla Valley Transportation fleet uses 'new condition' tire test values to make decisions on tires and fuel economy. Although the values will lessen over the life of the tires, the new condition test results provide a fast and consistent opportunity to quantify the differences in tires. In most cases, this process filters out the poor performing tires and narrows decision choices to one or two options.

Savings calculations compared the Michelin X Ones package to the Bridgestone Greatec package. Calculations showed that in 125,000 miles, the Michelin X One package would save 837.50 gallons of fuel at 72,000 GVW in comparison to the Bridgestone Greatec package. Using the 2019 average retail cost of diesel fuel of $3.056/gal, this equated to

$2,559.40 per year in fuel savings. Using an example cost difference whereby the Michelin package was $600 more than the Bridgestone Greatec package, the ROI (or Payback) was 2.8 months. Using a difference of $1000 produced a Payback of 4.7 months. With an assumption that both tires sets would reach 125,000 miles tire life, the profit would be $1,959.40 with the $600 price difference and $1,559.40 with the $1000 price difference. For a 1000-truck fleet, this equated to $1.959 Million and $1.559 Million for the $600 and $1000 cost differences, respectively.

Savings calculations for the Michelin Energy Guard system showed that at 125,000 miles annual per power unit, 2:1 trailer ratio, $3.056/gal fuel the fuel savings from the system would be 1,288.8 gallons and $3,938.57 per year. Using a cost of $2,000 per Energy Guard system, payback would be 12.2 months. Profit would be $15,692.85 per power unit for a five (5) year trailer life, which equated to $15.69 Million for a 1000-truck fleet. Financial calculations did not account for maintenance and product price was an estimate.

Test results of the Energy Guard were consistent between 2019 and 2020 tests at 10.00 and 10.31 gal/1000 miles respectively, a difference of 0.31 gal/1000 miles. However, the percent Fuel Saved values were 8.75% and 7.65%, a difference of 1.1%. Fleets should be aware that the larger difference as a percent is misleading. It was not due to the amount of fuel saved; it was due to a change in the MPG of the trucks. The 2020 test had lower MPG due to testing at a heavier load, which in turn caused the percent value of the 2020 test to be lower. This situation highlighted the errors that occur when using percent as a means of quantifying fuel savings for aerodynamic (or tire) technologies.

10.0: APPENDIX

10.1: TEST VEHICLE DETAILS

Note: tire details for each test run can be found here.

Figure 28: Vehicle Info, Modified Vehicle

Date	March 11, 2020		
Company	Mesilla Valley Transportation		
Location	Pecos, Texas		
Test Route	Pecos 9-mile Test Track		
TRUCK ID:	4302		
Brand	International		
Year	2015		
Model	LT		
Engine	Cummins X15		
VIN	3HSDJAPRXFN556641		
Mileage (miles):	650,767		
Transmission	Eaton 10-Speed		
Rear Gear	2.64		
Fuel Load	Full at start		
Fuel Type & Batch	No. 2 Diesel		
Axle Weights	12,040	29,880	30,120
Total weight	72,040		
No aero.			
Photo/Video/Audio folder name:			
TRAILER ID:	7543		
Model	Hyundai Composite XT		
VIN	3H3V532C0LT401199		
Year	2019		
Size	53' Dry Van		
Trailer Gap (inches)			
Add-ons			

10.2: COMPARE VEHICLE DETAILS

Figure 29: Vehicle Info, Compare Vehicle

Date	March 11, 2020				
Company	Mesilla Valley Transportation				
Location	Pecos, Texas				
Test Route	Pecos 9-mile Test Track				
TRUCK ID:	4303				
Brand	International				
Year	2015				
Model	LT				
Engine	Cummins X15				
VIN	3HSDJAPR4FN726119				
Mileage (miles):	541,682				
Transmission	Eaton 10-Speed				
Rear Gear	2.64				
Fuel Load	Full at start				
Fuel Type & Batch	No. 2 Diesel				
Axle Weights	12,020		30,040		29,940
Total weight	72,000				
No aero.					
Photo/Video/Audio folder name:					
TRAILER ID:	7423				
Model	Hyundai Composite XT				
VIN	3H3V532C7LT401104				
Year	2019				
Size	53' Dry Van				
Trailer Gap (inches)					
Add-ons					

10.3: TEST ROUTE

Pecos, Texas 9-mile circle track. Counter-clockwise direction, middle lane (of 3).

Figure 30: Pecos Test Track

10.4: TIRE DETAILS AND PRESSURES

Note: tire pressure values shown below were used to calculate the Pressure Comparison and Pressure Growth tables in section Test Results.

10.4a: RUN 2: BRIDGESTONE

Figure 31: Run 2 Tire Details (Veh. A)

Veh. A: Bridgestone WBS (All Positions)

			Truck	4302			
LF:	Bridgestone WBS		Front Axle Tires			Bridgestone WBS	RF: Same
Bridgestone R284 Ecopia			Type				Bridgestone R284 Ecopia
295/75R22.5			Size				295/75R22.5
18/32			Tread Depth (32nds)				18/32
116.5			Pressure (psi) Start				118.0
118.5			Pressure (psi) End				119.0
117.5			**Pressure (psi) Avg.**				**118.5**
LF-Outer Drive:		Bridgestone WBS	**Drive Axle Tires**		Bridgestone WBS		RF-Outer Drive
Bridgestone Greatec M835A Ecopia			Type				Bridgestone Greatec M835A Ecopia
445/50R22			Size				445/50R22
24/32			Tread Depth (32nds)				24/32
118.0			Pressure (psi) Start				120.0
120.0			Pressure (psi) End				122.5
119.0			**Pressure (psi) Avg.**				**121.3**
LR-Outer Drive:		Bridgestone WBS	**Drive Axle Tires**		Bridgestone WBS		RR-Outer Drive
Bridgestone Greatec M835A Ecopia			Type				Bridgestone Greatec M835A Ecopia
445/50R22			Size				445/50R22
24/32			Tread Depth (32nds)				24/32
119.5			Pressure (psi) Start				120.5
122.5			Pressure (psi) End				123.5
121.0			**Pressure (psi) Avg.**				**122.0**
			Trailer	7543			
LF-Outer Trailer:		Bridgestone WBS	**Tandem Front**		Bridgestone WBS		RF-Outer Trailer
Bridgestone Greatec R197 Ecopia			Type				Bridgestone Greatec R197 Ecopia
445/50R22.5			Size				445/50R22.5
12/32			Tread Depth (32nds)				12/32
115.0			Pressure (psi) Start				119.5
117.5			Pressure (psi) End				121.0
116.3			**Pressure (psi) Avg.**				**120.3**
LR-Outer Trailer:		Bridgestone WBS	**Tandem Rear**		Bridgestone WBS		RR-Outer Trailer
Bridgestone Greatec R197 Ecopia			Type				Bridgestone Greatec R197 Ecopia
445/50R22.5			Size				445/50R22.5
12/32			Tread Depth (32nds)				12/32
118.5			Pressure (psi) Start				120.0
121			Pressure (psi) End				122.0
119.8			**Pressure (psi) Avg.**				**121.0**

Figure 32: Run 2 Tire Details (Veh. B)

Veh. B (Compare)

			Truck	4303		
LF:			**Front Axle Tires**			RF: Same
Michelin X Line Energy Z			Type			Michelin X Line Energy Z
275/80R22.5			Size			275/80R22.5
19/32			Tread Depth (32nds)			19/32
114.0			Pressure (psi) Start			114.5
115.0			Pressure (psi) End			115.0
114.5			**Pressure (psi) Avg.**			**114.8**
LF-Outer Drive:	LF-Inner Drive:		**Drive Axle Tires**		RF-Inner Drive:	RF-Outer Drive
Michelin XDA Energy	Michelin XDA Energy		Type		Michelin XDA Energy	Michelin XDA Energy
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
22/32	22/32		Tread Depth (32nds)		22/32	22/32
111.5	113.0		Pressure (psi) Start		113.0	114.0
112.5	114.0		Pressure (psi) End		114.0	114.0
112.0	**113.5**		**Pressure (psi) Avg.**		**113.5**	**114.0**
LR-Outer Drive:	LR-Inner Drive:		**Drive Axle Tires**		RR-Inner Drive:	RR-Outer Drive
Michelin XDA Energy	Michelin XDA Energy		Type		Michelin XDA Energy	Michelin XDA Energy
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
22/32	22/32		Tread Depth (32nds)		22/32	22/32
112.0	114.0		Pressure (psi) Start		114.5	113.5
113.0	115.0		Pressure (psi) End		115.0	114.0
112.5	**114.5**		**Pressure (psi) Avg.**		**114.8**	**113.8**
			Trailer	7423		
LF-Outer Trailer:	LF-Inner Trailer:		**Tandem Front**		RF-Inner Trailer	RF-Outer Trailer
Michelin X Line Energy T	Michelin X Line Energy T		Type		Michelin X Line Energy T	Michelin X Line Energy T
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
12/32	12/32		Tread Depth (32nds)		12/32	12/32
111.5	112.0		Pressure (psi) Start		112.5	112.5
112.0	113.0		Pressure (psi) End		113.0	113.0
111.8	**112.5**		**Pressure (psi) Avg.**		**112.8**	**112.8**
LR-Outer Trailer:	LR-Inner Trailer:		**Tandem Rear**		RR-Inner Trailer	RR-Outer Trailer
Michelin X Line Energy T	Michelin X Line Energy T		Type		Michelin X Line Energy T	Michelin X Line Energy T
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
12/32	12/32		Tread Depth (32nds)		12/32	12/32
111.0	114.5		Pressure (psi) Start		113.0	113.5
112.0	115.5		Pressure (psi) End		113.5	114.0
111.5	**115.0**		**Pressure (psi) Avg.**		**113.3**	**113.8**

10.4b: RUN 3: MICHELIN

Figure 33: Run 3 Tire Details (Veh. A)

Veh. A: Michelin WBS (All Positions)							
			Truck	4302			
LF:	Michelin WBS		Front Axle Tires		Michelin WBS	RF: Same	
Michelin X Line Energy Z			Type			Michelin X Line Energy Z	
275/80R22.5			Size			275/80R22.5	
19/32			Tread Depth (32nds)			19/32	
116.5			Pressure (psi) Start			117.0	
115.5			Pressure (psi) End			115.5	
116.0			**Pressure (psi) Avg.**			**116.3**	
LF-Outer Drive:		Michelin WBS	**Drive Axle Tires**	Michelin WBS		RF-Outer Drive	
Michelin XOne Line Energy D			Type			Michelin XOne Line Energy D	
275/80R22.5			Size			275/80R22.5	
24/32			Tread Depth (32nds)			24/32	
116.0			Pressure (psi) Start			117.5	
115.5			Pressure (psi) End			117.5	
115.8			**Pressure (psi) Avg.**			**117.5**	
LR-Outer Drive:			**Drive Axle Tires**			RR-Outer Drive	
Michelin XOne Line Energy D			Type			Michelin XOne Line Energy D	
275/80R22.5			Size			275/80R22.5	
24/32			Tread Depth (32nds)			24/32	
117.0			Pressure (psi) Start			118	
116			Pressure (psi) End			118	
116.5			**Pressure (psi) Avg.**			**118.0**	
			Trailer	7543			
LF-Outer Trailer:		Michelin WBS	**Tandem Front**	Michelin WBS		RF-Outer Trailer	
Michelin XOne Line Energy T			Type			Michelin XOne Line Energy T	
275/80R22.5			Size			275/80R22.5	
13/32			Tread Depth (32nds)			13/32	
116.0			Pressure (psi) Start			117.0	
116			Pressure (psi) End			117.0	
116.0			**Pressure (psi) Avg.**			**117.0**	
LR-Outer Trailer:			**Tandem Rear**			RR-Outer Trailer	
Michelin XOne Line Energy T			Type			Michelin XOne Line Energy T	
275/80R22.5			Size			275/80R22.5	
13/32			Tread Depth (32nds)			13/32	
116.0			Pressure (psi) Start			116.5	
116			Pressure (psi) End			116.5	
116.0			**Pressure (psi) Avg.**			**116.5**	

Figure 34: Run 3 Tire Details (Veh. B)

Veh. B (Compare)

			Truck	4303		
LF:			Front Axle Tires			RF: Same
Michelin X Line Energy Z			Type			Michelin X Line Energy Z
275/80R22.5			Size			275/80R22.5
19/32			Tread Depth (32nds)			19/32
114.0			Pressure (psi) Start			114.5
113.0			Pressure (psi) End			113.0
113.5			**Pressure (psi) Avg.**			**113.8**
LF-Outer Drive:	LF-Inner Drive:		**Drive Axle Tires**		RF-Inner Drive:	RF-Outer Drive
Michelin XDA Energy	Michelin XDA Energy		Type		Michelin XDA Energy	Michelin XDA Energy
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
22/32	22/32		Tread Depth (32nds)		22/32	22/32
111.5	113.0		Pressure (psi) Start		113.0	113.5
110.5	111.5		Pressure (psi) End		111.0	112.0
111.0	**112.3**		**Pressure (psi) Avg.**		**112.0**	**112.8**
LR-Outer Drive:	LR-Inner Drive:		**Drive Axle Tires**		RR-Inner Drive:	RR-Outer Drive
Michelin XDA Energy	Michelin XDA Energy		Type		Michelin XDA Energy	Michelin XDA Energy
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
22/32	22/32		Tread Depth (32nds)		22/32	22/32
112.0	114.0		Pressure (psi) Start		114.0	113.5
111.0	113.0		Pressure (psi) End		113.0	112.0
111.5	**113.5**		**Pressure (psi) Avg.**		**113.5**	**112.8**
			Trailer	7423		
LF-Outer Trailer:	LF-Inner Trailer:		**Tandem Front**		RF-Inner Trailer	RF-Outer Trailer
Michelin X Line Energy T	Michelin X Line Energy T		Type		Michelin X Line Energy T	Michelin X Line Energy T
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
12/32	12/32		Tread Depth (32nds)		12/32	12/32
111.5	112.0		Pressure (psi) Start		112.0	112.0
109.5	110.5		Pressure (psi) End		110.5	110.5
110.5	**111.3**		**Pressure (psi) Avg.**		**111.3**	**111.3**
LR-Outer Trailer:	LR-Inner Trailer:		**Tandem Rear**		RR-Inner Trailer	RR-Outer Trailer
Michelin X Line Energy T	Michelin X Line Energy T		Type		Michelin X Line Energy T	Michelin X Line Energy T
275/80R22.5	275/80R22.5		Size		275/80R22.5	275/80R22.5
12/32	12/32		Tread Depth (32nds)		12/32	12/32
111.0	114.5		Pressure (psi) Start		112.5	113.0
109.5	113.5		Pressure (psi) End		111.0	111.5
110.3	**114.0**		**Pressure (psi) Avg.**		**111.8**	**112.3**

10.5: WEATHER CONDITIONS

Weather during testing was relatively warm with light wind. Weather data was acquired from a local Weather Underground weather station. Source shown below table.

The reader should be aware that MVTS methods include instantaneous and constant weather data acquisition on each vehicle, and this testing has minimal dependency on external weather data collection. MVTS test data accounts for changes in wind, temperature, and other pertinent variables instantaneously. Note, darkened rows pertain to test times.

Table 12: Test Run Times

	Begin	End
March 11, 2020		
Bridgestone Greatec	11:44 A.M.	2:24 P.M.
Michelin X One	6:37 P.M.	9:18 P.M.
March 12, 2020		
Michelin Energy Guard	6:58 A.M.	8:46 A.M.
Baseline (i.e. Michelin Energy Guard Removed)	11:42 A.M.	1:45 P.M.

Table 13: Weather Data, Mar. 11

Time	Temperature	Dew Point	Humidity	Wind	Wind Speed	Wind Gust	Pressure	Precip.	Condition
12:53 AM	63 F	58 F	84 %	SSW	10 mph	0 mph	27.17 in	0.0 in	Fair
1:53 AM	62 F	57 F	84 %	SSW	7 mph	0 mph	27.16 in	0.0 in	Fair
2:53 AM	60 F	57 F	90 %	SW	6 mph	0 mph	27.15 in	0.0 in	Fair
3:53 AM	60 F	57 F	90 %	S	7 mph	0 mph	27.13 in	0.0 in	Fair
4:53 AM	58 F	56 F	93 %	WNW	5 mph	0 mph	27.12 in	0.0 in	Fair
5:00 AM	56 F	54 F	93 %	NW	5 mph	0 mph	27.12 in	0.0 in	Fog
5:15 AM	58 F	55 F	90 %	SW	7 mph	0 mph	27.12 in	0.0 in	Fog
5:24 AM	59 F	57 F	93 %	SW	8 mph	0 mph	27.12 in	0.0 in	Fair
5:53 AM	60 F	57 F	90 %	SW	8 mph	0 mph	27.12 in	0.0 in	Fair
6:11 AM	60 F	58 F	93 %	SW	8 mph	0 mph	27.13 in	0.0 in	Partly Cloudy
6:19 AM	60 F	58 F	93 %	SW	10 mph	0 mph	27.12 in	0.0 in	Fog
6:53 AM	60 F	59 F	96 %	SSW	9 mph	0 mph	27.13 in	0.0 in	Fog
7:25 AM	60 F	59 F	96 %	SSW	7 mph	0 mph	27.13 in	0.0 in	Fog
7:51 AM	61 F	59 F	94 %	SW	5 mph	0 mph	27.13 in	0.0 in	Fog
7:53 AM	60 F	59 F	96 %	SW	5 mph	0 mph	27.13 in	0.0 in	Fog
8:53 AM	60 F	59 F	96 %	SW	7 mph	0 mph	27.13 in	0.0 in	Fog
9:51 AM	61 F	59 F	94 %	WSW	6 mph	0 mph	27.14 in	0.0 in	Fog
9:53 AM	61 F	59 F	93 %	W	5 mph	0 mph	27.15 in	0.0 in	Fog
10:53 AM	63 F	60 F	90 %	W	5 mph	0 mph	27.14 in	0.0 in	Partly Cloudy
11:15 AM	64 F	60 F	87 %	W	5 mph	0 mph	27.15 in	0.0 in	Fair
11:53 AM	68 F	60 F	76 %	SSW	3 mph	0 mph	27.15 in	0.0 in	Fair
12:53 PM	75 F	53 F	46 %		0 mph	0 mph	27.13 in	0.0 in	Fair
1:53 PM	76 F	48 F	37 %	CALM	0 mph	0 mph	27.10 in	0.0 in	Fair
2:53 PM	80 F	46 F	30 %	W	5 mph	0 mph	27.06 in	0.0 in	Fair
3:53 PM	81 F	48 F	31 %	W	7 mph	0 mph	27.01 in	0.0 in	Fair
4:53 PM	81 F	46 F	29 %	S	9 mph	0 mph	26.99 in	0.0 in	Fair
5:53 PM	83 F	45 F	26 %	SW	12 mph	0 mph	26.97 in	0.0 in	Fair
6:53 PM	81 F	45 F	28 %	SW	12 mph	0 mph	26.97 in	0.0 in	Fair
7:53 PM	78 F	46 F	32 %	SSW	8 mph	0 mph	26.98 in	0.0 in	Fair
8:53 PM	73 F	48 F	41 %	S	9 mph	0 mph	26.98 in	0.0 in	Fair
9:53 PM	71 F	48 F	44 %	S	7 mph	0 mph	26.97 in	0.0 in	Fair
10:53 PM	70 F	48 F	46 %	SSW	9 mph	0 mph	26.98 in	0.0 in	Fair
11:53 PM	67 F	51 F	57 %	SW	7 mph	0 mph	26.99 in	0.0 in	Fair

Source: https://www.wunderground.com/history/daily/us/tx/midland/KMAF/date/2020-3-11

Table 14: Weather Data, Mar. 12

Time	Temperature	Dew Point	Humidity	Wind	Wind Speed	Wind Gust	Pressure	Precip.	Condition
12:53 AM	65 F	53 F	65 %	SW	6 mph	0 mph	26.98 in	0.0 in	Fair
1:53 AM	66 F	55 F	68 %	SSW	8 mph	0 mph	26.96 in	0.0 in	Fair
2:53 AM	66 F	56 F	70 %	SW	7 mph	0 mph	26.95 in	0.0 in	Fair
3:53 AM	62 F	56 F	80 %	WSW	8 mph	0 mph	26.94 in	0.0 in	Fair
4:53 AM	61 F	55 F	81 %	WSW	7 mph	0 mph	26.93 in	0.0 in	Fair
5:53 AM	62 F	56 F	80 %	SW	8 mph	0 mph	26.92 in	0.0 in	Fair
6:53 AM	60 F	55 F	83 %	WSW	7 mph	0 mph	26.93 in	0.0 in	Fair
7:53 AM	61 F	55 F	81 %	SW	7 mph	0 mph	26.94 in	0.0 in	Fair
8:53 AM	64 F	56 F	75 %	SSW	3 mph	0 mph	26.94 in	0.0 in	Fair
9:53 AM	66 F	53 F	63 %	SSW	7 mph	0 mph	26.95 in	0.0 in	Mostly Cloudy
10:53 AM	71 F	51 F	49 %	SW	10 mph	0 mph	26.96 in	0.0 in	Fair
11:53 AM	75 F	50 F	41 %	WSW	10 mph	0 mph	26.97 in	0.0 in	Fair
12:53 PM	79 F	51 F	38 %	VAR	6 mph	0 mph	26.95 in	0.0 in	Cloudy
1:53 PM	79 F	50 F	36 %	W	10 mph	0 mph	26.94 in	0.0 in	Cloudy
2:53 PM	79 F	50 F	36 %	W	7 mph	0 mph	26.92 in	0.0 in	Cloudy
3:53 PM	80 F	50 F	35 %	WSW	7 mph	0 mph	26.90 in	0.0 in	Cloudy
4:53 PM	78 F	53 F	42 %	W	8 mph	0 mph	26.89 in	0.0 in	Cloudy
5:53 PM	77 F	53 F	43 %	WNW	3 mph	0 mph	26.89 in	0.0 in	Cloudy
6:53 PM	72 F	58 F	61 %	N	8 mph	0 mph	26.90 in	0.0 in	Cloudy
7:53 PM	70 F	57 F	63 %	NNE	6 mph	0 mph	26.91 in	0.0 in	Cloudy
8:53 PM	67 F	57 F	70 %	N	9 mph	0 mph	26.92 in	0.0 in	Cloudy
9:53 PM	65 F	57 F	75 %	N	6 mph	0 mph	26.93 in	0.0 in	Cloudy
10:53 PM	63 F	56 F	78 %	N	7 mph	0 mph	26.93 in	0.0 in	Fair
11:53 PM	63 F	57 F	81 %	NNE	10 mph	0 mph	26.94 in	0.0 in	Fair

Source: https://www.wunderground.com/history/daily/us/tx/midland/KMAF/date/2020-3-12

10.6: PRODUCT DETAILS

- Michelin Tires North America
  One Parkway South, Greenville, SC 29615 USA
  www.michelintruck.com

- Michelin Aerodynamic Solutions
  One Parkway South, Greenville, SC 29615 USA
  https://www.michelintruck.com/services-and-programs/aerodynamic-solutions/

- Bridgestone Commercial
  200 4th Ave S, Nashville, TN 37201
  www.commercial.bridgestone.com

10.7: TEST PERSONNEL

10.7a: MVT SOLUTIONS ENGINEERING

- Daryl Bear, Lead Engineer & COO
- Drew Cassidy, Test Engineer

10.7b: MVT SOLUTIONS DRIVERS & TECHNICIANS

- Allan Dahringer, Director of Maintenance, MVT fleet
- Andrew Burnett, Shop Foreman, MVT fleet Las Cruces
- Carlos Aragon
- Jack Burchell

10.7c: MICHELIN

- Bill Walmsley, Product Category Manager: Line Haul - Business to Business
- Calvin Bradley, Aerodynamic Solutions Technical Lead

10.8: MVT SOLUTIONS CONTACT INFO

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