MESILLA VALLEY TRANSPORTATION SOLUTIONS CERTIFIED
Fuel Economy Experts

TEST REPORT

MVT SOLUTIONS CERTIFIED™ FUEL ECONOMY TEST

JULY 2020

BASF
We create chemistry

BASF: AXLE LUBRICANTS

Emgard® XFE 7103 75W-85 (COMMERCIALLY AVAILABLE)

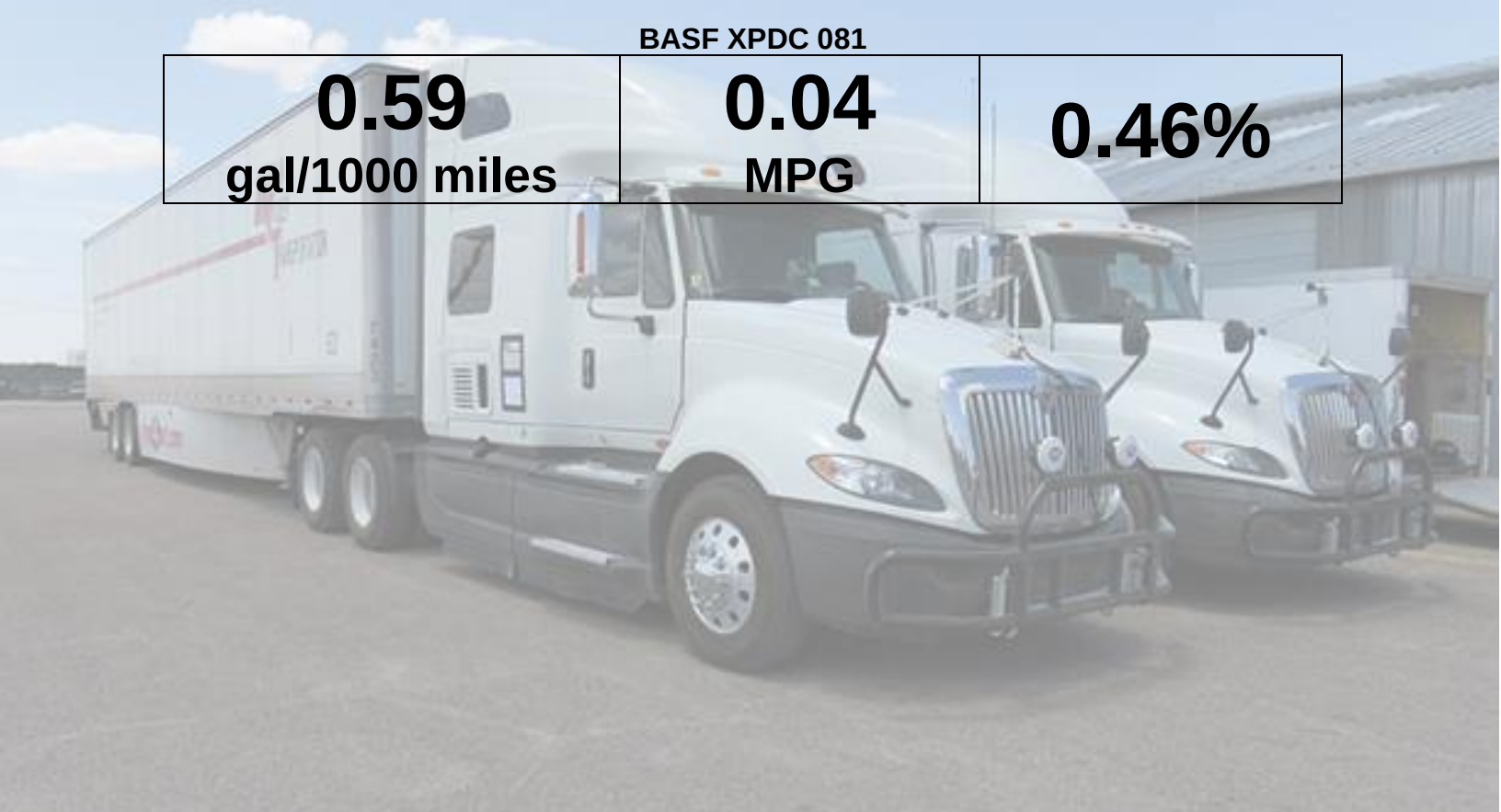
0.79 gal/1000 miles	**0.05** MPG	**0.62%**

BASF XPDC 048

1.00 gal/1000 miles	**0.06** MPG	**0.79%**

BASF XPDC 081

0.59 gal/1000 miles	**0.04** MPG	**0.46%**



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

BASF has developed axle lubricants to improve fuel efficiency. MVTS Certified™ tests showed savings of **0.79 gal/1000 miles (0.62%) for the BASF Emgard® XFE 7103 75W-85** lubricant, **1.00 gal/1000 miles (0.79%) for the BASF XPDC 048** lubricant, and **0.59 gal/1000 miles (0.46%) for the BASF XPDC 081** axle lubricant. These values were in comparison to reference axle lubricant BASF **Emgard® FE 75W-90 (aka E2986). Note:** XFE 75W-85 and FE 75W-90 are commercially available products whereas XPDC lubricants are still in development stages. the Axle oil temperatures improved (*i.e.* decreased) with better fuel efficiency. On the front Drive axle, the decreases were 2.7°C (5.6°F), 5.1°C (9.6°F), 2.3°C (5.0°F) respectively for the lubricants in the order listed above when compared to the E2986 reference oil. On the rear Drive axle, temperatures decreased by 3.7°C (8.9°F), 4.2°C (9.8°F), 2.7°C (7.1°F) respectively. The lubricants were changed in the differential housings and hubs (Drive axles only). The BASF lubricants were provided by BASF.

Testing was conducted on 2016 International ProStar tractors with two (2) drive axles (i.e. 'twin screw') Dana Spicer Drive axles with 3.36 to 1 axle ratios. Axle lubricants were changed with a double flush procedure to eliminate crossover from previous lubricants. Both trucks had new axles oils installed approximately 1000 miles prior to testing. Testing was conducted on a 9-mile test track at 65 miles per hour and a Gross Vehicle Weight (GVW) of 72,000 lbs.

Disclaimer: As with all MVT Solutions Certified™ tests, the Technology Provider (i.e. BASF) contracted MVTS to conduct the tests reported here. BASF is not responsible for any test results or procedures described in this report. Contact MVTS with any questions regarding the report, procedure, or products.

Table 1: Fuel Economy Results Summary

	Fuel Economy Improvement		
	Gal/1000 miles	MPG	Percent
Emgard® E7103 75W-85	0.79	0.05	0.62%
BASF XPDC 048	1.00	0.06	0.79%
BASF XPDC 081	0.59	0.04	0.46%

Table 2: Axle Temp. Results Summary

Δ Axle Temp	Front Drive Axle Temp		Rear Drive Axle Temp	
	°C	°F	°C	°F
Emgard® E7103 75W-85	2.7	5.6	3.7	8.9
BASF XPDC 048	5.1	9.9	4.2	9.8
BASF XPDC 081	2.3	5.0	2.7	7.1

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3.0: PROCEDURE

The two (2) vehicles ran simultaneously at 65 mph on the 9-mile circle track near Pecos, Texas. The vehicles were 1-minute apart, avoiding any aerodynamic influence on either vehicle during testing. The vehicles were termed “Compare Vehicle” and “Test Vehicle”. The Compare Vehicle remained unchanged throughout testing; it was used solely for comparison. The Test Vehicle had modifications made during the test (*i.e.* axle lubricants changed).

The test procedure may appear similar to the SAE J1321 method traditionally used in the trucking industry; however, the MVTS methods are a 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 MVTS methods. Overall, the MVTS test methods are a more advanced and reliable tool for predicting fuel savings than the trucking industry has used previously.

3.1: TEST VEHICLES

Test vehicles were 2016 International ProStar’s with Cummins ISX15 15-Liter engines and Eaton 10-Speed Manual Transmissions. The Test truck odometer was 376,035 miles at the commencement of testing. The Compare truck odometer was 369,329 miles. Trailer were 53’ Hyundai dry vans. Vehicle were loaded to a Gross Vehicle Weight (GVW) of 72,000 lbs. using water totes. Vehicles utilized dual tires and two (2) drive axles (i.e. ‘twin screw’). Vehicle details can be found in the Appendix.

Figure 1: Test Vehicles

Figure 2: Trailer Ballast (72,000 lbs. GVW)

Figure 3: 2 Drive Axles (aka “twin screw”)

Drive axles on the Test vehicle were Dana Spicer DS404 and RS404 (Figure 4 and Figure 5) for the front and rear Drive axles respectively. These were single Reduction, 40,000 lbs. capacity. This is the vehicle where the axle lubricants were changed during testing.

Figure 4: Test Veh. Front Drive Axle

Figure 5:Test Veh. Rear Drive Axle

Drive axles on the Compare vehicle were Dana Spicer D40-156 and R40-156 for the front and rear Drive axles respectively (Figure 6 and Figure 7). The axle lubricants in this vehicle remained unchanged throughout testing since it was the Compare vehicle.

Figure 6: Compare Veh. Front Drive Axle

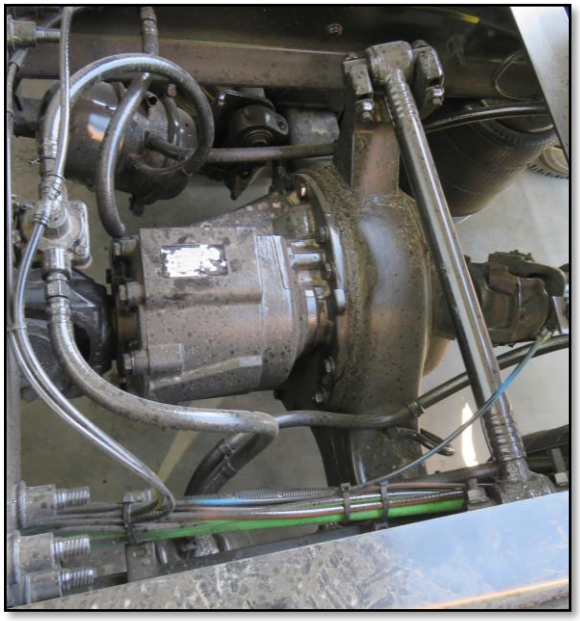
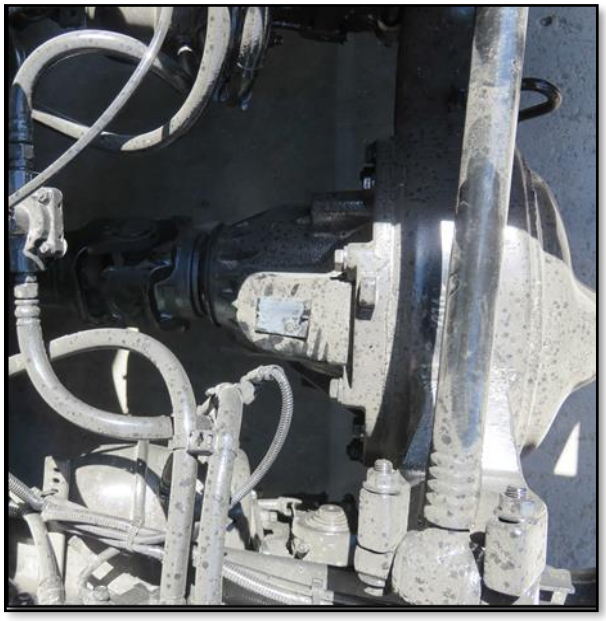


Figure 7:Compare Veh. Rear Drive Axle



Tire pressures were set at 110 psi in the morning prior to incurring any effect of daytime heat. Tire inflation systems were removed for testing to maintain consistent tire pressures. MVT vehicles were thoroughly inspected and received regular maintenance prior to testing. Approximately 1000 miles prior to testing, both tractors received Drive axle oil changes.

3.2: LUBRICANT CHANGES AND TEST RUNS

Drive axles were flushed twice prior to commencing each test run. The flush procedure was conducted as shown in Table 3 (Test vehicle only).

Table 3: Test Vehicle Drive Axle Lubricant Flush Procedure

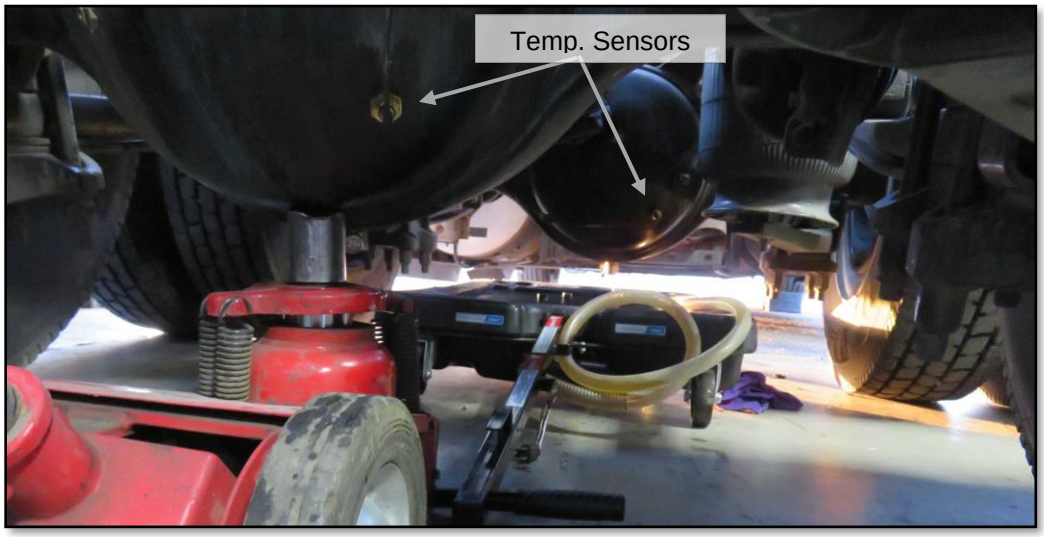
Step #	Description
1	Drain Drive axle lubricants
2	Install new axle lubricant
3	Drive 18 miles
4	Drain axle lubricants (Flush #1)
5	Drive 18 miles
6	Drain axle lubricants (Flush #2)
7	Drain axle lubricants
8	Install new axle lubricant (3rd iteration of new oil)

Differential housings were filled to their fill hole, which was 12.8L and 9.5L for the front and rear axles respectively as per the manufacturer's specification. The wheel ends (*i.e.* hubs) received 0.2L each as per specification in the manual[1]. This was conducted using a pneumatic pump with a handheld controller and digital display (Figure 8).

[1] Dana Lubricant Manual LM072012 provided by BASF.

Figure 8: Axle Lube Pump and Controller

Figure 9: Oil Draining



3.3: TEST RUN PROCEDURE

Upon conclusion of flushing procedure in Table 3, the test run of 150 miles was conducted using both trucks. Test result data included only the steady state driving, it excluded acceleration and deceleration laps. Therefore, the start and stopping procedures did not influence the test results (Figure 11).

Figure 10: Starting the Test

All vehicle settings remained unchanged throughout testing as per normal MVTS procedure. This included the air conditioning, fan setting, radio, and head lights.

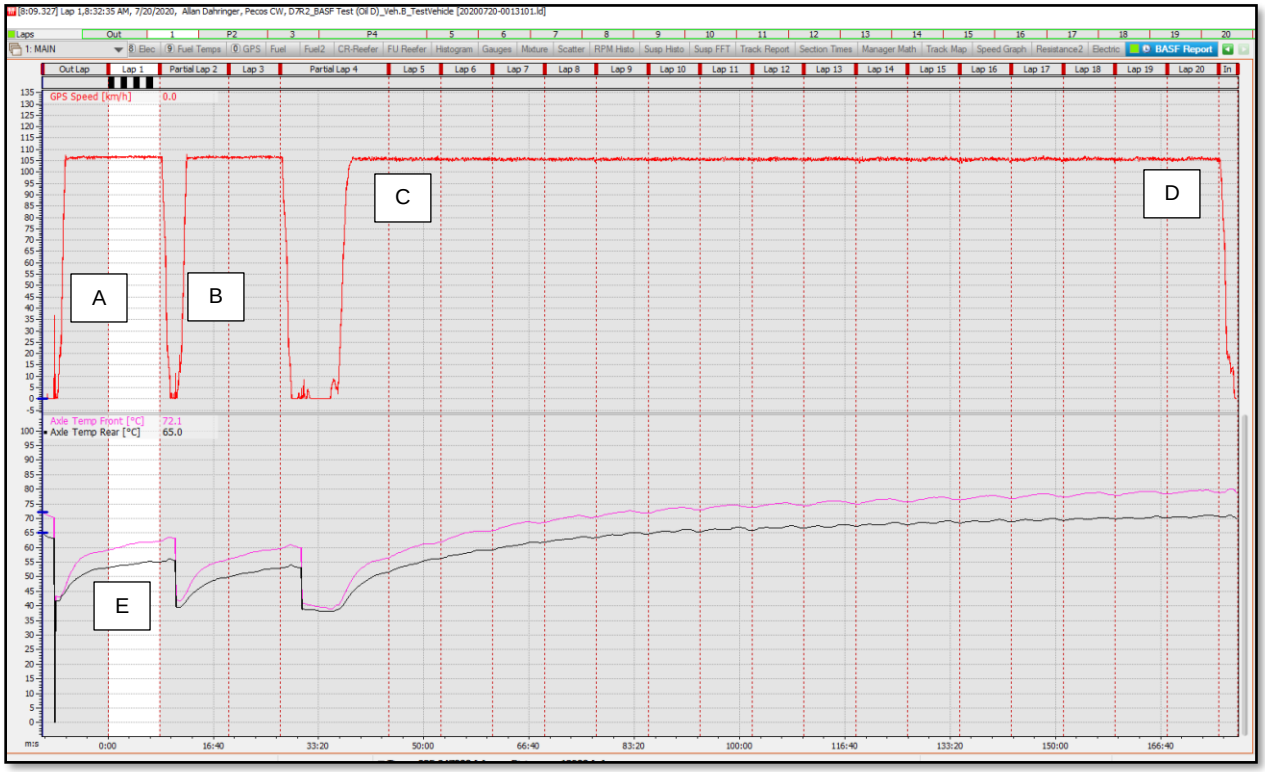
Stationary regenerations (*i.e.* Regens) were completed prior to the commencement of testing. Regens are a process the engine undertakes to clean the emissions system and a 'stationary' is done while the truck is parked. This is conducted by manually starting the regen using a laptop/vehicle link.

Since BASF axle testing was conducted over two (2) days, the trucks were not adjusted between the time of the Regen and the end of the first test day. The trucks were filled with fuel prior to the first run and not refilled during testing. This ensured a consistent batch of fuel used during all tests.

Figure 11 shows driving data from the flush procedure and a test run. Point A through D indicate the GPS speed of the vehicle (in km/h). To the left of Point A is the vehicle starting from 0 km/h, accelerating to 105 km/h, then slowing down to the right of Point A. This was Step 3 in Table 3, the driving cycle for flush #1. This step consisted of 2 laps (18 miles or 29 km). After the next oil change, Point B shows the vehicle conducting 2 more laps (Step 5 in Table 3). Point C indicates the vehicle accelerating after the final oil change and commencing the test run of 17 laps (153 miles or 246 km). Test results were extracted from data between Points C and D only.

Point E shows the axle temperatures in Celsius where the upper trace correlates to the front Drive axle. The traces show the temperatures increasing during each Flush run and then steadily increasing during the test run until reaching a plateau near the end of the test.

Figure 11: Vehicle Data from Flushes, Test Laps, and Axle Temp.



3.4: TESTED LUBRICANTS

Lubricants were labelled A through E to simplify management during testing, which can be seen in various photos. Oils were contained in 205 L (55 gallon) containers with the exception of Oil D, which was in multiple 5-gallon containers.

Figure 12: BASF Emgard® FE 75W-90 (aka E2986) (Oil “A”)

Figure 13: BASF Emgard® 7103 XFE 75W-85 (Oil “B”)

Figure 14: BASF XPDC 048 (Oil “C”)

Figure 15: BASF XPDC 081 (Oil “D”)

4.0: 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:

1. Data acquisition system (records sensor data)
2. Fuel flow meter (accurate to 0.2%)
3. Fuel temperature sensor
4. Tire temperature sensor (infrared, mounted on left-front drive tire)
5. Ground/road temperature sensor (infrared, mounted ahead of left-front drive tire)
6. Wind speed air pressure sensor (truck hood)
7. Wind direction sensor (truck hood)
8. Ambient air temperature sensor (truck hood)
9. Ambient air pressure sensor (truck cab)
10. High Precision GPS (latitude, longitude, altitude, time)
11. Drive Axle Temperature Sensors (for BASF test)

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

Figure 16: Aerodynamic Sensors

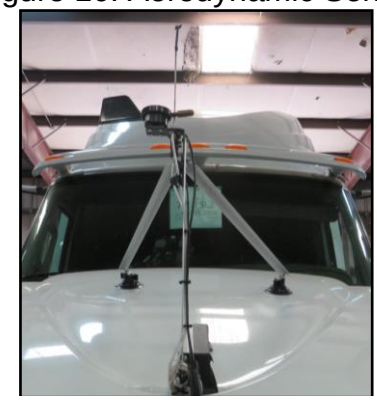


Figure 17: Data Acquisition System

Figure 18: Fuel Flow Meter

Figure 19: Tire Temp. Sensor

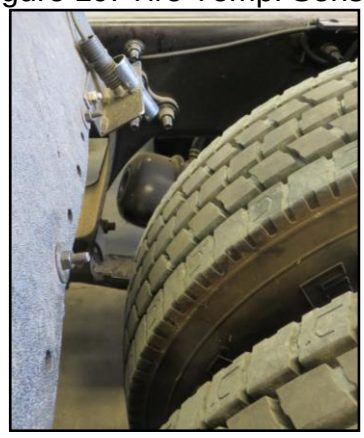


Figure 20: Front Axle Temp. Sensor

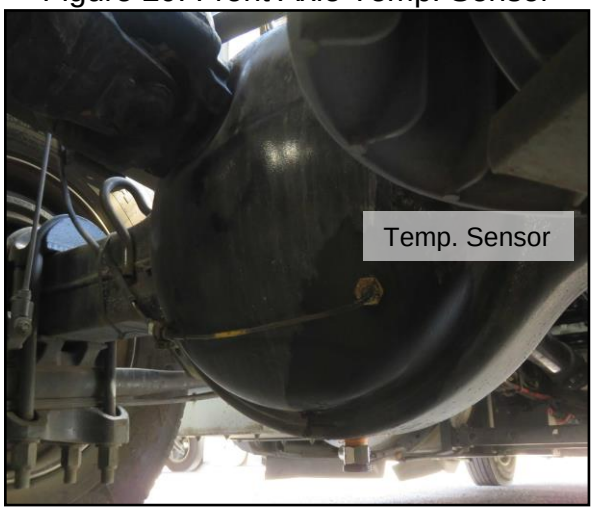
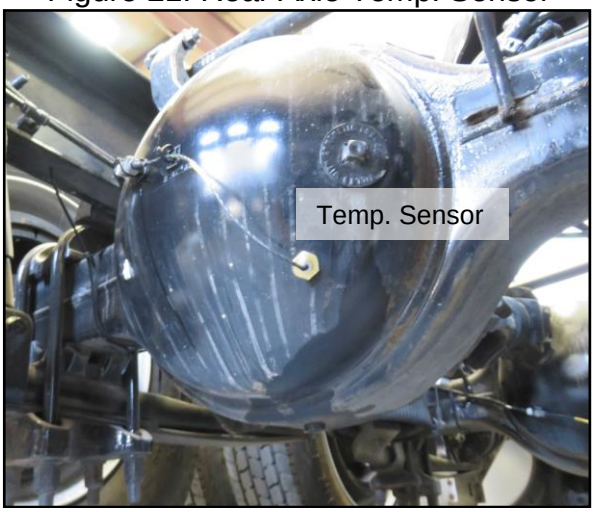


Figure 21: Rear Axle Temp. Sensor



5.0: TEST RESULTS

Testing began at 3am on July 19, 2020. Oil A was flushed twice prior to the 3am start time, therefore the test run began at 3am. Oils A, B, and C were tested on Friday. Oils C and D were tested on Saturday, starting again at 3am. Originally, all oil testing was intended to occur in a single day; however, windy conditions in the afternoons and evenings prevented testing at those times and the vehicles were parked.

5.1: FUEL ECONOMY

Testing showed savings of 0.79 gal/1000 miles (0.62%) for the Emgard XFE 7103 75W-85 lubricant, 1.00 gal/1000 miles (0.79%) for the XPDC 048 lubricant, and 0.59 gal/1000 miles (0.46%) for the XPDC 081 axle lubricant when compared to the reference oil Emgard® FE 75W-90 (aka E2986).

Table 4: Fuel Economy Improvement Summary

	Fuel Economy Improvement		
	Gal/1000 miles	MPG	Percent
Emgard® E7103 75W-85	**0.79**	0.05	0.62%
Accuracy	**+/- 0.33**	+/- 0.02	+/- 0.26%
BASF XPDC 048	**1.00**	0.06	0.79%
Accuracy	**+/- 0.48**	+/- 0.03	+/- 0.37%
BASF XPDC 081	**0.59**	0.04	0.46%
Accuracy	**+/- 0.38**	+/- 0.02	+/- 0.30%

Figure 22: Test Results (gal/1000 miles)

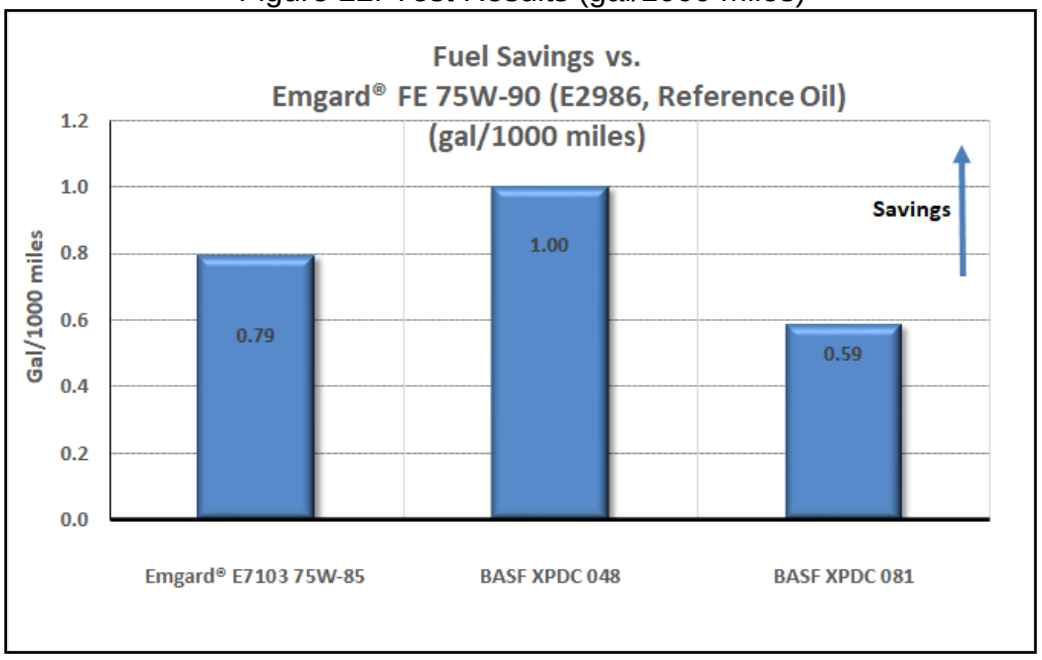
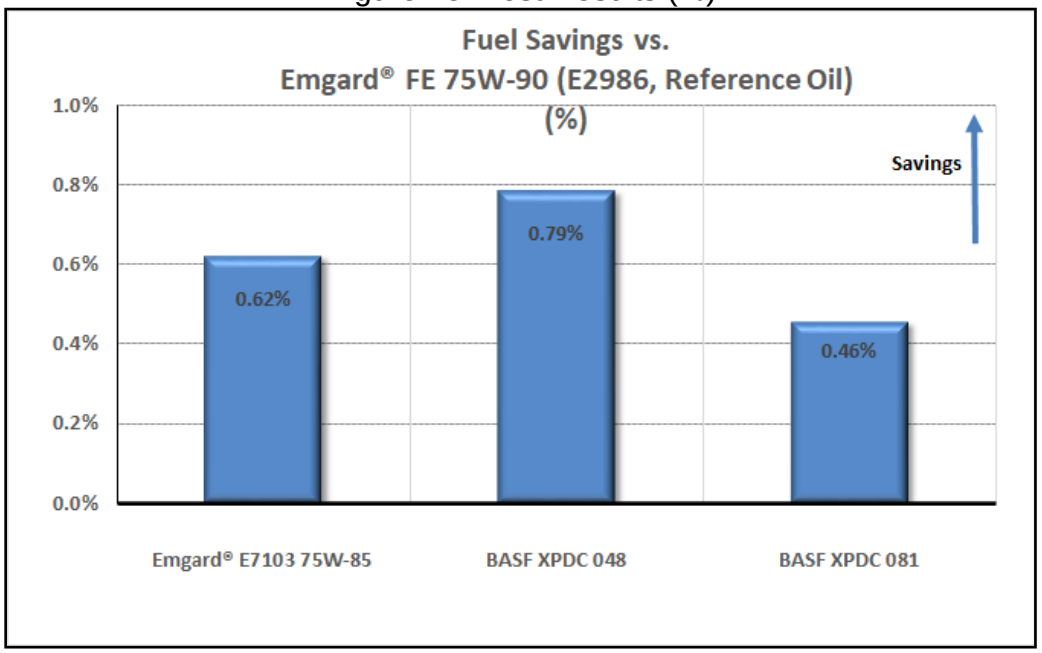


Figure 23: Test Results (%)



5.2: AXLE TEMPERATURE

Axle temperatures decreased when an improvement in fuel economy was measured. Temperatures shown correlate to the average for the respective run. The differences were quantified by comparing the Control and Test vehicles during the Baseline reference oil run to the differences in the run for each respective lubricant. Figure 27 shows the front Drive axle temperature from each run. The temperatures varied between runs due to the ambient conditions and torque through the axles. Torque can change during a test due to wind and temperature conditions. The formula is as follows:

$$Change\ in\ Axle\ Temp.(°C)\ = (T-C)Test\ Run - \ (T-C)Baseline$$

Where the values are for the respective axle oil temperatures as follows:

1. T is the Test vehicle
2. C is the Compare vehicle
3. Baseline reference oil run
4. Test Run is the respective lubricant run

When compared to reference oil Emgard® FE 75W-90 (aka E2986), Emgard® 7103 saw a temperature change of -2.7°C (-5.6°F), where a lower temperature indicates an improvement (Figure 25 and Figure 26). XPDC 048 saw a change of -5.1°C (-9.6°F), XPDC saw a change of -2.3°C (-5.0°F). **Note:** the values in the Introduction section are shown as positive since they were explained as a decrease in temperature.

$$Change\ in\ Axle\ Temp.\ (\%) = \frac{\frac{T}{C}Baseline - \frac{T}{C}Test\ Run}{\frac{T}{C}Baseline}$$

Where:

1. Formula identifications are the same as those listed in the previous formula.

Figure 24: Front Drive Axle Temp.

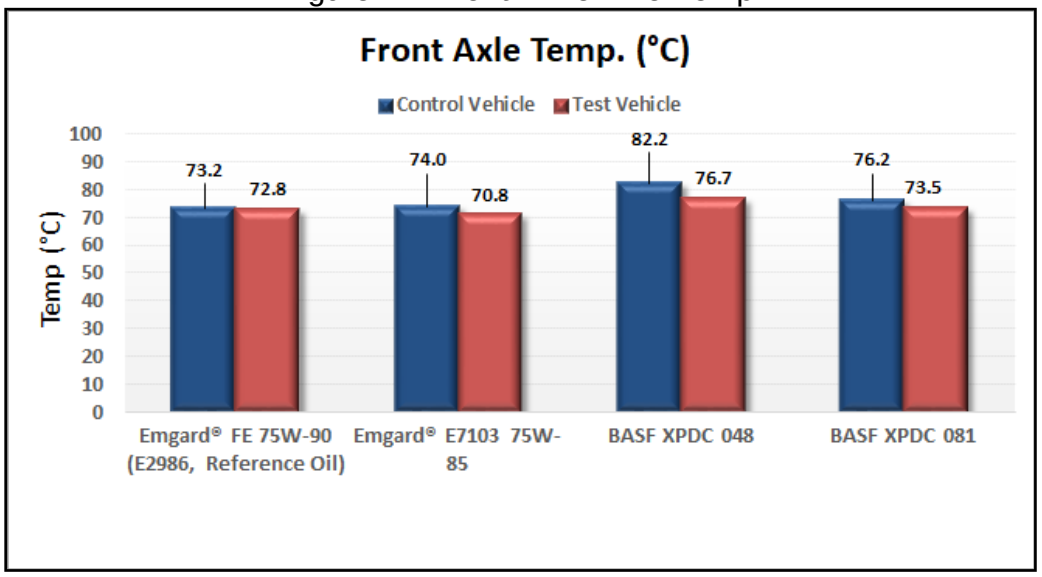


Figure 25: Change in Front Drive Axle Temp. (°C)

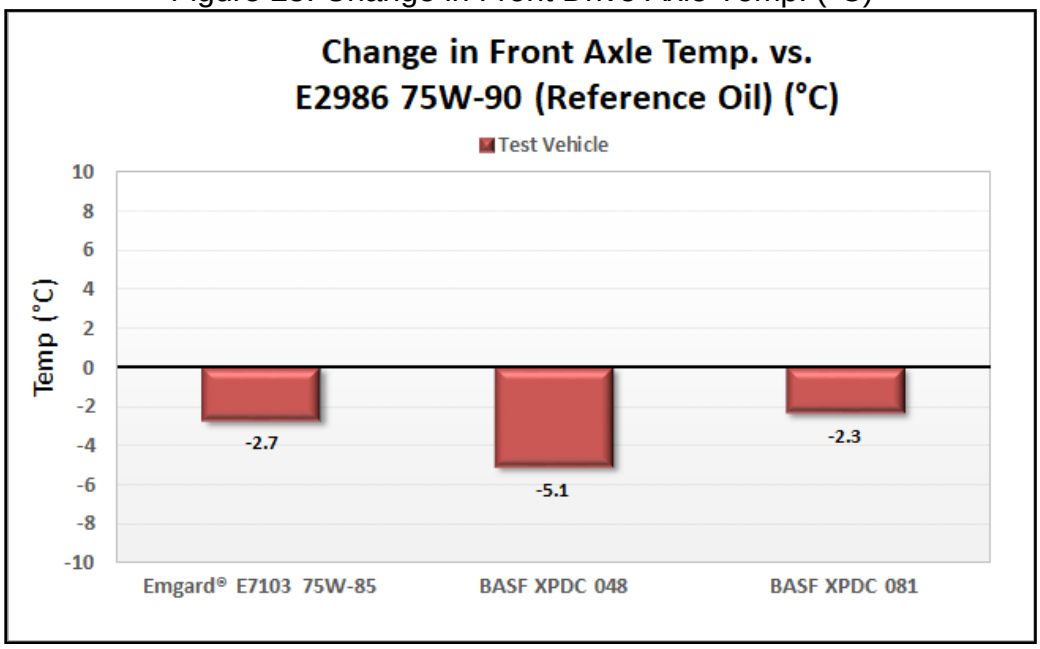
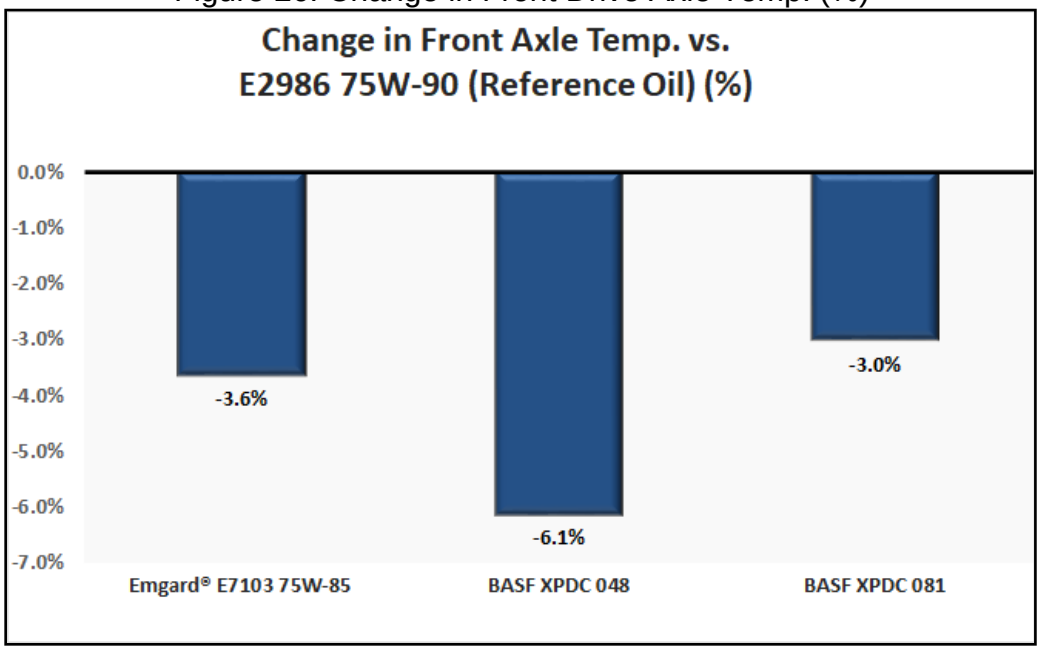


Figure 26: Change in Front Drive Axle Temp. (%)



Changes in rear Drive axle temperatures were comparable to the front. Compared to the reference oil Emgard® FE 75W-90 (aka E2986), the Emgard® 7103 saw a temperature change of -3.7°C (-8.9°F) (Figure 28 and Figure 29). XPDC 048 saw a change of -4.2°C (-9.8°F). XPDC 081 saw a change of -2.7°C (-7.1°F). **Note:** some percent values may appear skewed, such as the Emgard® 7103 versus XPDC 048, where the temperature change is larger for the Emgard® 7103; however, the percent value is lower. This is due to the Axle Temp values of the Emgard® 7103 being lower (Figure 27), which resulted in the percent change calculating higher.

Figure 27: RearDrive Axle Temp.

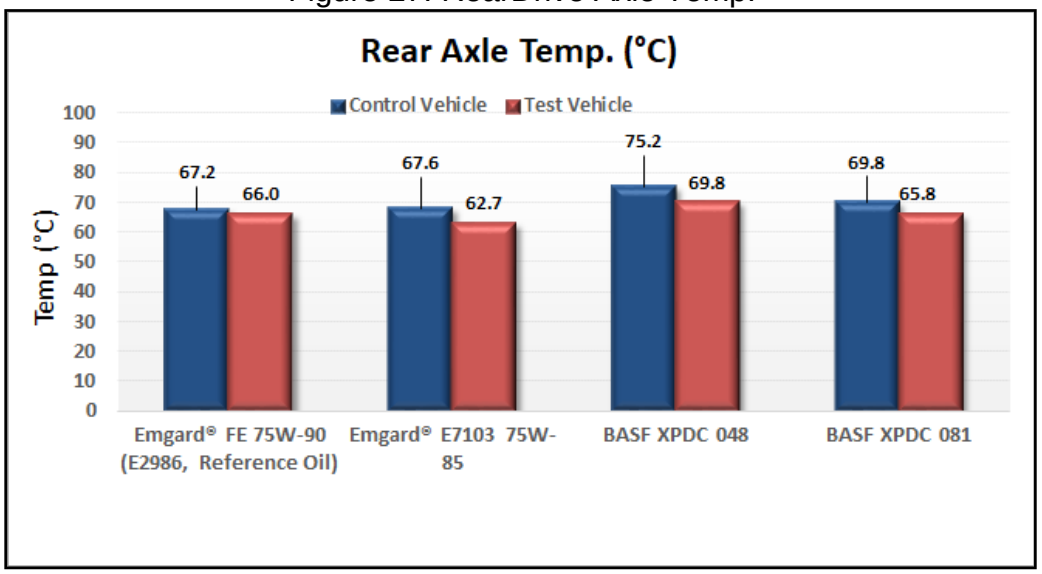


Figure 28: Change in Rear Drive Axle Temp. (°C)

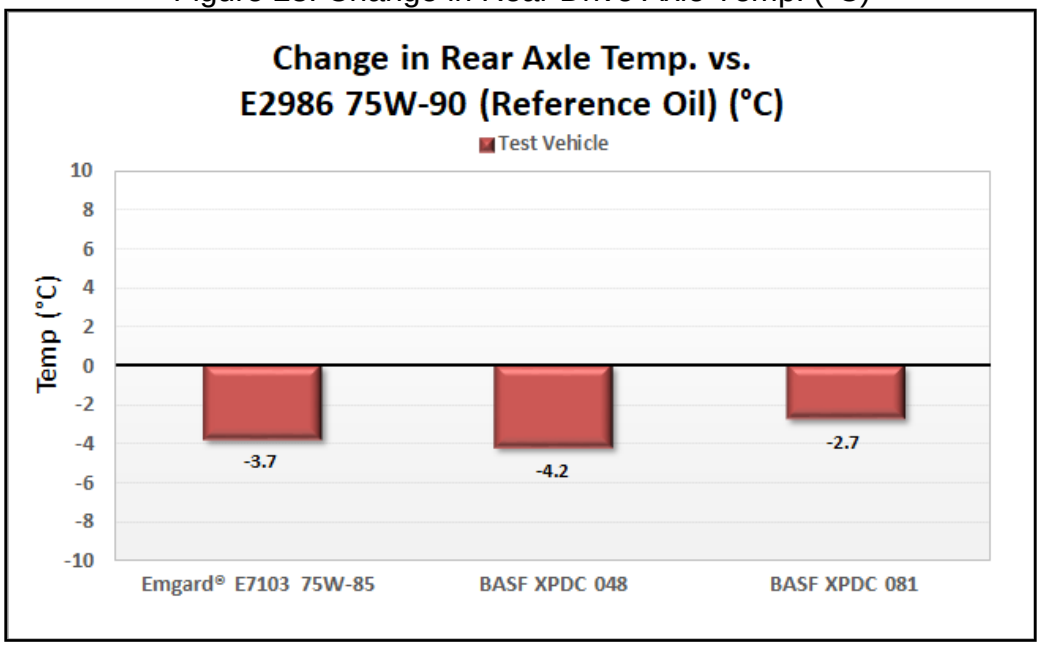


Figure 29: Change in Rear Drive Axle Temp. (%)

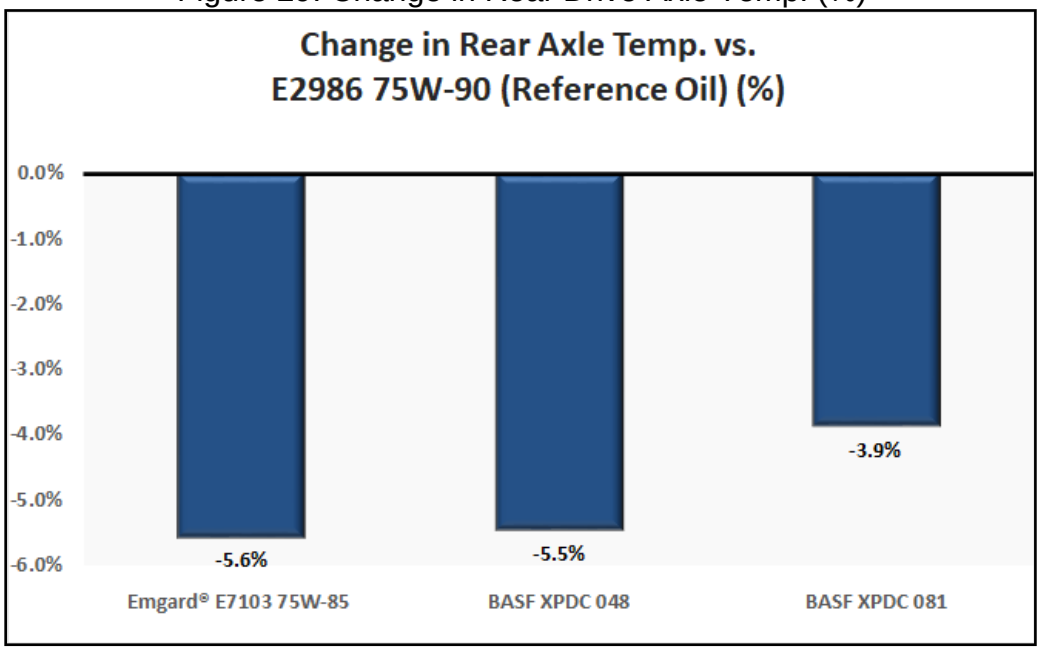


Table 5: Test Runs

Day	Run	Run Description	MVTS Designation	Start	End
1	Run 1	Emgard® FE 75W-90 (E2986, Reference Oil)	A	3:04am	5:25am
1	Run 2	Emgard® E7103 75W-85	B	7:34am	9:53am
1	Run 3	BASF XPDC 048	C	11:20am	1:48pm
2	Run 1	Rebaseline BASF XPDC 048	C	3:04am	5:25am
2	Run 2	BASF XPDC 081	D	7:08am	9:28am

5.3: 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.

Note: The following paragraphs were created mainly for aerodynamic and tire fuel economy tests and may vary for axle lubricant fuel savings. While gal/1000 miles are the preferred units for aerodynamics and tire rolling resistance, it is unclear at this time if the same applies to axle lubricants. While improvements in axle lubrication are related to distance, making gal/1000 miles the correct unit, they may also relate to drive train torque level, which would result in percent units being most applicable. In either case, the magnitude of the values is relatively small (below 1 gal/1000 miles and 1%), making the difference in magnitude of the two units minor and therefore making the use of either unit acceptable.

In case of aerodynamics or tire rolling resistance, 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).

5.4: WEATHER CONDITIONS SUMMARY

On the first day of testing, temperatures ranged from 72.0°F to 90.0°F. Winds ranged from 8 mph to 16 mph. On the second day of testing, temperatures ranged from 74.0°F to 92.0°F. Winds ranged from 3 mph to 18 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.

5.5: 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. This was critical for the lubricant tests reported here since the test values were relatively small.

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).

Theoretical accuracy is calculated with statistics and shown in Table 4 as a +/- value. The graph shows the arrow pointing to the left illustrating less fuel used (*i.e.* fuel saved). The distance between the peaks of the bell curves is the test result average, which was a fuel savings of 0.79 gal/1000 miles. Minimum and maximum values were calculated as the test result plus or minus the accuracy value (0.79 +/- 0.33), which was 1.13 and 0.46 gal/1000 miles. Figure 30 below shows the statistical bell curves of Emgard® XFE 7103 75W-85 test.

Figure 30: Emgard® XFE 7103 75W-85 Fuel Consumption Bell Curve

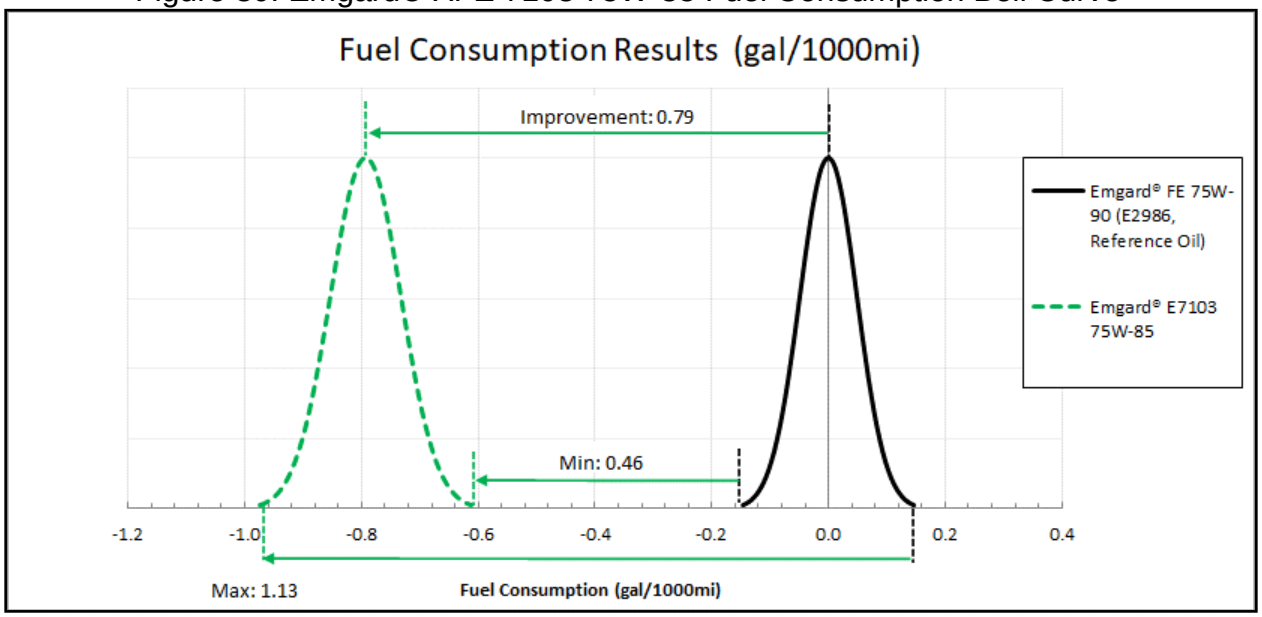


Figure 31 below illustrates the statistical bell curve for BASF XPDC 048. The bell curves illustrate a difference in fuel economy and have valid statistical accuracy. The fuel savings were 1.00 gal/1000 miles. As shown above, the minimums and maximums are the test results plus or minus the accuracy value (1.00 +/- 0.48), which were 1.48 and 0.53 gal/1000 miles.

Figure 31: BASF XPDC 048 Fuel Consumption Bell Curve

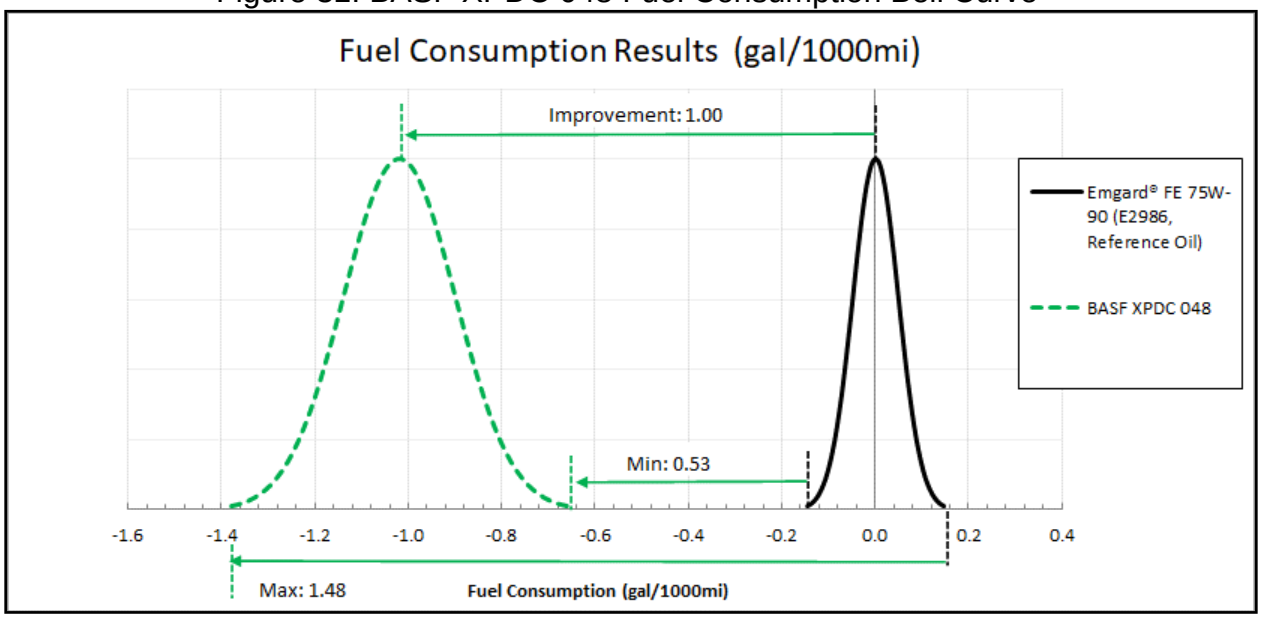
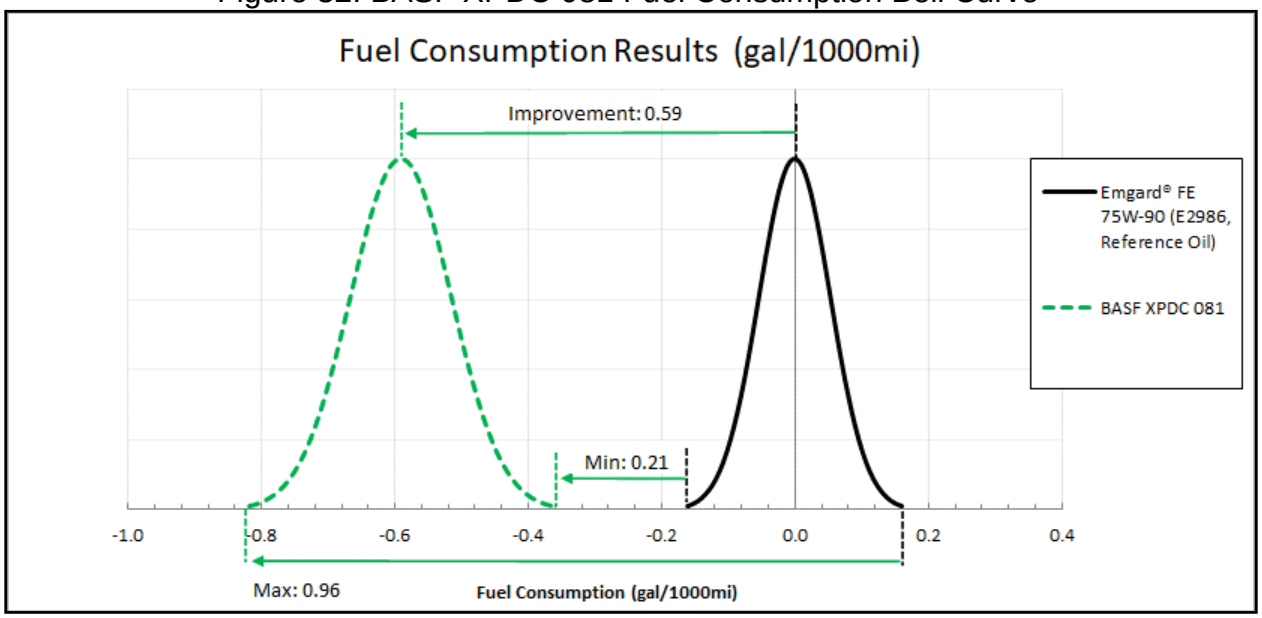


Figure 32 below illustrates the statistical bell curve for BASF XPDC 081. Similar to the previous graph, the bell curves illustrate a difference in fuel economy and have valid statistical accuracy. The fuel savings were 0.59 gal/1000 miles. As shown above, the minimums and maximums are the test results plus or minus the accuracy value (0.59 +/- 0.38), which were 0.96 and 0.21 gal/1000 miles.

Figure 32: BASF XPDC 081 Fuel Consumption Bell Curve



6.0: SAVINGS CALCULATIONS

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

6.1: FUEL SAVINGS CALCULATIONS

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

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

Example: BASF Emgard® XFE 7103 75W-85 and 125,000 miles travelled annually:

$$Fuel\ Savings = (0.79\ gal/1000\ miles)x\ \frac{(125{,}000\ miles/year)}{1000} = 99\ gal/year$$

Therefore, the BASF Emgard® XFE 7103 75W-85 axle lubricant would save 99 gallons of fuel per year for this vehicle travelling 125,000 miles.

6.2: 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

$Savings\ (\$/year) = \left(99\ \frac{gal}{year}\right)\ x\ \left(\frac{\$3.056}{gal}\right) = \$303\ /year$ in fuel savings

Therefore, the BASF Emgard® XFE 7103 75W-85 axle lubricant would save $303 per year in fuel for the vehicle travelling 125,000 miles at 72,000 lbs. GVW.

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

6.3: 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.

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

Where the 'Product cost' in the case of axle lubricants 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 @$50 'Price cost': Using example pricing with the BASF Emgard® XFE 7103 75W-85 being $50 more than the standard spec oil from the OEM when the truck is built:

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

$$Payback\ (months) = \frac{(\$50)}{(\$303\ /year)}\ x\ \left(12\frac{months}{year}\right) = 2.0\ months$$

Therefore, with a difference of $50 per vehicle, the BASF Emgard® XFE 7103 75W-85 axle lubricant would pay for itself (*i.e.* payback or ROI) in 2.0 months. This is extremely fast by comparison to other technologies. **Note:** the price of $50 is fictitious and MVTS is unaware what price difference, if any, would exist to other axle lubricants. Fleets are advised to investigate their own pricing and use the formulas above with their own values.

6.4: TECHNOLOGY PROFIT

Since saving money is the end goal, calculating profit is another important factor.

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

Example @$50 'Product cost': Using annual values from above.

$Profit\ (\$) = (\$303) - (\$50)$ = $253 saved in the first year and $303 each year afterward.

If this were translated to a 1000-truck fleet, the profits would be $253,000 in the first year and $303,000 in subsequent years for the life of the vehicle.

For a 5-year truck life, this would equate to $1,465 per truck. For a 1000-truck fleet this would equate to $1.465M in profit.

7.0: CONCLUSION

BASF axle lubricants proved to save fuel and decrease axle oil temperatures.

The savings were 0.79 gal/1000 miles (0.62%) for the BASF Emgard® XFE 7103 75W-85 lubricant, 1.00 gal/1000 miles (0.79%) for the BASF XPDC 048 lubricant, and 0.59 gal/1000 miles (0.46%) for BASF XPDC 081. All test results were in comparison to reference oil BASF Emgard® FE 75W-90 (aka E2986).

Decreases in front Drive axle temperatures were 2.7°C (5.6°F), 5.1°C (9.6°F), 2.3°C (5.0°F) respectively for the lubricants in the order listed above when compared to the E2986 reference oil. On the rear Drive axle, temperatures decreased by 3.7°C (8.9°F), 4.2°C (9.8°F), 2.7°C (7.1°F) respectively

Overall, improvements and fuel economy and temperature were both found with the BASF axle lubricants when compared to the reference oil. MVTS finds the fuel savings with BASF axle lubricants impressive and valuable. In addition to the fuel savings and temperature decreases, the financial benefits were also impressive. Using an example cost increase of $50[3] per tractor, the payback (*i.e.* ROI) was 2.0 months for the BASF Emgard® XFE 7103 75W-85. As a comparison, 12-18 months is considered a success in the Trucking industry today. The profit over a projected 5 year[4] life of the tractor was $1,465 and the profit for a 1000-truck fleet over 5 years was $1.465M. The fuel and financial benefits to a trucking company are very appealing, which are amplified by the oils being a no-touch option since the trucking company would simply spec' the oil on new tractors.

[3] $50 is a fictious value used by MVTS. Fleets should contact their dealer for pricing or BASF directly using information on the last page of this report.
[4] 5 years is an approximate service life for the original owner of the tractor

8.0: APPENDIX

8.1: TEST VEHICLE DETAILS

Figure 33: Vehicle Info, Modified "Test" Vehicle

Date	July 19-20, 2020					
Company	Mesilla Valley Transportation					
Location	Pecos, Texas					
Test Route	Pecos 9-mile Test Track					
TRUCK ID:	**77514V6**					
Brand	International					
Year	2016					
Model	ProStar +					
Engine	Cummins X15					
VIN	3HSDJAPR4GN030880					
Mileage (miles):	372,833					
Transmission	Eaton 10-Speed Manual					
Front Drive Axle	Dana Spicer DS404					
Rear Drive Axle	Dana Spicer RS404					
Rear Gear	3.36:1					
Fuel Load	Full at Pilot in Pecos					
Fuel Type & Batch	No. 2 Diesel					
Axle Weights	11,900		17,060		16,080	
Total weight	45,040					
Wheel covers off, solid mud flaps						
Photo/Video/Audio folder name:						
TRAILER ID:	**7423**					
Model	Hyundai					
VIN	3H3V532C7LT401104					
Year	2019					
Size	53' Dry Van					
Trailer Gap (inches)	36" from cab extender to trailer					
Add-ons	solid mudflaps, Greenwing skirts					

Figure 34: Tire Info, Modified "Test" Vehicle

TIRES					
		Truck	77514V6		
LF:		**Front Axle Tires**			RF: Same
Hankook E3 Max AL21		Type			Hankook E3 Max AL21
295/75R22.5		Size			295/75R22.5
19/32		Tread Depth (32nds)			19/32
110		Pressure (psi)			110
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
110	110	Pressure (psi)		110	110
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
13/32	13/32	Tread Depth (32nds)		13/32	13/32
110	110	Pressure (psi)		110	110
		Trailer	7423		
LF-Outer Trailer:	LF-Inner Trailer:	**Tandem Front**		RF-Inner Trailer	RF-Outer Trailer
Michelin X Line Energy	Michelin X Line Energy	Type		Michelin X Line Energy	Michelin X Line Energy
275/80R22.5	275/80R22.5	Size		275/80R22.5	275/80R22.5
13/32	13/32	Tread Depth (32nds)		13/32	13/32
110	110	Pressure (psi)		110	110
LR-Outer Trailer:	LR-Inner Trailer:	**Tandem Rear**		RR-Inner Trailer	RR-Outer Trailer
Michelin X Line Energy	Michelin X Line Energy	Type		Michelin X Line Energy	Michelin X Line Energy
275/80R22.5	275/80R22.5	Size		275/80R22.5	275/80R22.5
13/32	13/32	Tread Depth (32nds)		13/32	13/32
110	110	Pressure (psi)		110	110

8.2: COMPARE VEHICLE DETAILS

Figure 35: Vehicle Info, Compare Vehicle

Date	July 19-20, 2020				
Company	Mesilla Valley Transportation				
Location	Pecos, Texas				
Test Route	Pecos 9-mile Test Track				
TRUCK ID:	**77515L2**				
Brand	International				
Year	2016				
Model	ProStar +				
Engine	Cummins X15				
VIN	3HSDJAPR7GN284227				
Mileage (miles):	365,950				
Transmission	Eaton 10-Speed Manual				
Front Drive Axle	Dana Spicer D40-156				
Rear Drive Axle	Dana Spicer R40-156				
Rear Gear	3.36:1				
Fuel Load	Full at Pilot in Pecos				
Fuel Type & Batch	No. 2 Diesel				
Axle Weights	12,000		16,740		16,220
Total weight	44,960				
Wheel covers off, Solid mud flaps					
Photo/Video/Audio folder name:					
TRAILER ID:	**7543**				
Model	Hyundai				
VIN	3H3V532C0LT401199				
Year	2019				
Size	53' Dry Van				
Trailer Gap (inches)	36" from cab extender to trailer				
Add-ons	Solid mud flaps, Greenwing skirts				

Figure 36: Tire Info, Compare Vehicle

TIRES					
		Truck	77515L2		
LF:		**Front Axle Tires**			RF: Same
Hankook E3 Max AL21		Type			Hankook E3 Max AL21
295/75R22.5		Size			275/80R22.5
19/32		Tread Depth (32nds)			19/32
110		Pressure (psi)			110
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
23/32	22/32	Tread Depth (32nds)		22/32	22/32
110	110	Pressure (psi)		110	110
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
13/32	13/32	Tread Depth (32nds)		13/32	13/32
110	110	Pressure (psi)		110	110
		Trailer	7543		
LF-Outer Trailer:	LF-Inner Trailer:	**Tandem Front**		RF-Inner Trailer	RF-Outer Trailer
Michelin X Line Energy	Michelin X Line Energy	Type		Michelin X Line Energy	Michelin X Line Energy
275/80R22.5	275/80R22.5	Size		275/80R22.5	275/80R22.5
13/32	13/32	Tread Depth (32nds)		13/32	13/32
110	110	Pressure (psi)		110	110
LR-Outer Trailer:	LR-Inner Trailer:	**Tandem Rear**		RR-Inner Trailer	RR-Outer Trailer
Michelin X Line Energy	Michelin X Line Energy	Type		Michelin X Line Energy	Michelin X Line Energy
275/80R22.5	275/80R22.5	Size		275/80R22.5	275/80R22.5
13/32	13/32	Tread Depth (32nds)		13/32	13/32
110	110	Pressure (psi)		110	110

8.3: TEST ROUTE

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

Figure 37: Pecos Test Track

8.4: 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 6: Weather Data, July 19

Time	Temperature	Dew Point	Humidity	Wind	Wind Speed	Wind Gust	Pressure	Precip.	Condition
12:53 AM	83 F	57 F	41 %	SSE	13 mph	0 mph	27.04 in	0.0 in	Fair
1:53 AM	82 F	61 F	49 %	S	16 mph	24 mph	27.04 in	0.0 in	Fair
2:53 AM	78 F	62 F	58 %	SSW	16 mph	25 mph	27.04 in	0.0 in	Fair
3:53 AM	76 F	63 F	64 %	S	16 mph	0 mph	27.05 in	0.0 in	Fair
4:53 AM	75 F	63 F	66 %	S	10 mph	0 mph	27.05 in	0.0 in	Fair
5:53 AM	74 F	63 F	68 %	S	12 mph	0 mph	27.05 in	0.0 in	Fair
6:53 AM	72 F	63 F	73 %	SSE	10 mph	0 mph	27.04 in	0.0 in	Fair
7:53 AM	73 F	64 F	73 %	SSE	9 mph	0 mph	27.06 in	0.0 in	Fair
8:53 AM	74 F	66 F	76 %	SSE	10 mph	0 mph	27.09 in	0.0 in	Fair
9:53 AM	77 F	64 F	64 %	S	10 mph	0 mph	27.09 in	0.0 in	Fair
10:53 AM	81 F	63 F	54 %	S	10 mph	0 mph	27.08 in	0.0 in	Fair
11:53 AM	85 F	62 F	46 %	S	10 mph	0 mph	27.07 in	0.0 in	Fair
12:53 PM	87 F	60 F	40 %	SSE	9 mph	17 mph	27.07 in	0.0 in	Fair
1:53 PM	90 F	59 F	35 %	S	8 mph	21 mph	27.05 in	0.0 in	Fair
2:53 PM	91 F	59 F	34 %	VAR	7 mph	24 mph	27.03 in	0.0 in	Fair
3:53 PM	93 F	57 F	30 %	ESE	13 mph	0 mph	27.01 in	0.0 in	Partly Cloudy
4:53 PM	94 F	57 F	29 %	SSE	14 mph	20 mph	27.00 in	0.0 in	Fair
5:53 PM	94 F	57 F	29 %	SSE	14 mph	25 mph	26.98 in	0.0 in	Fair
6:53 PM	92 F	56 F	30 %	SE	15 mph	0 mph	26.96 in	0.0 in	Fair
7:53 PM	92 F	56 F	30 %	SE	17 mph	0 mph	26.96 in	0.0 in	Fair
8:53 PM	89 F	56 F	32 %	SSE	18 mph	0 mph	26.98 in	0.0 in	Fair
9:53 PM	88 F	56 F	34 %		0 mph	0 mph	27.00 in	0.0 in	Fair
10:53 PM	86 F	56 F	36 %	S	14 mph	0 mph	27.01 in	0.0 in	Fair
11:53 PM	85 F	56 F	37 %	S	13 mph	0 mph	27.02 in	0.0 in	Fair

Source: https://www.wunderground.com/history/daily/us/tx/midland/KMAF/date/2020-7-19

Table 7: Weather Data, July 20

Time	Temperature	Dew Point	Humidity	Wind	Wind Speed	Wind Gust	Pressure	Precip.	Condition
12:53 AM	83 F	56 F	39 %	S	10 mph	0 mph	27.04 in	0.0 in	Fair
1:53 AM	81 F	57 F	44 %	S	10 mph	0 mph	27.05 in	0.0 in	Fair
2:53 AM	80 F	58 F	47 %	S	12 mph	0 mph	27.04 in	0.0 in	Fair
3:53 AM	78 F	58 F	50 %	SSE	7 mph	0 mph	27.04 in	0.0 in	Fair
4:53 AM	77 F	57 F	50 %	S	8 mph	0 mph	27.03 in	0.0 in	Fair
5:53 AM	75 F	57 F	53 %	SSE	7 mph	0 mph	27.04 in	0.0 in	Fair
6:53 AM	74 F	56 F	53 %	SE	3 mph	0 mph	27.06 in	0.0 in	Fair
7:53 AM	74 F	56 F	53 %	ESE	7 mph	0 mph	27.06 in	0.0 in	Fair
8:53 AM	77 F	57 F	50 %	SSE	8 mph	0 mph	27.07 in	0.0 in	Fair
9:53 AM	80 F	59 F	48 %	SSE	18 mph	0 mph	27.04 in	0.0 in	Fair
10:53 AM	83 F	60 F	46 %	SSE	17 mph	0 mph	27.02 in	0.0 in	Fair
11:53 AM	85 F	60 F	43 %	SSW	12 mph	0 mph	27.03 in	0.0 in	Fair
12:53 PM	89 F	58 F	35 %	S	12 mph	21 mph	27.02 in	0.0 in	Fair
1:53 PM	92 F	55 F	29 %	S	13 mph	24 mph	27.01 in	0.0 in	Fair
2:53 PM	94 F	54 F	26 %	SE	14 mph	22 mph	26.98 in	0.0 in	Fair
3:53 PM	94 F	53 F	25 %	VAR	3 mph	21 mph	26.96 in	0.0 in	Fair
4:53 PM	96 F	52 F	22 %	ESE	15 mph	23 mph	26.94 in	0.0 in	Fair
5:53 PM	93 F	52 F	25 %	SE	13 mph	22 mph	26.92 in	0.0 in	Fair
6:53 PM	94 F	53 F	25 %	SE	21 mph	25 mph	26.92 in	0.0 in	Fair / Windy
7:53 PM	92 F	51 F	25 %	SE	20 mph	0 mph	26.92 in	0.0 in	Fair
8:53 PM	89 F	50 F	26 %	SE	15 mph	0 mph	26.92 in	0.0 in	Fair
9:53 PM	87 F	53 F	31 %	SE	10 mph	0 mph	26.94 in	0.0 in	Fair
10:53 PM	85 F	53 F	33 %	SE	7 mph	0 mph	26.97 in	0.0 in	Fair
11:53 PM	85 F	55 F	36 %	ESE	12 mph	0 mph	26.99 in	0.0 in	Cloudy

Source: https://www.wunderground.com/history/daily/us/tx/midland/KMAF/date/2020-7-20

8.5: PRODUCT DETAILS

- BASF Emgard® FE 75W-90 (aka E2986)
- BASF Emgard® XFE 7103 75W-85
- BASF XPDC 048
- BASF XPDC 081

8.6: TEST PERSONNEL

8.6a: MVT SOLUTIONS ENGINEERING

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

8.6b: MVT SOLUTIONS DRIVERS & TECHNICIANS

1. Allan Dahringer, Director of Maintenance, MVT fleet
2. Andrew Burnett, Shop Foreman, MVT fleet Las Cruces
3. Carlos Aragon
4. Jack Burchell
5. Seth Knight

8.6c: BASF

1. Arjun Goyal, Technical Marketing Manager – Axle Lubricants
2. Donna Mosher, Technical Service Manager – Transportation Lubricants

8.7: MVT SOLUTIONS CONTACT INFO

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