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Energotest 2008:

Fuel Consumption Tests for Prototypes of the Freight Wing Trailer Belly Fairing

Contract Report CR-441-14

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Introduction

The objective of the Energotest 2008 project was to conduct controlled test-track studies of solutions for achieving higher fuel efficiency and lower emissions of greenhouse-effect gases (GHG) in the trucking industry.

With access to vehicles from Robert Transport, Transport Hervé Lemieux, Transport Bourassa, SAQ, and SLH Transport, the members of Project Innovation Transport (PIT) selected 12 technologies for testing, including fuel additives, trailer skirts, trailer boat tails, bumpers, tires, and various fuel-saving devices.

Freight Wing was interested in testing their Belly Fairing aerodynamic devices during this program. The objective of these devices is to reduce the aerodynamic drag underneath the vehicle. Freight Wing submitted three different Belly Fairing prototypes for testing.

Test site

The Energotest 2008 project took place from 2 to 12 September 2008 at Transport Canada's Motor Vehicle Test Centre (MVTC) in Blainville (Quebec), which is currently operated by PMG Technologies. The fuel-consumption tests were performed on the high-speed test track (BRAVO). This track is a high-banked, parabolic oval with a length of 6.4 km (4 miles). The length of a test run was 15 laps (almost 100 km), with departure and arrival at the same position along the track. Figure 1 shows the test site.

Figure 1. Aerial view of the Blainville test site.

Test methodology

The test procedure was based on the SAE J1321 Joint TMC/SAE Fuel Consumption Test Procedure - Type II. The fuel-consumption test compared the fuel consumption of a test vehicle, operating under two conditions, with that of an unmodified control vehicle. Fuel consumption was accurately measured by weighing temporary tanks before and after each trip.

The vehicles had the same general configuration and were in good working condition, with all settings adjusted to the manufacturer's specifications. The load weights were representative of fleet operations and remained the same throughout the entire test period.

The test consisted of a baseline stage (using non-modified vehicles) followed by a test stage (using the test vehicle equipped with the technology to be tested):

- **Baseline test**: An initial test was conducted before installing the technology on the test truck. For this test, the control and test trucks completed a minimum of three test runs until the results of a group of three tests were within 2% of each other.
- **Final test**: The same trucks then completed the same trips a second time, the test truck equipped with the technology being tested. The control truck was maintained in its original state. As in the baseline test, the trucks completed the test trips a minimum of three times until the results of a group of three tests were within 2% of each other.

For both the baseline and final trials, the representative results were the ratio between the average fuel consumed by the test truck and the average fuel consumed by the control truck. The result of the complete trial consisted of the percentage difference between the final ratio and baseline ratio. Details of the baseline and final trials are presented in Appendix A[1].

Driving procedure

Each day, before the start of testing, all vehicles were warmed up for the same amount of time at test speeds.

The driver's influence on the results was minimized as much as possible by conducting the tests on a closed circuit and by strictly controlling the driving cycle as follows:

- A fixed idling time was used.
- The drivers started with maximum acceleration.
- A cruising speed of 98 km/h.
- The drivers steered as close as possible to the painted line at the right side of the track, without touching it.
- The drivers maintained a constant driving speed.
- After the established test duration was complete, the driver stopped using the speed regulator at the designated point.

[1] Discrepancies in odometer readings between the vehicles resulted from inaccuracy of these instruments.

- During deceleration, the driver used only the service brakes and did not accelerate.
- Once at the meeting point, the trucks idled for the same duration before stopping the engine.

During the tests, the driving cycle was controlled with a radar gun and drivers received instructions by CB radio. The time interval between two consecutive trucks remained the same in order to avoid the effects of turbulence caused by other trucks and to prevent multiple trucks from being present at the same place and time on the track.

Test vehicles

The control and test vehicles were 2003 Volvo VNL 630 tractors powered by Volvo VED 12 engines, pulling loaded Manac 53-foot Cube Van trailers. Details of the vehicles are given in Table 1.

Table 1. Vehicle data

Parameters	***Vehicles***			
	Control	***Test, Prototype 1***	***Test, Prototype 2***	***Test, Prototype 3***
Tractors				
Vehicle test ID	**R1**	**R2**	**R4**	**R5**
Vehicle fleet ID	**102732**	**102712**	**102740**	**102719**
VIN	4V4NC9GG37N386838	4V4NC9GG17N386823	4V4NC9GG67N386879	4V4NC9GG37N386869
Make and model	Volvo VN 630			
Year	2003			
Engine make and model	VED 12			
Rated power	395 HP			
Peak torque	1550 lb-ft			
Transmission	Mo 16Z12A Meritor ZF	RTLO 16193L DM3 13	Mo 16Z12A Meritor ZF	RTLO 16193L DM3 13
Differential ratio	3.55	3.7	3.55	3.7
Vehicle test weight	8591 kg	8573 kg	8714 kg	8636 kg
Tires	Michelin 275/80 R 22.5			
Tire pressure (cold)	100 psi			
Trailers				
Vehicle test ID	**T3**	**T4**	**T1**	**T2**
Vehicle fleet ID	**773614**	**117C518**	**117C513**	**117C642**
VIN	2M592161X51099430	2M5921610Y1064318	2M5921617Y1064335	2M5921612Y1064398
Make and model	MANAC 94253001	MANAC 94253002		
No. of axles	2			
Year	2004	1999		
Type	Van			
Tires	Goodyear 11 R22.5	Michelin 275/80 R 22.5		
Tire pressure (cold)	100 psi			
Vehicle test weight	21 718 kg	21 627 kg	21 419 kg	21 645 kg

Test equipment

The following equipment was used during the tests (Figure 2):

- Portable tanks with a capacity of 144 L (38 gallons): Norcan Aluminum 103461.
- A calibrated scale with a capacity of 150 kg and a resolution of 0.02 kg: Ohaus 3000, serial number 0015208-635; calibration certificate number 1298867, dated 20 August 2008.

The repeatability of the scale measurements was periodically checked during the tests using a set calibration weight.

Figure 2. Installation and weighing of the temporary fuel tank.

Test results

The Freight Wing Belly Fairing devices showed the following fuel consumption improvements during Energotest 2008:

- Prototype no. 1 (figure 3): 1.85 %
- Prototype no. 2 (figure 4): 3.90 %
- Prototype no. 3 (figure 5): 7.45 %

Details on the fuel consumption results are presented in Appendix B.

Discussions of tests limitations

Road tests and track tests are subject to variations in conditions between runs, and controlling or accounting for these variables as much as is possible is an important part of ensuring accurate results.

Air density varies with temperature, relative humidity, and barometric pressure, and changes in air density affect the aerodynamic resistance. The density of the air can be computed from measurements of these parameters[2]. Figure 6 presents the variation in air density during the testing of the three prototypes. The only possibility for minimizing the influence of the ambient conditions variation is to use unchanged control and test vehicles (with the exception of the modification being tested on the test vehicle), with the assumption that both vehicles will be equally affected by these variations. For this purpose, the test and control vehicles were of the same general configuration and were confirmed to be in proper operating condition prior to and during the tests. The trailers were matched to each test and the control vehicles remained matched with their respective tractors throughout the entire series of tests.

For aerodynamic device testing, the results may also be higher or lower than under average conditions depending upon the wind velocity and direction. As shown in Appendix A, the maximum wind speed recorded during the tests was 8 km/h, which was much less than the acceptable limit of 20 km/h. Moreover, in order to minimize the effects of wind yaw angle, we used a closed-loop parabolic oval.

Another variable is the driver. Testing took place on a closed test track at a fixed speed of 98 km/h, with a standard acceleration and braking protocol for all drivers, in order to eliminate the influences of traffic and variations in driver response. In addition, travel speeds were monitored throughout the trials using a radar gun, and drivers were instructed by radio if it became necessary to adjust their travel speed. The driver's influence on the results was thus minimized as much as possible by strictly controlling the driving cycle.

To minimize measurement uncertainties, the only measured parameter that we used to calculate the test results was the weight of the portable tanks. Other parameters, such as vehicle speed, distance, and time, were recorded for information purposes only. In order to avoid potential problems related to the instruments, three recently calibrated scales were available on the site. For each run, the portable tanks

[2] Surcel, M.-D.; Michaelsen, J.; Provencher, Y. 2008. Track-test evaluation of aerodynamic drag reducing measures for Class 8 Tractor-Trailers. SAE 2008-01-2600. Paper presented at the 2008 SAE Commercial Vehicle Engineering Congress and Exhibition, Chicago, IL.

were weighed using the same portable scale. Furthermore, the scales were checked against a known weight of 90.72 kg (200 lb) before each series of readings. The portable scales were not moved between the initial and final weighings for a given test run. Distance measurement was not a factor because for each run, all the vehicles departed and arrived at the same point after traveling the same number of laps and following the same path along the track.

Figure 3. The tested technology: prototype no. 1.

Figure 4. The tested technology: prototype no. 2.

Figure 5. The tested technology: prototype no. 3.

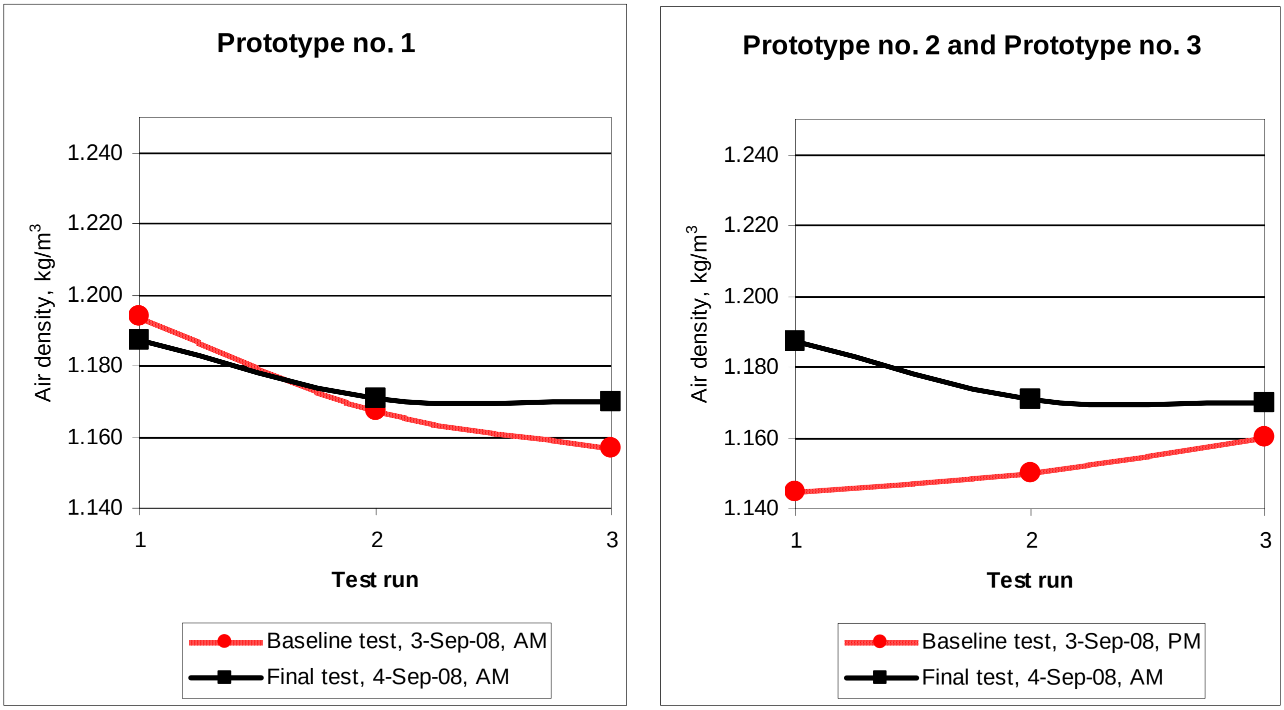

Figure 6. Air density variations during the testing of Freight Wing Belly Fairing prototypes.

Discussion and recommendations regarding the tested technologies

The three prototypes were straight devices (one section), with similar width, ground clearance and positions relative to the rear of the trailers. Prototype no. 2 and no. 3 had comparable lengths, and prototype no. 1 was much shorter than the other two. Prototype no. 2 was installed parallel to the longitudinal axis of the trailer, and prototype no. 3 was positioned at an angle to the longitudinal axis (around 5°). Prototype no. 1 was installed at a more obtuse angle than for the prototype no. 2.

Prototypes no. 2 and 3 performed better than prototype no. 1, which can mainly be explained by their larger surface area, and possibly by the overly obtuse inclination angle of prototype no. 1, which probably was too blunt and created additional resistance and turbulence.

Prototype no. 3 performed better than prototype no. 2, a difference that can only be explained by the sharper inclination angle of prototype no. 3, which helped to stream the air underneath the trailer.

The results obtained with the three prototypes were consistent with the performance of comparable designs under similar test conditions, and allow us to draw some preliminary conclusions about the design of trailer skirts (based strictly on the test results and visual observations): it is preferable to avoid curved surfaces, and although longer and lower skirts appear to be better, straight trailer skirts running parallel to the trailer's long axis, at a small angle to this axis, or with combination of the two designs, are expected to offer better performance. It is advisable to evaluate preliminary designs using simulation software, or with a scale model in a wind tunnel.

Conclusions

The percentage differences between the final ratios[3] and the baseline ratios[4] show fuel improvements for the test vehicles equipped with the three Freight Wing prototypes.

The best result was the 7.45 % fuel consumption reduction for the test vehicle equipped with Freight Wing Belly Fairing prototype no. 3, which had the following characteristics during the tests [5]:

- One straight section installed at an angle, with a maximum offset of 0.51 m from the trailer's exterior edges;
- Principal dimensions: a ground clearance of 0.18 m, an overall length of 6.87 m, and an overall width of 0.90 m.

Disclaimer

The result refers only to the vehicles and to the specimen of technology tested according to the procedure and conditions described in this report. FPInnovations-Feric cannot guarantee the reproducibility of this result for particular operating conditions.

[3] The average mass of fuel consumed by the test vehicle in the final test / average mass of fuel consumed by the control vehicle during the final test.
[4] The average mass of fuel consumed by the test vehicle in the baseline test / average mass of fuel consumed by the control vehicle during the baseline test.
[5] Dimensions are approximate.

Appendix A. Test trial forms

ENERGOTEST 2008 **TEST TRIAL FORM**

Date: 3-Sep-08 **Trial:** **BASE** **Test no.:** 2 **Vehicle:** ***Test Vehicle***
R2-T4 (102712-117C518)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 1)

Meteorological conditions:

Run	*Temp. (^{0}C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	18.2	0		84	Mainly clear
2	24.4	0		64	Mainly clear
3	26.7	0		56	Mainly clear
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	3	8:09:00	479920	105.46	9:14:00	480019.1	75.88	1:05:00	99.1	29.58
2	1	10:20:00	480029.1	85.66	11:25:00	480128.2	56.22	1:05:00	99.1	29.44
3	6	11:50:00	480128.2	109.96	12:55:00	480227.4	80.82	1:05:00	99.2	29.14
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau, Eric Auger***
Prepared by	***Marius-Dorin Surcel***

ENERGOTEST 2008 **TEST TRIAL FORM**

Date: 3-Sep **Trial:** **BASE** **Test no.:** 3 **Vehicle:** ***Test Vehicle***
R4-T1 (102740-117C513)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 2)

Meteorological conditions:

Run	*Temp. (^{0}C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	29.2	7	SW	48	Mainly clear
2	27.8	8	SW	49	Mainly clear
3	25.2	0		57	Mainly clear
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	4	15:18:00	418590.5	101.10	16:23:00	418688.7	70.48	1:05:00	98.2	30.62
2	9	16:43:00	418695.7	103.84	17:48:00	418793.9	73.92	1:05:00	98.2	29.92
3	12	18:17:00	418793.9	96.10	19:22:00	418892.1	66.28	1:05:00	98.2	29.82
4										
5										
6										
								Autofill after each row		

Observer	***Rob Jokai, Jonathan Martineau***
Prepared by	***Marius-Dorin Surcel***

Date: 3-Sep-08 **Trial:** **BASE** **Test no.:** 3 **Vehicle:** ***Test Vehicle***
R5-T2 (102719-112C642)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 3)

Meteorological conditions:

Run	*Temp. (^0C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	29.2	7	SW	48	Mainly clear
2	27.8	8	SW	49	Mainly clear
3	25.2	0		57	Mainly clear
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	2	15:19:00	392873.7	120.08	16:24:00	392971.1	88.80	1:05:00	97.4	31.28
2	3	16:44:00	392971.1	109.94	17:48:00	393068.5	78.66	1:04:00	97.4	31.28
3	1	18:18:00	393068.5	101.70	19:23:00	393166	70.80	1:05:00	97.5	30.90
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau***
Prepared by	***Marius-Dorin Surcel***

Date: 3-Sep-08 **Trial:** BASE **Test no.:** 2 **Vehicle:** ***Control Vehicle***
R1-T3 (102732-773614)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 1)

Meteorological conditions:

Run	*Temp. (^0C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	18.2	0		84	Mainly clear
2	24.4	0		64	Mainly clear
3	26.7	0		56	Mainly clear
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	4	8:11:00	400037.2	117.74	9:16:00	400134.7	88.80	1:05:00	97.5	28.94
2	4	10:22:00	400144.7	88.80	11:27:00	400242.2	60.14	1:05:00	97.5	28.66
3	7	11:52:00	400245.2	108.98	12:57:00	400342.7	80.70	1:05:00	97.5	28.28
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau, Eric Auger***
Prepared by	***Marius-Dorin Surcel***

Date: Sep. 3 **Trial:** BASE **Test no.:** 3 **Vehicle:** ***Control Vehicle***
R1-T3 (102732-773616)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 2 and 3)

Meteorological conditions:

Run	*Temp. (^{0}C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	29.2	7	SW	48	Mainly clear
2	27.8	8	SW	49	Mainly clear
3	25.2	0		57	Mainly clear
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	8	15:20:00	400342.8	107.64	16:25:00	400439.7	78.18	1:05:00	96.9	29.46
2	11	16:45:00	400439.7	106.24	17:50:00	400536.5	76.88	1:05:00	96.8	29.36
3	8	18:19:00	400536.5	101.48	19:24:00	400633.4	72.24	1:05:00	96.9	29.24
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau***
Prepared by	***Marius-Dorin Surcel***

ENERGOTEST 2008 **TEST TRIAL FORM**

Date: Sep. 4 **Trial:** **FINAL** **Test no.:** 4 **Vehicle:** ***Test Vehicle***
R2-T4 (102712-117C518)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 1)

Meteorological conditions:

Run	*Temp. (⁰C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	19.1	6	SW	86	Mostly cloudy
2	23.2	4	N	71	Mostly cloudy
3	23.9	6	E	64	Mostly cloudy
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	4	7:08:00	480550.2	89.02	8:13:00	480649.6	58.94	1:05:00	99.4	30.08
2	10	8:47:00	480656.3	98.42	9:52:00	480755.7	68.66	1:05:00	99.4	29.76
3	8	10:38:00	480755.7	95.26	11:46:00	480855.1	68.52	1:08:00	99.4	26.74
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau, Eric Auger***
Prepared by	***Marius-Dorin Surcel***

ENERGOTEST 2008 **TEST TRIAL FORM**

Date: Sep. 4 **Trial:** **FINAL** **Test no.:** 4 **Vehicle:** ***Test Vehicle***
R4-T1 (102740-117C513)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 2)

Meteorological conditions:

Run	*Temp. (^0C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	19.1	6	SW	86	Mostly cloudy
2	23.2	4	N	71	Mostly cloudy
3	23.9	6	E	64	Mostly cloudy
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	1	7:08:40	418590	101.94	8:13:40	418688	72.34	1:05:00	98.0	29.60
2	6	8:47:40	418695.7	102.70	9:52:40	418793.9	73.76	1:05:00	98.2	28.94
3	2	10:38:40	418793.9	107.68	11:43:40	418892.1	78.56	1:05:00	98.2	29.12
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau, Eric Auger***
Prepared by	***Marius-Dorin Surcel***

Date: 4-Sep-08 **Trial:** **FINAL** **Test no.:** 4 **Vehicle:** ***Test Vehicle***
R5-T2 (102719-112C642)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 3)

Meteorological conditions:

Run	*Temp. (^0C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	19.1	6	SW	86	Mostly cloudy
2	23.2	4	N	71	Mostly cloudy
3	23.9	6	E	64	Mostly cloudy
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	71	7:09:20	393178.6	96.60	8:14:20	393275.9	67.20	1:05:00	97.3	29.40
2	4	8:48:20	393282.9	83.36	9:53:20	393380.2	54.38	1:05:00	97.3	28.98
3	12	10:39:20	393380.2	100.46	11:44:20	393477.5	71.52	1:05:00	97.3	28.94
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau, Eric Auger***
Prepared by	***Marius-Dorin Surcel***

ENERGOTEST 2008 **TEST TRIAL FORM**

Date: Sep. 4 **Trial:** **FINAL** **Test no.:** 4 **Vehicle:** ***Control Vehicle***
R1-T3 (102732-773614)

Supplier (technology): Freight Wing (Belly Fairing, Prototype no. 1, 2 and 3)

Meteorological conditions:

Run	*Temp. (^{0}C)*	*Wind speed (km/h)*	*Wind direction*	*Relative humidity*	*Weather*
1	19.1	6	SW	86	Mostly cloudy
2	23.2	4	N	71	Mostly cloudy
3	23.9	6	E	64	Mostly cloudy
4					
5					
6					

Test Runs Details:

Run	*Tank ID*	*Start*			*Finish*			*Difference*		
		Time	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*	*Time*	*Odometer (km)*	*Fuel tank weight*
1	3	7:10:00	400652	100.02	8:15:00	400749	69.90	1:05:00	97.0	30.12
2	13	8:49:00	400756.3	99.48	9:54:00	400853.3	70.18	1:05:00	97.0	29.30
3	5	10:40:00	400853.3	97.82	11:45:00	400950.4	68.34	1:05:00	97.1	29.48
4										
5										
6										

Observer	***Rob Jokai, Jonathan Martineau, Eric Auger***
Prepared by	***Marius-Dorin Surcel***

Appendix B. Test result form

ENERGOTEST 2008 **TEST RESULTS FORM**

Technology: Belly Fairing, Prototype no. 1
Supplier: Freight Wing

RESET BASE DATA

VALIDATE BASE DATA

BASE TRIAL **DATE:** 3-Sep-08

T/C ratio calculation			
Test run	*Consumed fuel (kg): vehicle "**C**" R1-T3 (102732-773614)*	*Consumed fuel (kg): vehicle "**T**" R2-T4 (102712-117C518)*	*T / C ratio*
1	28.940	29.580	1.022
2	28.660	29.440	1.027
3	28.280	29.140	1.030
4			
5			
6			
Valid test runs and T/C average (T/CavB)			
Test run	1	2	3
T/C ratio	1.022	1.027	1.030
T/CavB	1.027		

RESET TEST DATA

VALIDATE TEST DATA

TEST TRIAL **DATE:** 4-Sep-08

T/C ratio calculation			
Test run	*Consumed fuel (kg): vehicle "**C**" R1-T3 (102732-773614)*	*Consumed fuel (kg): vehicle "**T**" R2-T4 (102712-117C518)*	*T / C ratio*
1	30.120	30.080	0.999
2	29.300	29.760	1.016
3	29.480	26.740	0.907
4			
5			
6			
Valid test runs and T/C average (T/CavT)			
Test run	1	2	3
T/C ratio	0.999	1.016	1.009
T/CavT	1.008		

TEST RESULTS

Parameter	***Notation***	***Equation***	***Value***
Base trial T/C average	T/CavB		1.027
Test trial T/C average	T/CavT		1.008
Percent fuel saved	PS	100(T/CavB - T/CavT) ÷ T/CavB	1.850

Prepared by	***Marius-Dorin Surcel***

ENERGOTEST 2008 | TEST RESULTS FORM

Technology: Belly Fairing, Prototype no. 2
Supplier: Freight Wing

RESET BASE DATA

VALIDATE BASE DATA

BASE TRIAL **DATE:** 3-Sep-08

T/C ratio calculation			
Test run	*Consumed fuel (kg): vehicle "**C**" R1-T3 (102732-773616)*	*Consumed fuel (kg): vehicle "**T**" R4-T1 (102740-117C513)*	*T / C ratio*
1	29.460	30.620	1.039
2	29.360	29.920	1.019
3	29.240	29.820	1.020
4			
5			
6			
Valid test runs and T/C average (T/CavB)			
Test run	1	2	3
T/C ratio	1.039	1.019	1.020
T/CavB	1.026		

RESET TEST DATA

VALIDATE TEST DATA

TEST TRIAL **DATE:** 4-Sep-08

T/C ratio calculation			
Test run	*Consumed fuel (kg): vehicle "**C**" R1-T3 (102732-773616)*	*Consumed fuel (kg): vehicle "**T**" R4-T1 (102740-117C513)*	*T / C ratio*
1	30.120	29.600	0.983
2	29.300	28.940	0.988
3	29.480	29.120	0.988
4			
5			
6			
Valid test runs and T/C average (T/CavT)			
Test run	1	2	3
T/C ratio	0.983	0.988	0.988
T/CavT	0.986		

TEST RESULTS

Parameter	***Notation***	***Equation***	***Value***
Base trial T/C average	T/CavB		1.026
Test trial T/C average	T/CavT		0.986
Percent fuel saved	PS	100(T/CavB - T/CavT) ÷ T/CavB	3.899

Prepared by	***Marius-Dorin Surcel***

ENERGOTEST 2008 **TEST RESULTS FORM**

Technology: Belly Fairing, Prototype no. 3
Supplier: Freight Wing

RESET BASE DATA

VALIDATE BASE DATA

BASE TRIAL **DATE:** 3-Sep-08

T/C ratio calculation			
Test run	*Consumed fuel (kg): vehicle "**C**" R1-T3 (102732-773616)*	*Consumed fuel (kg): vehicle "**T**" R5-T2 (102719-112C642)*	*T / C ratio*
1	29.460	31.280	1.062
2	29.360	31.280	1.065
3	29.240	30.900	1.057
4			
5			
6			
Valid test runs and T/C average (T/CavB)			
Test run	1	2	3
T/C ratio	1.062	1.065	1.057
T/CavB	1.061		

RESET TEST DATA

VALIDATE TEST DATA

TEST TRIAL **DATE:** 4-Sep-08

T/C ratio calculation			
Test run	*Consumed fuel (kg): vehicle "**C**"R1-T3 (102732-773616)*	*Consumed fuel (kg): vehicle "**T**" R5-T2 (102719-112C642)*	*T / C ratio*
1	30.120	29.400	0.976
2	29.300	28.980	0.989
3	29.480	28.940	0.982
4			
5			
6			
Valid test runs and T/C average (T/CavT)			
Test run	1	2	3
T/C ratio	0.976	0.989	0.982
T/CavT	0.982		

TEST RESULTS

Parameter	***Notation***	***Equation***	***Value***
Base trial T/C average	T/CavB		1.061
Test trial T/C average	T/CavT		0.982
Percent fuel saved	PS	100(T/CavB - T/CavT) ÷ T/CavB	7.446

Prepared by	***Marius-Dorin Surcel***