



Michael Roeth
Executive Director, North American Council for Freight Efficiency (NACFE)
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Daniel Burrows
Founder & CEO, XStream Trucking Inc.
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Redwood City, CA 94063

Dear Daniel:

June 14, 2016

Thank you for allowing us to support the fuel economy test that we conducted jointly with your company and Hobby Lobby. The North American Council for Freight Efficiency is working to fulfill our mission to help double the efficiency of North American goods movement, and this project allowed us to get closer to our goal by helping XStream Trucking with the development and validation of its freight efficiency technology.

The following report was written in our role as an independent third party organization witnessing and validating the processes used to ensure an unbiased test of XStream's tractor trailer gap-closing system. The combined team of XStream engineers, technicians from Hobby Lobby, and a NACFE representative conducted the tests during the week of May 9th, 2016, which demonstrated an average fuel savings of 2.5% across five paired runs.

Please contact Dave Schaller or me to discuss any details of the report or to answer any questions. Thank you for engaging us -- we look forward to supporting additional projects in the future that help both of our organizations realize our goals.

Sincerely,

Michael Roeth, Executive Director
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cc: David Schaller, NACFE Industry Engagement Manager

Summary

The North American Council for Freight Efficiency (NACFE) was engaged to assist in the planning, witnessing of the test execution and validation of a test of the XStream GapGorilla system. NACFE, specifically Dave Schaller, Industry Engagement Manager, joined XStream at Hobby Lobby's headquarters in Oklahoma City for these tests. The responsibility of the NACFE was to confirm that the test was run to the prescribed protocol and that the results are accurate for the fuel performance of the technology. The following report discusses the scope of the test, the test protocol, how the team executed the protocol and the results achieved from the testing. The test was conducted per the identified protocol and the results are shown in this report, and demonstrated a 2.5% savings in fuel over five runs.

XStream GapGorilla

The GapGorilla system was created to close the gap between the back of a highway tractor and the front edge of a trailer. The system is comprised of side extenders that reach from the existing OEM extenders to the front side edges of the trailer. A top portion lifts up and closes the gap from the top rear edge of the sleeper to the front edge of the top of the trailer. Additionally, a plastic floor replaces the deck plates above the frame rails behind the cab and covers the area from rear of the sleeper to the lower front edge of the trailer and all the way between the tractor chassis skirts on both sides of the tractor. In essence, the system nearly blocks out air flow in all directions between the tractor and trailer. The system automatically deploys at highway speeds, and automatically stows as the speed drops down from highway speeds.



System stowed w/floor & blue fuel tank



System deployed

Test Protocol

Hobby Lobby provided the tractor, trailer, drivers, facilities and fuel for the testing. Its personnel did not otherwise actively participate in the test runs, other than the presence of its drivers. Only one truck was available to conduct these tests planned for real world conditions on public roadways. The format for these tests was agreed to considering the Type II test procedures of TMC RP 1102A and SAE J1321 as well as Type IV test procedures of TMC RP 1109 with some notable exceptions:

1. Only one tractor with one trailer was utilized. The deployed tests were run with system in full deployment to close the tractor-to-trailer gap when at highway speeds. The comparison runs were made with the system stowed, the plastic floor removed except for the aluminum frames that supported the floor and the floor section immediately under the 20-gallon test tank. The top section of the GapGorilla behind the upper rear edge of the sleeper roof was also removed for the un-deployed tests. Comparisons to a completely stock tractor would not have been feasible due to time constraints to add and remove the full system between test pairs.
2. Two different drivers were utilized, but only on separate days. All compared runs were done on the same day with the same driver over the same routes at the same cruise set speeds and the automated manual transmission in full automatic mode.
3. No load was placed in the trailer.

The fuel lines were removed from a main fuel tank and extended back to a 20-gallon tank that was secured on the GapGorilla floor above the frame rails, behind the sleeper, and between the GapGorilla extenders while in the stowed position.

The tractor was a Volvo 77" Tall Roof sleeper XE (Exceptional Efficiency package) equipped with a D13 engine. It had an iShift automated manual transmission, so shifting was consistent over the same course. The trailer was a 53-foot dry van trailer manufactured by Utility and it was equipped with trailer skirts. Traffic issues were very minimal over the course of the tests due to careful course selection.

The test process was as follows:

1. Roughly 40-mile warm-up trip from Hobby Lobby shop to starting point.
2. Once at the starting point, the test fuel tank was disconnected via quick connect fittings. The test tank was filled near to its top from diesel fuel fill containers.
3. Weigh reference weight. Weigh tank & record (along with odometer and climate info). Weigh reference weight. If the reference weight did not match prior readings, the process of weighing started over again.
4. Reconnect fuel lines and secure test tank in place.
5. Make modifications as required. To switch to the deployed runs, the floor was added back above the frame rail and secured with nuts. The D shaped surface was added back to the top of the GapGorilla. When going back to the reference configuration, the floor and D surface were removed.
6. Test run was made, with a round trip of 68 miles using cruise control set at 65 MPH. Each trip was just over an hour in length, given the need to exit the interstate and re-enter in the opposite direction.

7. Upon returning to the test coordination point the engine was shutoff immediately.
8. Weigh reference weight. Weigh tank & record (along with odometer and climate info).
Weigh reference weight
9. Each stop to refill, weigh and reconfigure was roughly 30 minutes long.



Test reference weight on scale



Filling the 20-gallon test tank



Installing the GapGorilla floor between runs



Weighing the test tank (no floor on this run)

NACFE Approach to Validation

During the weeks leading up to the tests, NACFE (Mike Roeth & Dave Schaller) agreed to test protocol procedures with XStream and oversaw the preparation for the testing conducted at Hobby Lobby. Dave Schaller attended the testing in Oklahoma City and verified that the procedures used matched the planned methods. Finally, this report is submitted by NACFE to document the results.

Test Schedule

Sunday May 8th, and Monday 9th

The XStream employees installed the components of their GapGorilla system to the back of the sleeper cab of a Volvo tractor owned by Hobby Lobby. A climbing frame was attached to the frame to serve as an installation platform. Part of the team scouted the area's interstates to find a long section that did not have any construction zones or other potential delays.



System installation with ladder rig



Installing actuator with system deployed

Tuesday May 10th

The main actuator was installed along with wiring to the cab to the control system. All systems were tested in the garage before taking the tractor out to the lot and validating functionality. The deploy and stow speeds were lowered in the control software to allow low speed test runs. Additional runs were made to record the system visually.

The tractor was mated to a 53' dry van trailer in preparation for testing. Operations were again checked to insure proper fit of the GapGorilla between the tractor and trailer.

Discussions with the test driver allowed for confirmation of the test route. A 69 mile round trip on interstate 44 was selected starting at the rest area south of Oklahoma City. The test route would take the team back up into Oklahoma City just past the airport to a turnaround at exit 119 and then return back to the rest area.

The last item of the day was to install a separate 20-gallon racing fuel tank on top of the frame rails behind the sleeper the tucked in between the two sides of the GapGorilla in the stowed position. The feed and return lines were removed from the normal tanks and extended to reach the new auxiliary fuel tank.

The team agreed to a tank weighing procedure that would be used before and after every test run.

Wednesday May 11th

On the warm-up drive to the test control point, high cross winds put too much force on the actuator and the control system, causing the system to hit a safety threshold and stow to protect against deploying into a stationary object. The system was reconfigured via a software update to

raise the threshold to a higher value such that the high winds would not falsely trigger the safety threshold. The update successfully enabled the system to stay deployed.

Later, the software also had some issues with noisy speed data from the truck that created a similar effect - to stow the system when that really wasn't necessary. The team opted to bypass the safety software and deploy and stow the system via manual commands for the rest of the day's testing to avoid losing time, and in the evening work on a small software update to fix the issue.

Two complete test runs were made:

- Full run with full system deployed.
- Full run with GapGorilla stowed, D shaped top removed and floor removed.

Data collected at the beginning and end of each run included climatic conditions and vehicle information.

Thursday May 12th

Revised control software was successfully installed which allowed the GapGorilla to automatically deploy and stow.

After reaching the starting point, four complete test runs were made, in an alternating pattern of deployed, un-deployed, deployed, and un-deployed for a total of:

- 2 - Full runs with full system deployed.
- 2 - Full runs with GapGorilla stowed, D shaped top removed and floor removed.

Some photography & video was captured in the Hobby Lobby lots following completion of testing. A forced exhaust regeneration was completed at the end of the day.

Friday May 13th

After reaching the starting point, four complete test runs were made, in an alternating pattern of deployed, un-deployed, deployed, and un-deployed for a total of:

- 2 - Full runs with full system deployed.
- 2 - Full runs with GapGorilla stowed, D shaped top removed and floor removed.

On the third run of the day, a fault code was set by the engine due to an error in fuel line connection to the test tank. The truck returned to the starting point was refueled, reweighed and testing was resumed.

Saturday May 14th

System was removed from the test tractor.

Test Results

As stated above, test fuel tank weights were recorded after each segment, along with information on general test conditions (temperature, wind, etc). The information was tabulated by XStream and NACFE on a clipboard and later entered into a spreadsheet for analysis. NACFE’s Dave Schaller witnessed this data collection. Analysis was completed and the test data summarized as follows:

		Run Set 1	Run Set 2	Run Set 3	Run Set 4	Run Set 5	Total
GapGorilla Deployed	Starting Weight	148.7	128.0	124.9	139.5	125.9	
	D Gap Roof in place						
	Ending Weight	100.0	77.5	74.1	87.5	74.8	
Floor installed	Weight Consumed	48.70	50.50	50.80	52.00	51.05	253.05
GapGorilla Stowed	Starting Weight	147.3	126.4	133.9	137.0	133.1	
	D Gap Roof removed						
	Ending Weight	96.5	74.6	82.5	84.0	80.6	
Floor removed	Weight Consumed	50.80	51.80	51.40	53.00	52.50	259.50
Difference In Fuel Weight Consumed:		2.10	1.30	0.60	1.00	1.45	6.45
Percentage Improvement When Deployed:		4.13%	2.51%	1.17%	1.89%	2.76%	2.49%
All weights are in pounds of diesel fuel							
All comparison runs performed on the same route at the same cruise set speed by the same driver on the same day within 30 minutes of preceding run							

The median decrease in fuel consumed for the five pairs of runs was 2.51%, while the average (or combined) decrease of the five runs was 2.49%. The coefficient of variation for the five pairs of runs was a relatively high 44% as on-highway tests are subject to wind, traffic and other variations that cannot be precisely controlled. Discarding the high and low pairs (4.13% and 1.17%) lowers the variability to 19% and shows an average decrease in fuel consumption of 2.38%.

Dave Schaller confirmed test data collection, and a test analysis meeting was held on Thursday May 26th, between XStream Trucking and NACFE via teleconference.

Conclusion

XStream successfully executed the testing procedures as previously agreed upon with NACFE to estimate the on-highway performance of its gap closing system, comparing five paired runs of a Hobby Lobby tractor-trailer with the fully deployed GapGorilla system with a control (the same tractor-trailer with the GapGorilla stowed and D Gap Roof and floor removed).

Results demonstrated an average decrease in fuel consumption of 2.5% with the GapGorilla system deployed.