VORTEX GENERATORS
For Trucks & Trailers

TECHNICAL TRIALS
ARTICULATED HGV
Tractor-Trailer Gap Tests

IRTE Institute of Road Transport Engineers
BTAC Brewing Transportation Advisory Committee

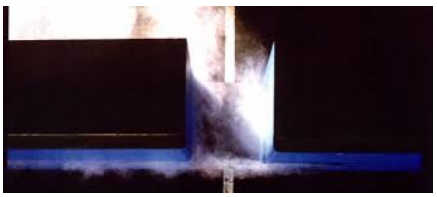
IRTE/ BTAC TECHNICAL TRIALS at MIRA

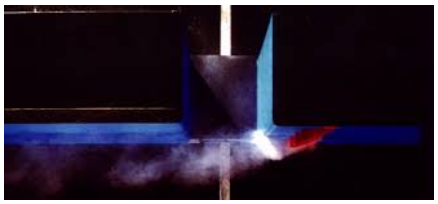
BTAC / IRTE TECHNICAL TRIALS

The overall theme of this technical trial was “at what cost extra payload”. More specifically, what is the debt or credit of an extra 6 tonnes GVW from 38 to 44 tonnes? However one operator, Parcelforce, that was more interested in cargo volume than weight, compared a high volume step frame double deck trailer to one of their standard frame trailers.
As always, there were some vehicle/engine comparisons, which for the first time, included public service vehicles from Northumbria Motor Services and an evaluation of an American developed aerodynamic aid, scientifically described as “vortex generators”.

VORTEX GENERATORS

Vortex generators are scientifically shaped ramps that extend into airstreams and create "vortices" – whirlwinds of air which help smooth the flow of air onto surfaces or into the void behind a bluff trailing edge. When used on heavy vehicles, this smoothing of the air flow is claimed to improve fuel consumption significantly- indeed, on-road tests in North America show an improvement of between 2-3.5% in typical consumption in US driving conditions for just the tractor-trailer gap.
BTAC tests at MIRA were designed to evaluate Vortex Generators independently and in British motoring conditions.
It should be noted that these tests were only for the tractor trailer gap.


Without Vortex Generators


With Vortex Generators

The photographs above were taken in a wind tunnel with the vehicle moving from left to right. In the left hand photograph, note how much smoke is in the gap between tractor and trailer without Vortex Generators being fitted. This represents aerodynamic inefficiency and drag, which takes horsepower to overcome. When Vortex Generators are fitted, in the right hand photograph, the vortices generated by the Vortex Generators carry most of the smoke past the tractor/trailer gap. This is a much more efficient aerodynamic configuration.
Another effect of the Vortex Generators is to reduce the amount of rain and spray that will enter the gap and deposit dirt and grit on the back of the tractor or front of the trailer.

Photographs courtesy of Cranfield University Atmospheric Boundary Layer Wind Tunnel

POST TEST REPORT

Post Test Report

General

Place: Motor Industry Research Association Test Track, Nuneaton

Weather: Morning – overcast, drizzle, wind estimated at 15 - 20mph
Afternoon – overcast; drizzle, wind estimated at 5 – 10mph. Average Temperature approx. 10 ºC

Vehicles: Low mileage DAF tractors with streamlined trailers. BTAC vehicle Test numbers were 12 and 13. Tractors had roof mounted air deflectors in the lowered position, and side mounted wings (side extenders or deflectors).

Equipment under test- Vortex Generators fitted on the wings (side extenders) only to the top of the tractor cab. No Vortex Generators fitted to back of trailer.

Both tractors were warmed prior to the test runs, the fuel quantity in special tanks weighed, and fuel temperature measured before and after the runs. Each truck did one run fitted with VG's and one run without the VG's.

The runs were a total of 74.2km, consisting:

	Distance (miles / km)	% Total
5 laps at 40mph	13.5 miles 22.6 km	31
5 laps at 50mph	13.5 miles 22.6 km	31
5 laps at 55mph	13.5 miles 22.6 km	31
Positioning /depositioning	6.4	7
Average Speed (mph/ kph)	48mph 76 kph	

BTAC / IRTE TECHNICAL TRIALS

Summary
More Detailed Background to Tests

The MIRA (Motor Industry Research Association) high-speed test track is roughly 4.55km in length, with lanes for 40mph, 50mph, and higher speeds. The 40 and 50mph sections are not banked, and the higher speed section is banked.

Access to the high-speed track is via a one-way system of roads that requires an additional 6km to be driven (about 2km to start and 4km to end.) from and to tank weighing site.

Fuel was placed in special test tanks with pressure fittings, and the tanks weighed at the start and end of each run. Fuel temperature was also taken at the start and end of the run as the fuel was re-circulated by the trucks normal fuel system. Fuel temperatures were about 15 to 20 ºC warmer at the end of the run than the beginning.

The trucks were equipped with speed restrictors (all new UK trucks must have this) and this restricts the speed to a maximum of 56mph. The trucks were never either slipstreaming behind another truck, or being slipstreamed by any other trucks on the track.

Speeds were kept to within +/- 1 mph of the target speed. The first driver to drive the course noted that he might not have used the optimum gear for the 40mph section; however, both trucks used the same gear in order to have identical conditions.

The VG's were mounted only on the side deflectors, and these deflectors were exchanged between trucks between runs. The VG's were not a full kit. They were mounted only to the top of the normal cab, there were no VG's on the roof mounted air deflector and there were none on the trailers. The deflector on the roof was the same angle on both vehicles. The tractors were identical and the trailers were laden with identical loads. The aerodynamics and tyre pressures were the same on both vehicles.

BATC/IRTE TECHNICAL TRIALS

Company Name: Parcelforce
Vehicle: Leyland DAF 85
Engine: DAF WS 242 L,
Power: 242 kW @ 2000rpm,
Torque: 1350 nm @ 1200rpm
Gearbox: 12 gears Top Ratio 1:1
Axle: DAF F 1346 ratio 3.7:1
Max Geared Speed: 64.5 @ 2000rpm
Speed per 1000rpm: 32
Tires Michelin: 11R 22.5

Type of Test **IRTE Type I Test**

Entrant	12C	12D	13A	13B
Driver Name	K. Atkins	K. Atkins	C. Lake-Bullen	C. Lake-Bullen
Vortex Generator	Without	With*	With*	Without
Gross Weight (kg)	28,000	28,000	28,000	28,000
Un-laden (kg)	13,480	13,480	13,480	13,480
Payload (kg)	14,520	14,520	14,520	14,520
Distance (km)	73.13	73.13	73.13	73.13
Fuel Temperature (ºC)	24	27	21	25
Specific Gravity (corrected)	.8542	.8563	.8521	.8549
Fuel Weight (kg) Start	76.25	56.80	74.25	55.05
Fuel Weight (kg) End	56.80	37.60	55.60	36
Fuel Used (kg)	19.45	19.20	18.65	19.05
Fuel Consumption (mpg)	9.05	9.20	9.41	9.25
Fuel consumption (ltr/100km)	31.21	30.70*	30.02*	30.54

** - not fitted to trailers. Only fitted to tractor trailer gap.*

Courtesy of R. McGowan & R. Lovelock

With Vortex Generators			
Vehicle No.	Make and Model		Average mpg
12D	Leland DAF 85 series with straight frame GRPtandem axle box van.	9.20	9.3
13A	Leland DAF 85 series with straight frame GRPtandem axle box van.	9.41	

Without Vortex Generators			
Vehicle No.	Make and Model		Average mpg
12C	Leland DAF 85 series with straight frame GRPtandem axle box van.	9.05	9.15
13B	Leland DAF 85 series with straight frame GRPtandem axle box van.	9.25	

Summary

	Vortex Generators			
Vehicle	Without	With	MPG Improvement	% Improvement
12	9.05	9.20	.15 mpg	1.6%
13	9.25	9.41	.16 mpg	1.7%

Notes:
It should be noted that to achieve full effect, VG's should have been fitted to the top and sides of the tractor. For the BTAC trials, VG's were only fitted to the lower part of the side extenders of the cabs – less than 50% of the recommended fit. It would be correct to assume that the improvements in fuel economy recorded at MIRA would effectively be doubled with the recommended full fit. Further, the greatest operational savings from VG's will undoubtedly be achieved at motorway speeds – the Parcelforce tests were primarily concerned with mixed urban/motorway usage, and a consequently greater fuel savings on motorway journeys could realistically be expected.
It should also be noted that the average speed on the track was 48mph / (76kpm), which is much slower than normal motorway speeds (even with the speed limiter set to 56mph).

MORE DETAILED EXAMINATION OF THE DATA

There are several ways to look at this data in more depth.

Extrapolation for full set of VG's to Tractor.

If the length of VG's installed was only 2/3rd of a full set, then the improvement would conservatively be 33% better making the savings 3.5 and 2.1% respectively. This gives an average of 2.8%, which is consistent with other data.

Extrapolation to a steady 56 mph.

If we consider that the VG's were only effective for 2/3rd of the test (above 40mph), and that the effect of the Airtabs is more pronounced at higher speeds, then the fuel economy improvement would be even larger. Again this would improve the baseline figures to 3.5 and 2.1% respectively. Again the average is 2.8%.

Adding the two extrapolations

If we put the two extrapolations together, namely, greater length of the VG and higher speeds, we should see fuel economy improvements of 5.3% and 3.1% respectively. (Average is 4.1%). This gives great confidence that the figure quoted of 3.5% is slightly conservative.

We are encouraged by these results, and we have every reason to believe that the really meaningful results will be well within our predicted fuel savings of 3 to 4%