Southern California Gas Company

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CNG Port Drayage Truck Demonstration Program

Final Report

GLADSTEIN, NEANDROSS & ASSOCIATES

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Draft Final Report

PROJECT DESCRIPTION

In early 2008, Southern California Gas Company, Autocar LLC, Crossroads Equipment and Lease LLC, California Cartage Company (CCC), and Gladstein Neandross and Associates joined forces to develop and demonstrate the use of compressed natural gas (CNG) in Class 8 drayage trucks serving the Ports of Los Angeles (POLA) and Long Beach (POLB).

Autocar agreed to build the drayage tractors on its existing and well-proven CNG refuse collection vehicle chassis. Crossroads agreed to handle the financing of the Autocar vehicles through its existing truck sales/leasing operation. CCC agreed to run the vehicles in its own fleet of port drayage vehicles. Southern California Gas agreed to finance the project under its R&D program and with support from the Ports of Los Angeles and Long Beach under their Technology Advancement Program (TAP).

The program partners contracted with Gladstein Neandross and Associates (GNA) to spearhead the overall management and implementation of the demonstration project, including the initial project development plan, test program design, project monitoring, grant funding management, and fuel station permitting. GNA was also tasked with keeping all program partners informed during each step of the project and with managing all financial transactions between the partners during the production and purchase of the vehicles.

The trucks built under the program were the first CNG drayage trucks using the lowest emission heavy-duty engine available, the Cummins ISL-G natural gas engine. The ISL-G was certified three years early to the 2010 NOx emission standard of 0.2 grams / bhp-hr. The program built and is currently operating four drayage trucks at CCC in Wilmington, California. One of the four trucks (No. 7792) was funded by POLA and POLB under the TAP.

The TAP funding required the project team to collect data on the TAP-funded truck for at least six months and to operate the truck in port service for a minimum of one year. After the one year of operation, the project was required to submit a final report to review and evaluate the demonstration project. *This is the final report for the CNG Port Drayage Truck Demonstration Program.*

DATA COLLECTION RESULTS

As discussed in the original test plan (Appendix 1), CCC primarily drives two common drayage duty-cycles, its local "landbridge" routes between the docks and the CCC yard (in Wilmington, CA) and longer delivery routes to the Inland Empire (e.g., Ontario, CA). The mix of landbridge and inland routes are highly dependent on CCC's daily contracts. CCC only handles a small

portion of the inland routes in its company-owned trucks because most of those routes are handled by contract drivers. The project wanted to document how the CNG truck performed under local stop-and-go type operation and more steady-state, higher speed operation, so the two common CCC duty-cycles were ideal for collecting this data.

The CNG truck entered service in early February 2009 and was used exclusively in local drayage service around the ports in an effort to get the drivers used to the new vehicle and to build confidence in the local, public CNG infrastructure. CCC's management did not want to begin sending this truck on longer inland routes until they knew the drivers would be comfortable and thus, that the runs would be successful.

The original program called for the truck to use public CNG infrastructure initially and then transition over to a small private CNG station that was going to be installed at CCC by Southern California Gas Company using a grant from the South Coast Air Quality Management District (SCAQMD).

In early May 2009, CCC's management decided they had the comfort level with the CNG truck to begin running it on longer inland routes. Beginning on May 4, 2009, the CNG truck began running one inland route from CCC to Ontario each morning. The truck would run local routes each afternoon. The CNG truck continued running this single daily inland route for most of May 2009 through September 2009. After September, the CNG truck returned to running two local shifts per day. The test program only collected mileage and engine hour information during refueling events, so exact mileage per trip information was not available.

Truck Performance Results

To obtain the proper performance data on the CNG truck, the project kept a comprehensive fueling log for the CNG truck. This log included entries for all fueling events, as well as the number of engine operating hours and vehicle odometer readings.

Table 1 below shows three excerpts from the full fueling log. The excerpts are designed to show summary results information from three phases of the data collection program. The complete fueling log is presented in Appendix 2 for further review.

The first section of the table shows several records from the first few weeks of truck operation. The second section of the table shows several records near the end of the data collection phase when the truck was running two local shifts per day. The last section of the table shows several records from the early May timeframe when the truck was running one inland route every morning.

The first few weeks with any vehicle are a break-in phase, where results generally tend to be impacted by a new engine/vehicle really just beginning to operate properly after manufacture. Engines do not tend to operate at peak efficiency during this phase as the engine components are just beginning to take on their correct shapes and tolerances. This is a generally accepted process and its duration depends on the specific engine and duty-cycle. Cummins does not publish an official statement on their engines, but at least one dealer publication references the break-in

period at 1,000 to 5,000 miles. The truck was only running local routes during this phase. As these results show, the CNG truck demonstrated a fuel economy of 4.16 miles per diesel equivalent gallon (DGE) of fuel. This result is not unexpected with the truck running all local routes with a brand new engine under the hood.

Table 1 – CNG Truck Fueling Log Excerpts

CNG Port Truck Fueling Log - Unit No. 7792									
Phase	Date	Time	Driver (initials)	Hour Meter Reading (hr)	Odometer Reading (mi)	Amount of Fuel Purchased (DGE)	Fuel Economy (mi/DGE)	Fuel Cost ($/DGE)	Cost of Fuel Purchased ($)
Startup Phase Sample	11-Feb	16:53	JAJ	48	512	40.53	3.73	$ 1.87	$ 75.93
	13-Feb	15:13	JAJ	62	674	40.39	4.01	$ 1.87	$ 75.66
	17-Feb	22:49	JAJ	76	870	43.90	4.46	$ 1.87	$ 89.73
	24-Feb	20:07	JAJ	90	1,041	39.07	4.39	$ 2.04	$ 79.84
	26-Feb	21:54	JAJ	103	1,226	44.02	4.20	$ 2.04	$ 89.96
	Average Fuel Economy for Period						4.16		
Port-Only Phase Sample	18-Nov	19:00	JML	1,411	22,910	57.56	4.66	$ 2.84	$ 166.32
	21-Nov	13:00	JML	1,424	23,120	44.67	4.70	$ 2.89	$ 126.80
	24-Nov	23:00	JML	1,438	23,330	45.40	4.63	$ 2.84	$ 128.89
	2-Dec	2:00	JML	1,451	23,522	43.44	4.42	$ 2.84	$ 123.34
	4-Dec	13:00	JML	1,467	23,814	57.22	5.10	$ 2.84	$ 162.45
	Average Fuel Economy for Period						4.70		
Inland Empire Phase Sample	4-May	3:30	JML	405	5,421	30.35	6.05	$ 2.04	$ 62.03
	6-May	19:06	JML	423	5,721	65.67	4.57	$ 2.04	$ 134.20
	8-May	3:30	JML	438	5,894	28.60	6.05	$ 2.04	$ 58.44
	12-May	7:00	LH	450	6,072	31.80	5.61	$ 2.04	$ 64.99
	14-May	6:00	LH	469	6,356	61.22	4.63	$ 2.04	$ 125.12
	Average Fuel Economy for Period						5.38		

The second section of Table 1 shows the performance of the truck running two local shifts per day after the truck was fully "broken in". As the table shows, the demonstrated fuel economy during this phase rose to 4.70 miles per DGE, a 13% increase in fuel economy over similar operating conditions. This difference shows the significant impact of the break-in period and improved driver experience on vehicle performance.

The third section of Table 1 shows the performance of the truck running one inland shift (higher speed, steady state) and one local shift per day. As the table shows, the demonstrated fuel economy during this phase rose to 5.38 miles per DGE, a 14.5% increase over the normal two local shift operating performance. This result is not unexpected as fuel economy improves with less stop-and-start driving patterns. These results over the daily inland route show the true fuel economy potential for CNG drayage trucks. At 5.38 miles per DGE, these trucks are approaching the typical diesel drayage truck fuel economy of 5.5 to 6.0 miles per gallon. On continued longer haul routes to inland destinations, the CNG truck's fuel economy would undoubtedly go even higher.

Full Year Fuel Results

Table 2 below shows the cumulative results for the CNG truck over the course of the data collection phase through January 26, 2010. The truck used 5,579 DGEs during the data collection period and ran over 27,500 miles. The combined fuel economy, including the break-in period, local-only usage, and the period running inland routes, is 4.94 miles per DGE.The total cost of the CNG used in the truck over the period was $13,598. The average cost of the CNG purchased during the period was $2.44 per DGE, which was calculated based on the total DGEs purchased and the total cost of fuel purchased during the period (see Appendix 2).

To compare the cost of CNG to that of diesel over the same period, one needs to calculate the amount of diesel fuel the truck would have used to travel the same 27,500 miles. Assuming an average diesel fuel economy of 5.75 miles per gallon[1], this translates to 4,796 gallons of diesel. Using the average cost of California ultra-low sulfur diesel (ULSD) fuel over the past two years of $3.27 per gallon[2], these 4,796 gallons of ULSD would have cost $15,395. Table 2 below shows these calculations and shows that the diesel drayage truck would have spent approximately $2,085 more on fuel than the CNG drayage truck, a 13% increase.

Table 2 – CNG Truck Cumulative Data Results

CNG Port Truck - Cumulative Results	
Total Program Distance Driven (miles)	27,577
Total CNG Fuel Used (DGE)	5,579
Average CNG Fuel Economy (mi/DGE)	4.94
Average Cost of CNG ($/DGE)	$ 2.44
Total Cost of CNG Fuel	**$ 13,598**
Equivalent diesel used in a diesel drayage truck (DGE)	**4,796**
Cost of Equivalent Diesel (@ $3.27 / DGE)	**$ 15,683**
CNG cost vs. Diesel	**$ (2,085)**
Percentage Reduction	**13.29%**

This fuel cost savings associated with the CNG fuel use was relatively modest because CCC was forced to purchase its CNG strictly from retail fueling infrastructure located near its Wilmington yard. The original plan for the CNG drayage truck program included Southern California Gas Company installing a small CNG fuel station at the CCC yard with project financial support in the amount of $421,000 from the SCAQMD. Unfortunately, during the project execution, the Port of Los Angeles denied the project's permit request for the station due to concerns about the future use of CCC's Wilmington yard. The SCAQMD funding was contingent upon permit approval from POLA, so the final contract for the funds was never able to be executed.

[1] Based on estimates from CCC management about diesel drayage truck fuel economy, which tends to be in the range of 5.5 to 6.0 miles per gallon.

[2] http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_dcus_sca_a.htm

CCC Private CNG Station

If CCC had been able to take advantage of its own fueling infrastructure, it would have had significantly lower fuel costs for the project vehicles during the past year. Private party CNG stations are able to take advantage of low delivered prices for pipeline natural gas and the federal excise tax credit for CNG of $0.50 per gasoline gallon equivalent (GGE) or approximately $0.57 per DGE.

Table 3 below shows the breakdown of CNG costs for a private CNG station owner. The delivered commodity natural gas has averaged approximately $1.01 per DGE over the past two years (to match the average diesel price time horizon used above) based on Southern California utility gas rates. Assuming a capital recovery cost of $0.20 per DGE, compression cost of $0.62 per DGE for station maintenance and electricity, and State Use & Federal Excise taxes of approximately $0.37 per DGE, the total cost of CNG before the federal tax credit is approximately $2.20 per DGE. After accounting for the federal tax credit, the realized cost of CNG could have been as low as $1.63 per DGE at CCC's proposed private fuel station.

Table 3 – Private Station CNG Cost Breakdown

Private Station CNG Cost		
	Units	**Price**
Commodity Natural Gas	$/DGE	$ 1.01
Capital Recovery	$/DGE	$ 0.20
Compression (electricity & maintenance)	$/DGE	$ 0.62
State & Federal Taxes	$/DGE	$ 0.37
Sub-Total	$/DGE	$ 2.20
Federal Tax Credit	$/DGE	$ (0.57)
Total Fuel Cost	**$/DGE**	**$ 1.63**

While the proposed CNG station at CCC would not have had to bear any capital cost for equipment because it was going to be paid for by grant funds and contributions from the project partners, a typical private fuel station would have to account for the cost of its capital investment. To maintain an "apples-to-apples" comparison in this analysis against diesel, we have included this capital recovery cost. The assumptions for capital recovery and compression costs are typical of other small to medium-sized private CNG stations.

Using the private station CNG cost of $1.63 and the total amount of CNG used from Table 2 above, the fuel for the CNG port truck would have only cost $9,261 over the first 12 months of operation. ***This cost would have been roughly $6,400 less than the equivalent diesel fuel or 42% less costly.*** Table 4 below shows the costs comparison.

Table 4 – Private Station CNG costs vs. diesel fuel

Private Station CNG vs. Diesel Cost Comparison	
Total Cost of CNG Fuel (@ $1.63 / DGE)	$ 9,094
Total Cost of Diesel (@ $3.27 / DGE)	$ 15,683
Fuel cost reduction with CNG	**$ 6,589**
Percentage Reduction	**42.0%**

Driver Satisfaction Results

Aside from measuring truck performance under the CNG drayage truck program, the management team also wanted to assess the opinions of the drivers using these vehicles regularly. The original test plan called for a driver evaluation log to be filled out by the various drivers that used the truck during the first six months the trucks were in operation. In addition to the evaluation log, Gladstein, Neandross & Associates (GNA) also had one of its staff members monitor the experience using the vehicle, including a ride-along on an inland route to gauge driver experience with the vehicle.

Table 5 below shows the results of the driver satisfaction survey. While the log results don't show an enormous variation in driver opinion, there are two very specific instances where a driver noticed a significant performance problem with the vehicle and recorded that in the log. Not surprisingly, those poor performance events both correlated directly with maintenance issues that required dealer repairs. These repairs and dates are detailed further in the next section and in Table 5 below.

Table 5 – Driver Evaluation Log Results

Name of Driver	Date of Survey	Vehicle Number	Pulling Power*	Handling	In Cab Visibility	Ride Comfort	In Cab Ergonomics	Braking	Noise Level	Overall Rating	Additional Comments
JJ	6-Feb	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	13-Feb	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	20-Feb	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	27-Feb	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	6-Mar	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	13-Mar	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	20-Mar	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	27-Mar	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JJ	3-Apr	7792	ok	ok	ok	ok	ok	ok	ok	ok	
LH	19-May	7792	**bad**	ok	ok	ok	ok	ok	ok	**poor**	***can't pull hills - no power***
LH	20-May	7792	ok	ok	ok	ok	ok	ok	ok	ok	
LH	4-Jun	7792	ok	ok	ok	ok	ok	ok	ok	ok	
LH	9-Jun	7792	ok	ok	ok	ok	ok	ok	ok	ok	
LH	2-Jul	7792	**bad**	ok	ok	ok	ok	ok	ok	**poor**	**can't pull hills - no power**
LH	9-Jul	7792	ok	ok	ok	ok	ok	ok	ok	ok	
JL	14-Jul	7792	ok	ok	ok	ok	ok	ok	ok	ok	

In regular discussions with the CCC management staff and various conversations with all of the CCC drivers, it is clear that the drivers generally like the CNG drayage vehicles and particularly favor the visibility provided in the Autocar cab design.

The drivers did complain that the vehicle seems to require more maintenance than they would have expected in a new CNG or diesel vehicle, even if that maintenance was mostly covered under the vehicle warranty. These additional maintenance events still take the vehicle out of

service and force CCC management and drivers to use alternative means to run their daily operations.

Maintenance Costs

As expected when developing the original test plan for the CNG drayage trucks, the maintenance costs during the first year were minimal because there was very little required maintenance and most unforeseen maintenance was covered under the vehicle's warranty. In addition, the truck is covered under a regular maintenance plan from South Bay Truck Center. This is a maintenance plan that South Bay offers for all diesel and natural gas drayage trucks to operators that want to purchase coverage for all original equipment manufacturer (OEM) required regular maintenance (i.e., oil changes, spark plugs, etc.) on new vehicles.

Table 6 below shows a listing of all maintenance issues handled by South Bay on the CNG truck during its first year of operation. As the table shows, there were a number of required maintenance actions, but nearly all of them were covered under the Autocar OEM warranty. Only the last item on January 28, 2010 was not covered under warranty and it totaled $1,136.81.

Table 6 – First Year Maintenance Issues/Costs

First Year Maintenance Issues - Truck 7792		
Date	**Description**	**Total Cost**
5/22/2009	Replace Delta P sensor, humidity sensor	warranty
6/23/2009	Brake adjustment on all axles	warranty
7/2/2009	Recall calibration on O2 and knock sensor	warranty
7/2/2009	Replace all sparkplugs	warranty
7/2/2009	Replace instrument cluster light bar, wipers, repaired A/C switch	warranty
12/17/2009	Recall on turbine sensor	warranty
12/17/2009	Replaced fuel pressure regulator	warranty
1/28/2010	Replace accelerator pedal harness, interior lighting relays, re-sealed windshields	**$1,136.81**

Conclusions

Overall, the CNG drayage truck program has been a success as it has demonstrated that CNG can be used in Class 8 drayage trucks in daily port operations. CCC has been running the CNG Autocar trucks for over one year now and has plans to continue operating them for at least the next two years. Truck No. 7792 is now a permanent member of the CCC fleet as the 12-month lease is now complete and ownership has been transferred to CCC. Ownership and disposition of the remaining three vehicles will be decided at the end of the test program between all the project parties.

Unfortunately, the CCC financial experience with the CNG trucks has been mixed because it has been forced to strictly utilize more expensive retail infrastructure to fuel the four CNG trucks.

The original scope of work included Southern California Gas Company installing a small CNG fuel station at the CCC yard. While the necessary funding and design plans were in place, the project never received permit approval from the POLA to install the station. Even after the project team committed its willingness to remove the CNG station at no charge to the port under any future circumstances, POLA management would still not give approval for the station construction permit. Since the CCC trucks could only use retail infrastructure, CCC paid prices that were higher than LNG and approached the cost of diesel.

If the CCC private fuel station had been approved, the CNG truck could have saved significantly more than the 13% that it realized over diesel fuel. If CCC had been able to take advantage of very low cost CNG at its own private station, including the federal tax credit on CNG, it could have realized a 42% reduction in fuel cost compared to diesel trucks.

CCC believes that the original intent of this trial was to test CNG as a heavy-duty transportation fuel. At that level, CCC believes the trial (and fuel) was a success. CCC stated that the performance of the CNG trucks equaled that of LNG and was comparable to diesel. As a result of the trial, CCC feels CNG is a viable alternative to both diesel and LNG.

CCC also commented that during the trial period, its drivers experienced excessive down time for mechanical problems on these demonstration trucks, but none of the down time was related to the fuel or fuel system. All the issues were mechanical and related to other system parts and accessories on the trucks. CCC still believes that natural gas is a very viable alternative fuel in this region whether CNG or LNG. CNG has advantages in cost and is easier to build out infrastructure. LNG has the advantage of being currently in the port infrastructure and supporting the existing fleet. CCC would be comfortable buying CNG trucks in the future given the right fueling infrastructure availability.

Appendix 1 – Original Truck Test Plan

The vehicle test plan will be a comprehensive data collection effort to ensure that, after the project is completed, quantitative information is available on the fuel economy, operating hours, fuel costs, driver satisfaction, and maintenance costs of the TAP-funded CNG truck in California Cartage Company's (CCC) daily port drayage operations. The CNG truck will run in this operation for a minimum of 12 months and data will be collected for a minimum of six months.

The test plan includes two parts, the vehicle usage methodology and the actual data collection methodology.

Vehicle Usage Methodology

In order to understand how the CNG truck performs over various duty cycles, the truck must be run in a variety of different ways that allow specific data collection on those cycles.

Duty Cycles

The two most common duty-cycles for CCC drayage trucks are the local "landbridge" routes between the docks and the California Cartage yard (in Wilmington, CA) and longer delivery routes in to the Inland Empire (e.g., Ontario). The mix of landbridge and inland routes are highly dependent on CCC's daily contracts. CCC only handles a small portion of the inland routes in its company-owned trucks because most of those routes are handled by contract drivers. Given that the project would like to document how the CNG truck performs under local stop-and-go type operation and more steady-state, higher speed operation, testing the truck over those two common CCC duty-cycles should produce that information.

Data Collection Methodology

These are the actual methods the project will use to collect the data on the CNG truck during the testing period.

Fuel Economy, Fuel Costs and Operating Hours

One of the common questions about a project like this is what the fuel economy of the CNG truck is in comparison to a diesel counterpart. While CCC does not use any comparable new diesel trucks in its operation (it only maintains several older, high-power diesels for overweight projects), it will be possible to convert the fuel economy measurements from the CNG truck to a diesel gallon equivalent (DGE) basis. This conversion will allow a direct comparison to standard diesel fuel economy.

To obtain this data, the project will keep a comprehensive fueling log (See Appendix 2) for the CNG truck. This log will include entries for all fueling events, as well as the number of engine operating hours and vehicle odometer readings. Exhibit 1 shows the format for the fuel log that will be used at each fueling event.

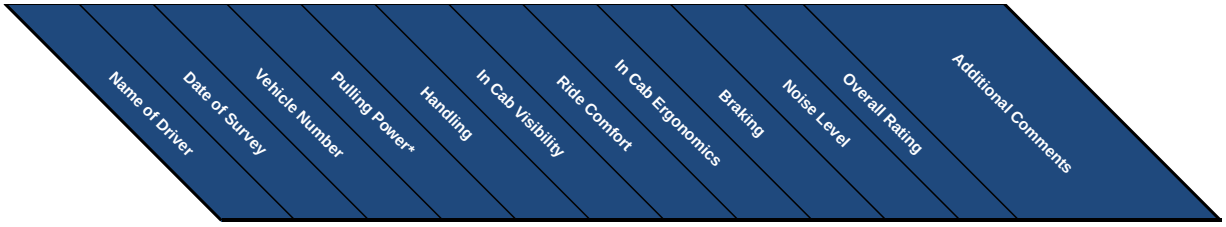
Exhibit 1 – Fuel Log Entry Form

Date	Vehicle Number	Time	Driver (initials)	Hour Meter Reading (hr)	Vehicle Odometer Reading (mi)	Amount of Fuel Purchased (GGE or Diesel Gallons)	Cost of Fuel Purchased ($)	Comments

Driver Satisfaction

One of the keys measurements necessary in this test plan will be driver satisfaction. While the CNG truck will have a primary driver/operator, several CCC drivers will have the opportunity to drive the CNG truck and assess their satisfaction with it. Exhibit 2 shows the format for the driver evaluation log that will be used during the data collection process. The truck drivers will need to complete a driver evaluation form roughly once per month during the first six months of the program.

Exhibit 2 – Driver Evaluation Form



Maintenance Costs

While the maintenance costs on the CNG truck should be minimal during the first year of operation because of the manufacturer's warranty, CCC will still have to perform regular maintenance (e.g., oil changes) on the CNG truck. CCC generally handles these maintenance costs directly with the service center (South Bay Truck Center in this case), GNA will collect the maintenance records on the CNG truck from CCC accounting directly for publication in the final project report.

Appendix 2 – Data Table

Date	Time	Driver	Hour Meter Reading (hr)	Odometer Reading (mi)	Amount of Fuel Purchased (GGE)	Amount of Fuel Purchased (DGE - calculated)	Fuel Economy (mi/GGE)	Fuel Economy (mi/DGE)	Fuel Cost ($/DGE)	Cost of Fuel Purchased ($)
19-Jan	17:45	JAJ		275						
6-Feb	16:20	JAJ	34.1	361	47.37	41.70	1.82	2.06	1.87	$ 78.12
11-Feb	16:53	JAJ	47.5	512	46.04	40.53	3.28	3.73	1.87	$ 75.93
13-Feb	15:13	JAJ	62.0	674	45.88	40.39	3.53	4.01	1.87	$ 75.66
17-Feb	22:49	JAJ	76.1	870	49.87	43.90	3.92	4.46	2.04	$ 89.73
24-Feb	20:07	JAJ	89.5	1,041	44.38	39.07	3.87	4.39	2.04	$ 79.84
26-Feb	21:54	JAJ	103.0	1,226	50.00	44.02	3.70	4.20	2.04	$ 89.96
2-Mar	10:07	GGR	115.9	1,406	46.60	41.02	3.85	4.37	2.04	$ 83.83
3-Mar	20:21	JAJ	131.1	1,596	51.06	44.95	3.74	4.24	2.04	$ 91.86
4-Mar	22:10	JAJ	142.5	1,747	42.26	37.20	3.58	4.06	2.04	$ 76.04
7-Mar	10:40	JAJ	155.7	1,915	42.26	37.20	3.96	4.50	2.30	$ 85.72
10-Mar	20:36	JAJ	167.8	2,073	44.21	38.92	3.57	4.06	2.04	$ 79.55
12-Mar	21:00	JAJ	178.5	2,215	42.67	37.56	3.34	3.79	2.04	$ 76.78
13-Mar	14:00	JAJ	187.2	2,352	35.49	31.24	3.85	4.37	2.04	$ 63.86
18-Mar	13:28	JAJ	198.5	2,499	42.76	37.64	3.44	3.91	2.04	$ 76.93
20-Mar	12:52	JAJ	209.6	2,666	42.93	37.79	3.88	4.41	2.04	$ 77.24
23-Mar	21:02	JAJ	219.4	2,798	38.40	33.80	3.46	3.93	2.04	$ 69.09
25-Mar	23:06	JAJ	229.2	2,940	40.68	35.81	3.49	3.96	2.04	$ 73.20
27-Mar	16:04	JAJ	239.0	3,095	41.16	36.23	3.75	4.26	2.04	$ 74.05
1-Apr	0:32	JAJ	252.3	3,271	58.4	51.41	3.01	3.42	1.76	$ 90.68
2-Apr	15:27	JAJ	265.1	3,450	48.90	43.05	3.66	4.16	2.04	$ 87.97
4-Apr	11:29	JAJ	275.3	3,580	35.69	31.42	3.65	4.15	2.04	$ 64.22
8-Apr	17:53	JAJ	284.7	3,751	43.09	37.93	3.97	4.51	2.04	$ 77.52
8-Apr	22:07	JAJ	287.4	3,797	14.97	13.18	3.05	3.46	2.04	$ 26.94
10-Apr	0:00	JAJ	296.5	3,962	42.52	37.43	3.88	4.40	2.04	$ 76.49
13-Apr	16:15	JML	307.8	4,133	42.89	37.76	4.00	4.54	2.04	77.16
20-Apr	21:25	JML	335.7	4,520	42.00	36.97			2.04	$ 75.57
23-Apr	22:00	JML	350.7	4,723	59.07	52.00	3.43	3.89	2.04	$ 106.27
27-Apr	22:30	JML	361.5	4,899	46.8	41.17	3.76	4.27	2.04	$ 84.15
30-Apr	6:10	LH	372.8	5,033	38.11	33.55	3.53	4.01	2.04	$ 68.56
30-Apr	21:00	JML	391.4	5,237	50.68	44.61	4.03	4.58	2.04	$ 91.18
4-May	3:30	JML	405.1	5,421	34.48	30.35	5.32	6.05	2.04	$ 62.03
8-May	3:30	JML	438.4	5,894	107.09	94.27	4.42	5.02	0.62	$ 58.44
12-May	7:00	LH	450.2	6,072	36.12	31.80	4.94	5.61	2.04	$ 64.99
14-May	6:00	LH	469.4	6,356	69.55	61.22	4.07	4.63	2.04	$ 125.12
18-May	10:00	JML	483.5	6,518	39.69	34.94	4.10	4.65	2.16	75.38
19-May	1:15	JML	496.0	6,727	49.77	43.81	4.19	4.75	2.16	$ 94.52
19-May	12:00	LH	503.0	6,836	30.88	27.18	3.55	4.03	2.16	$ 58.64
20-May	19:00	LJ	512.5	7,071	50.29	44.27	4.68	5.31	2.16	$ 95.51
21-May	8:30	JML	518.1	7,223	36.37	32.02	4.17	4.73	2.16	$ 69.07
28-May	1:24	JML	531.3	7,417	45.2	39.78	4.28	4.86	2.27	$ 90.34
29-May	5:00	JML	537.3	7,509	24.1	21.17	3.85	4.37	2.27	$ 48.09
1-Jun	9:00	LH	542.6	7,652	31.2	27.44	4.59	5.21	2.27	$ 62.30
2-Jun	10:00	LH	549.0	7,805	31.9	28.04	4.80	5.46	2.27	$ 63.67
2-Jun	11:30	JML	557.1	7,920	31.2	27.49	3.68	4.18	2.27	$ 62.43
3-Jun	9:00	LH	562.0	8,054	30.2	26.54	4.44	5.05	2.27	$ 60.27
3-Jun	10:30	JML	569.2	8,164	26.4	23.25	4.17	4.73	2.27	$ 52.80
4-Jun	9:30	LH	574.1	8,304	30.2	26.56	4.64	5.27	2.27	$ 60.31
4-Jun	9:40	JML	580.7	8,390	20.9	18.42	4.11	4.67	2.27	$ 41.86
8-Jun	10:30	LH	593.1	8,695	37.0	32.54			2.43	$ 79.06
8-Jun	9:15	JML	601.8	8,898	39.22	34.53	5.19	5.89	2.43	$ 83.89
9-Jun	5:45	LH	605.7	8,961	22.04	19.40	2.84	3.23	2.43	$ 47.13
9-Jun	12:00	LH	609.6	9,099	32.27	28.41	4.28	4.86	2.43	$ 69.03

Date	Time	Driver	Hour Meter Reading (hr)	Odometer Reading (mi)	Amount of Fuel Purchased (GGE)	Amount of Fuel Purchased (DGE - calculated)	Fuel Economy (mi/GGE)	Fuel Economy (mi/DGE)	Fuel Cost ($/DGE)	Cost of Fuel Purchased ($)
9-Jun	11:30	JML	615.3	9,185	23.70	20.86	3.62	4.12	2.43	$ 50.70
10-Jun	9:30	JML	637.0	9,658	101.16	89.05	4.67	5.31	1.27	$ 113.32
12-Jun	5:00	JML	646.0	9,852	42.34	37.27	4.59	5.22	2.43	$ 90.58
12-Jun	13:00	LH	652.6	9,919	21.52	18.95	3.07	3.49	2.43	$ 46.04
16-Jun	12:00	LH	660.4	9,980	19.07	16.79	3.23	3.67	2.43	$ 40.79
16-Jun	1:00	JML	669.4	10,110	31.62	27.84	4.10	4.66	2.43	$ 67.65
17-Jun	10:00	LH	674.6	10,255	31.44	27.68	4.62	5.25	2.43	$ 67.25
17-Jun	11:30	JML	682.4	10,398	22.80	20.07	6.27	7.12	2.43	$ 48.79
18-Jun	7:02	LH	687.2	10,494	33.07	29.11	2.89	3.28	2.43	$ 70.73
19-Jun	10:40	JML	695.0	10,591	25.33	22.30	3.83	4.35	2.43	$ 54.19
20-Jun	3:45	JML	705.0	10,799	42.21	37.16	4.93	5.61	2.43	$ 90.30
22-Jun	10:00	LH	710.5	10,943	35.18	30.97	4.10	4.66	2.43	$ 75.26
12-Jun	2:45	JML	716.4	11,039	24.61	21.66	3.90	4.43	2.61	$ 56.59
23-Jun	9:30	LH	721.1	11,179	29.43	25.91	4.76	5.40	2.61	$ 67.66
26-Jun	1:00	JML	730.8	11,380	21.17	18.64	9.48	10.77	2.61	$ 48.69
26-Jun	14:30	LH	735.5	11,428	18.32	16.13	2.62	2.98	2.61	$ 42.12
27-Jun	3:30	JML	743.3	11,560	26.82	23.61	4.92	5.59	2.61	$ 61.68
29-Jun	9::00	LH	748.6	11,706	31.85	28.04	4.58	5.21	2.60	$ 72.99
29-Jun	14:45	LH	752.5	11,785	20.91	18.41	3.78	4.29	2.61	$ 48.08
30-Jun	1:00	JML	759.4	11,887	25.01	22.02	4.08	4.63	2.61	$ 57.50
30-Jun	11:00	LH	764.8	12,026	30.87	27.17	4.50	5.12	2.61	$ 70.97
1-Jul	1:00	JML	771.6	12,140	29.17	25.68	3.91	4.44	2.61	$ 67.08
2-Jul	6:30	LH	779.9	12,328	40.05	35.26	4.69	5.33	2.61	$ 92.08
8-Jul	23:50	LH	785.0	12,385	20.75	18.27	2.75	3.12	2.61	$ 47.71
9-Jul	2:20	JML	792.8	12,473	24.29	21.38	3.62	4.12	2.61	$ 55.73
9-Jul	9:00	LH	798.1	12,613	21.78	19.18	6.43	7.30	2.61	$ 50.08
9-Jul	15:30	LH	801.8	12,661	22.61	19.91	2.12	2.41	2.61	$ 51.99
10-Jul	11:30	LH	808.9	12,827	35.33	31.10	4.70	5.34	2.61	$ 81.22
13-Jul	10:00	LH	816.4	12,998	32.28	28.41	5.30	6.02	2.61	$ 74.20
15-Jul	2:00	JML	826.3	13,178	38.76	34.12	4.64	5.28	2.61	$ 89.13
15-Jul	10:30	LH	832.4	13,272	27.30	24.04	3.44	3.91	2.61	$ 62.77
16-Jul	14:00	LH	838.8	13,346	20.45	18.00	3.62	4.11	2.61	$ 47.02
16-Jul	23:30	JML	845.7	13,441	29.69	26.14	3.20	3.63	2.61	$ 68.26
20-Jul	11:00	LH	856.0	13,638	35.61	31.35	5.53	6.28	2.61	$ 81.87
21-Jul	12:00	LH	862.3	13,719	24.43	21.50	3.32	3.77	2.61	$ 56.16
22-Jul	0:40	JML	869.9	13,817	25.94	22.84	3.78	4.29	2.61	$ 59.65
6-Aug	12:09	JML	989.6	15,879	21.09	18.57			2.73	$ 50.61
7-Aug	15:00	LH	992.8	16,068	39.70	34.95	4.74	5.39	2.73	$ 95.24
10-Aug	8:30	LH	1,001.6	16,253	43.23	38.05	4.28	4.86	2.73	$ 103.71
11-Aug	1:00	JML	1,010.8	16,380	34.6	30.46	3.69	4.19	2.73	$ 83.03
11-Aug	8:00	LH	1,015.8	16,537	37.66	33.15	4.17	4.74	2.73	$ 90.35
12-Aug	0:00	JML	1,023.7	16,645	27.16	23.91	3.97	4.51	2.73	$ 65.17
12-Aug	9:00	LH	1,030.0	16,806	30.83	27.14	5.23	5.94	2.73	$ 73.95
13-Aug	1:00	JML	1,039.9	16,958	36.02	31.71	4.21	4.79	2.73	$ 86.42
13-Aug	8:00	LH	1,044.4	17,101	29.11	25.62	4.92	5.59	2.73	$ 69.82
13-Aug	23:00	JML	1,047.8	17,150	15.27	13.44	3.16	3.59	2.73	$ 36.64
14-Aug	9:00	LH	1,053.4	17,308	29.52	25.99	5.38	6.11	2.73	$ 70.82
15-Aug	15:00	JML	1,062.4	17,413	24.39	21.47	4.29	4.87	2.73	$ 58.53
17-Aug	23:00	JML	1,073.9	17,650	54.68	48.14	4.33	4.92	2.73	$ 131.21
18-Aug	8:30	LH	1,080.2	17,804	34.53	30.40	4.47	5.07	2.73	$ 82.85
18-Aug	23:00	JML	1,086.2	17,877	12.18	10.72	6.03	6.85	2.73	$ 29.22
19-Aug	8:00	LH	1,091.4	18,025	33.21	29.24	4.44	5.05	2.73	$ 79.67
2-Sep	1:40	JML	1,107.5	18,276	24.15	21.26	10.39	11.81	2.84	$ 60.38
3-Sep	0:00	JML	1,112.9	18,354	43.47	38.27	1.79	2.03	2.85	$ 108.91
3-Sep	15:30	LH	1,118.4	18,428	22.08	19.44	3.37	3.82	2.84	$ 55.17
8-Sep	11:30	JML	1,127.7	18,530	29.15	25.66	3.51	3.98	2.84	$ 72.85
9-Sep	0:00	JML	1,136.2	18,673	29.28	25.78	4.87	5.54	2.84	$ 73.17
11-Sep	1:00	JML	1,150.4	18,877	43.89	38.64	4.65	5.28	2.84	$ 109.68

Date	Time	Driver	Hour Meter Reading (hr)	Odometer Reading (mi)	Amount of Fuel Purchased (GGE)	Amount of Fuel Purchased (DGE - calculated)	Fuel Economy (mi/GGE)	Fuel Economy (mi/DGE)	Fuel Cost ($/DGE)	Cost of Fuel Purchased ($)
15-Sep	0:00	JML	1,166.0	19,084	48.68	42.85	2.99	3.40	2.37	$ 101.66
17-Sep	0:00	JML	1,179.6	19,282	47.13	41.49	4.21	4.79	2.84	$ 117.78
24-Sep	0:30	JML	1,199.6	19,480	51.70	45.51	3.82	4.34	2.84	$ 129.26
25-Sep	17:00	JML	1,210.1	19,677	50.43	44.39	3.91	4.44	2.84	$ 126.09
28-Sep	19:00	JML	1,220.0	19,887	57.30	50.44	3.66	4.16	2.84	$ 143.21
30-Sep	2:00	JML	1,233.5	20,108	51.52	45.35	4.29	4.87	2.84	$ 128.76
2-Oct	16:00	JML	1,251.6	20,359	59.16	52.08	4.24	4.82	2.84	$ 147.86
5-Oct	1:00	JML	1,263.3	20,542	51.18	45.05	3.58	4.06	2.84	$ 127.90
6-Oct	21:00	JML	1,274.7	20,764	20.46	18.01	10.85	12.33	2.81	$ 50.59
7-Oct	9:00	LG	1,277.0	20,813	45.25	39.83	1.08	1.23	2.84	$ 113.10
7-Oct	22:00	JML	1,284.3	20,998	28.00	24.65	6.61	7.51	2.84	$ 69.99
9-Oct	16:00	JML	1,296.8	21,177	49.34	43.43	3.63	4.12	2.85	$ 123.63
11-Oct	23:00	JML	1,307.2	21,343	51.57	45.40	3.22	3.66	2.84	$ 128.89
13-Oct	23:00	JML	1,319.6	21,487	32.35	28.48	4.45	5.06	3.12	$ 88.87
15-Oct	0:00	JML	1,328.0	21,673	46.13	40.61	4.03	4.58	2.84	$ 115.29
19-Oct	22:00	JML	1,337.8	21,814	41.96	36.94	3.36	3.82	2.84	$ 104.88
21-Oct	21:00	JML	1,351.1	22,033	48.99	43.13	4.47	5.08	2.84	$ 122.41
24-Oct	14:00	JML	1,369.4	22,276	62.23	54.78	3.90	4.44	2.84	$ 155.53
28-Oct	1:00	JML	1,379.8	22,439	41.35	36.40	3.94	4.48	2.84	$ 103.33
3-Nov	23:00	JML	1,393.3	22,642	51.52	45.35	3.94	4.48	2.84	$ 128.76
18-Nov	19:00	JML	1,411.3	22,910	65.39	57.56	4.10	4.66	2.89	$ 166.32
21-Nov	13:00	JML	1,424.0	23,120	50.74	44.67	4.14	4.70	2.84	$ 126.80
24-Nov	23:00	JML	1,438.3	23,330	51.57	45.40	4.07	4.63	2.84	$ 128.89
2-Dec	2:00	JML	1,451.0	23,522	49.35	43.44	3.89	4.42	2.84	$ 123.34
4-Dec	13:00	JML	1,466.8	23,814	65.00	57.22	4.49	5.10	2.84	$ 162.45
8-Dec	1:30	JML	1,474.6	24,019	25.50	22.45	8.04	9.13	2.84	$ 63.74
10-Dec	20:00	JML	1,489.0	24,144	61.32	53.98	2.04	2.32	2.84	$ 153.25
12-Dec	14:00	JML	1,501.8	24,306	48.08	42.33	3.37	3.83	2.84	$ 120.16
28-Dec	14:00	LH	1,513.2	24,469	41.44	36.48	3.93	4.47	2.84	$ 103.56
29-Dec	8:30	LH	1,522.2	24,617	38.32	33.73	3.86	4.39	2.84	$ 95.77
30-Dec	7:00	LH	1,533.2	24,800	44.43	39.11	4.12	4.68	2.84	$ 111.03
4-Jan	18:00	JML	1,549.3	25,055						
5-Jan	16:00	LG	1,559.0	25,252	48.74	42.91	4.03	4.58	2.84	$ 121.80
6-Jan	10:00	LG	1,567.2	25,399	38.21	33.63	3.85	4.37	2.84	$ 95.48
7-Jan	22:00	JML	1,584.7	25,714	63.29	55.71	4.98	5.65	2.84	$ 158.09
11-Jan	21:00	JML	1,601.2	25,985	63.58	55.97	4.26	4.84	2.84	$ 158.91
13-Jan	1:00	JML	1,610.5	26,168	47.88	42.15	3.82	4.34	2.84	$ 119.65
15-Jan	10:00	LG	1,622.0	26,359	65.00	57.22	2.94	3.34	2.84	$ 162.44
19-Jan	9:00	LG	1,639.4	26,664	59.85	52.69	5.10	5.79	2.84	$ 149.57
19-Jan	23:00	JML	1,648.5	26,781	37.19	32.74	3.15	3.57	2.84	$ 92.82
21-Jan	1:00	JML	1,662.0	26,953	23.06	20.30	7.46	8.47	2.84	$ 57.64
21-Jan	16:18	LG	1,668.4	27,023	67.42	59.35	3.59	4.08	2.84	$ 168.52
23-Jan	14:00	JML	1,686.2	27,236	59.21	52.12	3.60	4.09	2.84	$ 148.00
26-Jan	1:30	JML	1,698.9	27,406	42.95	37.81	3.96	4.50	2.84	$ 107.34
26-Jan	21:00	JML	1,709.9	27,577	41.07	36.15	4.16	4.73	2.84	$ 102.66

Note: the handful of blank cells in the total dataset above occurred when individual fueling events were not recorded properly in the truck's fuel log. These minor deviations do not have a material impact on the overall results.

Definitions: Gasoline gallon equivalent (GGE) – 114,000 BTU/gal
Diesel gallon equivalent (DGE) – 129,500 BTU/gal

>> Conversion DGE/GGE = 129,500/114,000 = 1.14