BTAC/IRTE TECHNICAL EVALUATION EVENT 2003

Report for 7th and 8th June 2003

Prepared by the Institute of Road Transport Engineers
A professional sector of the Society of Operations Engineers

Although this event was sponsored by the Department, the findings and recommendations included in this report are those of the authors and do not necessarily represent the views of the Department for Transport.

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INTRODUCTION

The world's supply of oil is limited. Burning fuel in an internal combustion engine is expensive both in financial terms to the transport industry and in terms of the environmental impact of harmful emissions.

According to the January 2002 edition of *Transport Engineer*, the journal of the Institute of Road Transport Engineers, fuel and oil spend equates to approximately 36 % of annual operating costs for a 40 Tonnes articulated vehicle. Improving vehicle fuel efficiency is therefore a key aim for operators of heavy commercial vehicles.

An ever-expanding industry has developed to market interventions, which claim to offer fuel savings to operators, and it is important that such products can be independently and economically evaluated.

The Technical Evaluation Event, run by the British Transport Advisory Committee (BTAC) and the Institute of Road Transport Engineers (IRTE), provides the road transport industry with a forum for independent evaluation.

The purpose of this report is to outline the results of tests carried out on a variety of alleged fuel saving interventions at the BTAC/IRTE Technical Evaluation Event held in June 2003.

The event was financially supported by the Department for Transport (DfT) through its TransportEnergy BestPractice programme.

It should be remembered, of course, that fuel efficiency should be seen in the context of reducing the total fuel used through, for example, enhanced routing and scheduling and improved vehicle utilisation and not just focused on improving vehicle mpg.

In practice, operational efficiency is not derived solely from the vehicle itself (which will always be an overhead), but from prudent thinking and sound management practice throughout the entire operation.

BACKGROUND

Prior to the rationalisation of the brewing industry in the 1990s, considerable resources were invested by the brewery companies in research and development relating to the efficient use of vehicles and vehicle combinations.

The main thrust of this research was concerned with fuel economy and focused on developing methods of improving general vehicle efficiency and safety. In order to evaluate theories, devices and equipment in a scientific manner, a number of test procedures and systems were developed by the breweries' transport departments. This resulted in the establishment of a system of robust, practical and independent tests capable of producing impartial results.

From this initiative, the Brewery Technical Advisory Committee (the original BTAC) was established and was supported by the Institute of Road Transport Engineers (IRTE).

Since the early 1980s, practical testing has been carried out at the MIRA (formerly the Motor Industry Research Association) test facility in Nuneaton, Warwickshire, over the first weekend in June. As the concept of independent testing became established, the annual BTAC/IRTE Technical Evaluation Event attracted interest from operators and manufacturers from outside the brewing industry.

This event is still widely recognised as a truly independent system of testing.

Over the years, the event has attracted considerable support from the road transport industry, manufacturers and Government. As the industry has evolved over time, it was deemed appropriate, in this, its 27th year, that the Brewery Technical Advisory Committee should reflect this evolution in a change of name to the "British Transport Advisory Committee".

The original BTAC was made-up of the major brewing companies and provided a means of disseminating information of a technical and engineering nature in order to promote best practice, identify common goals, highlight innovation in vehicle development and develop evaluations of vehicle fuel efficiency.

As the road transport industry has evolved, so the membership of the committee has become more diverse. BTAC currently includes; Britvic Soft Drinks, Exel, Safeway Stores plc, Tesco plc, Sainsbury's plc and Centrica. BTAC holds regular meetings of its membership and stages the annual "Consult and Exhibition" where specialist speakers are invited to address the industry on fleet engineering issues.

Many manufacturers make claims about their products in relation to performance. Testing these claims can be both time-consuming and expensive. The only realistic method of testing for the average operator is through the development of an in-service trial using their own vehicles.

It should be possible for commercial vehicle operators to access independent, tailor-made, low-cost testing to suit their individual needs. The annual BTAC/IRTE event offers industry this opportunity to carry out independent, practical measurements and technical evaluations on operators' own vehicles.

This year's BTAC/IRTE Technical Evaluation Event took place on the 7th and 8th June, 2003 at MIRA in Nuneaton, Warwickshire. The 2003 event concentrated on evaluations relating to the performance of a variety of vehicles, in three core categories:

1. Tyres
2. Transmissions
3. Fuels and additives

MIRA in Nuneaton, Warwickshire

The details and results of these core tests, as well as a number of additional tests outside the scope of the core categories, are contained within this report.

*During planning for the BTAC 2003 event, it was intended that telematics systems would also be evaluated as one of the core testing categories. Telematics systems were fitted on a number of test vehicles and OBC readings were used in a number of tests, but no data on the actual testing of telematics systems themselves was made available for inclusion in this report. Problems of equipment calibration and data transfer contributed to the exclusion of telematics systems testing data from this report.

METHODOLOGY for the TECHNICAL TRIALS

Purpose:

To evaluate the effectiveness of assorted fuel saving interventions in commercial vehicle operations.

Method:

The test procedures are designed to provide a means of measuring, to an agreed standard, the fuel consumption of vehicles.

They involve the controlled running of vehicles in either one or both of two test situations at the MIRA test facility. A high-speed test simulates motorway conditions and a stop-start test replicates urban operations. The high-speed test is carried out on MIRA's high-speed circuit while the stop-start test is conducted on the site's inner durability track.

To ensure tests are undertaken correctly, an independent observer accompanies each driver and records relevant test data.

Procedures:

***Vehicle preparation*:** All vehicles must be roadworthy prior to testing and be fitted with an appropriate test fuel tank. Vehicles should be fully laden to their gross legal limits or to their normal operating weights.

***Test fuel tanks*:** Demountable fuel tanks used for the tests must not exceed 18 gallons (81.8 litres). Tanks must be fitted with two flexible fuel lines equipped with Aeroquip self-sealing couplings. One fuel line is used to connect the test tank to the engine's primary fuel filter and the second connects the fuel-return line back to the tank.

Demountable fuel tanks for fuel weighing

Vehicle registration**:** On arrival at MIRA, vehicles are registered and technical specification is verified.

Vehicle weighing**:** The test vehicles are weighed with only the driver in the cab, the test tank empty and the main fuel tank filled to its normal capacity. To ensure consistency, all vehicles are weighed at MIRA prior to the commencement of testing.

Fuel weighing**:** Test tanks filled with test fuel are weighed prior to the start of the test procedure. In addition, the specific gravity and temperature of the fuel is recorded. At the end of both high-speed and stop-start tests, fuel weighing and temperature measurement takes place and the relevant data is recorded. In some test situations, where the gravimetric method is deemed inappropriate, On Board Computer (OBC) systems are used to determine mpg.

Test tanks filled with test fuel are weighed prior to test procedure

NB: Fuel weighing is considered an accurate means of determining the amount of fuel used but accurate conversion to volume is also required. As both specific gravity and temperature are carefully recorded, it is possible to calculate the total volume of fuel used. This method of fuel measurement is referred to as the Gravimetric System. However, as an increasing number of vehicle manufacturers are using complex, electronically monitored fuel systems which are intolerant of intervention into fuel supply and return lines, there is an increasing use of vehicle OBC equipment, during the trials, to obtain data relating to fuel consumption, speed and time.

Check the test fuel temperature

***Scrutineering*:** The test vehicle is subject to a mechanical safety check prior to testing, including a check of the security of any load or equipment.

***Track and test familiarisation*:** Drivers and observers are briefed on track safety and driving procedures and instructed on the number of laps to be completed and the speeds to be observed.

***MIRA Test Facility*:** The main high-speed circuit is 4.5 km long and is divided into four lanes; the two outer lanes are for speeds above 95 km/h and the two inner lanes are for speeds up to 95 km/h. The bends are banked up to 33° which, at a radius of 216 m, gives a neutral speed of 136 km/h. Constant speed testing up to 200 km/h is possible at the facility.

***Observers*:** Observers accompany drivers to verify the correct operation of the test. In the case of the high-speed test, the observer checks the number of laps completed, the vehicle's speed and the distance covered. During the stop-start test, the observer records the number of laps completed, the number of stops made, the distance completed at each stop and monitors speed throughout. The observer also records any discrepancies that may occur during the test procedure.

***Test procedure*:** Initially vehicles undertake a number of warm-up laps of the MIRA inner durability track. Once the warm-up laps have been completed, vehicles are directed to the start line, where fuel tanks are weighed and a starting check is completed.

MIRA high-speed circuit

Procedure for high-speed test – total distance 73.13km:

1. Complete five laps of the high-speed circuit at 60 km/h (37 mph), using the inner lanes.
2. Complete a further five laps of the high-speed circuit at a constant speed of 80 km/h (50 mph), using the inner lanes.
3. Complete a further five laps of the high-speed circuit at a constant speed of 96 km/h (60 mph), or at the maximum speed to which the vehicle is limited, using the outer lanes.
4. After completing all 15 laps, vehicle returns to start point.
5. Fuel tanks to be weighed, temperature recorded and time checked.

Procedure for stop-start test – total distance 38.80km:

1. Complete five laps of the inner durability circuit at a constant 50 km/h (31 mph), observing instructions on track signs and stopping once at the end of each lap.
2. Complete a further five laps, with six stops and restarts on each lap. On two of the stops, previous maximum speed must be 32 km/h (20 mph). On the remaining four stops, previous maximum speed must be 48 km/h (30 mph). Maximum acceleration should be used to obtain the specified speed after each stop.
3. After completing all 10 laps, vehicle returns to start point.
4. Fuel tanks to be weighed, temperature recorded and time checked.

Speeds, number of laps completed and stop/start procedures are carefully monitored and recorded by the independent observer assigned to each test.

Depending on the specific intervention under scrutiny (and the type of operation for which it is alleged to be suitable), some tests may only use either the high-speed or the stop-start test.

Fixed pedal test**:** In some test situations it may be appropriate to employ a system of limiting the travel of the accelerator pedal to a predetermined point. This test procedure reduces the degree of variation in driver application of the accelerator pedal.

Tachographs**:** The tachograph is used to determine the speed and distance completed by the vehicle. At the end of the test run, the chart is removed from the tachograph head and speed and distance traces are analysed to verify data recorded by observers.

Speed evaluation**:** Operating speeds within each test run are monitored to ensure consistency and accuracy. This function is carried out by an independent observer to ensure the driver conforms with procedures outlined in the methodology applicable to each test.

Results: On completion of the test procedures, the results are calculated using a computer spreadsheet programme. In addition, a random selection is audited manually.

Further information on the methodology used: For further information relating to the methodology used, refer to the Fuel Consumption Evaluation (FCE) publication produced by TransportEnergy BestPractice (TEBP) with the assistance of The Institute of Road Transport Engineers. This publication is available, free of charge, from the TransportEnergy BestPractice Hotline on 0845 602 1425 or from the programme's website at www.transportenergy.org.uk, following the links to BestPractice.

TEST RESULTS

TEST No 1

Participants: Exel/Somerfield and Michelin.

Objective: To evaluate the effects on fuel consumption of new energy efficient tyres compared to new standard tyres.

Test Type: High-speed test only.

Vehicle Type: Volvo FM12.340 tractor unit and tri-axle semi-trailer.

GTW: 30,280 kg.

Checking the energy efficient tyres

Discussion and notes to test: The energy efficient tyres show an improvement in fuel consumption of 8% when measured against the standard tyres, over the high-speed test. Michelin states that energy efficient tyres are not designed to show significant fuel saving benefits on stop/start transport operations. Therefore, the trial was restricted to the high speed section of the test procedure to simulate motorway driving at fixed speeds of 60, 80 and 90km/h (note: vehicle limited to 90km/h – 56 mph).

Initially the vehicle was fitted with a new set of standard tyres. In the second part of the test, all tyres on both the tractor unit and semi-trailer were replaced with energy efficient tyres.

Tread depth measurements and pressure checks were carried out before and after the tests. Tread depths on all tyres remained the same, which was to be expected given the relatively short overall distance travelled. Pressures were found to have increased on both sets of tyres following the test runs.

Comparative MPG Results

	High Speed
	Mpg
Standard tyres	9.09
Fuel efficient tyres	9.82

Recommendations: Although the test results indicate a significant improvement in fuel consumption during the high-speed trials (which simulate motorway driving), further tests should be conducted to establish the performance of energy efficient tyres under stop-start conditions (illustrative of vehicles operating in urban environments).

In the past, there have been concerns relating to the durability of energy efficient tyres. This question of tyre tread life may be an influencing factor in the general acceptance and fitment of fuel efficient tyres within vehicle fleets. Additional in-use fleet trials may therefore be an appropriate means of obtaining the necessary comparative data on tyre durability.

TEST No 2

Participant: Inchcape Automotive.

Objective: To compare the performance of the manual setting with the automatic setting of an I-shift automated 12-speed gearbox.

Test Type: High-speed and stop-start tests (I-shift was engaged and disengaged for both types of test)

Vehicle Type: Volvo FM12.380 articulated car transporter fitted with I-shift automated gearbox.

GTW: 36,400 kg.

Inchcape - Volvo FM12.380 articulated car transporter under test

Discussion and notes to test: During the first cycle of tests the I-shift was engaged, therefore enabling automatic gear selection. When the test cycle was repeated, the driver made all the necessary gear-changes manually. During the stop-start section of the test, with the I-shift fully engaged, an improvement of 9.4 % in fuel consumption was achieved. On the high-speed test, when gear-changes were performed manually by the driver, an improvement of 1.8 % was obtained. The results indicate that the automatic setting provided an overall improvement in fuel consumption of 2.7 %, despite the fact that its relative fuel consumption was worse on the high-speed test.

Comparative MPG Results

	High Speed	Stop-Start
	Mpg	Mpg
Automatic Setting	7.40	5.36
Manual Setting	7.53	4.90

Recommendations: The fitment and use of automatic gearboxes (or gearboxes with automatic settings) in large goods vehicles appears to provide potential for improvements in fuel economy and has other potential benefits such as reductions in driver fatigue. In order to confirm these potential benefits, extended in-use fleet trials of such transmission systems, in varying and diverse operating conditions, should be undertaken.

TEST No 3

Participant: Volvo Truck and Bus

Objective: Comparison of the I-shift automated gearbox with a manual gearbox.

Test Type: High-speed and stop-start tests using two drivers.

Vehicle Type (1): FM12.340 tractor unit fitted with an I-shift automated 12-speed gearbox and tri-axle semi-trailer.

GTW: 40,000 kg.

Vehicle Type (2): FM12.340 fitted with a 9-speed manual gearbox and tri-axle semi-trailer.

GTW: 40,000 kg.

Volvo comparison of I-shift and manual gearboxes

Discussion and notes to test: The results of this test showed the differences in overall fuel economy performance between manual and automated-shift gearboxes to be minimal. The vehicle fitted with the 9-speed manual gearbox may have been at a disadvantage due to its more limited gearing ratios and consideration must also be given to the possible impact of the differing experience and driving styles of the drivers involved.

Volvo I-Shift MPG Results

	High Speed	**Stop-Start**
	Mpg	Mpg
Driver A	8.85	5.40
Driver B	9.39	5.74

Volvo Manual MPG Results

	High Speed	Stop-Start
	Mpg	Mpg
Driver A	9.14	5.30
Driver B	9.09	5.92

Comparative MPG Results

	Average MPG		
	Overall	Stop-start	High speed
I-Shift Gearbox	7.35	5.57	9.12
Manual Gearbox	7.37	5.61	9.12

Recommendations: Carrying out trials of this type at the MIRA test facility provides only a basic comparison of manual and automated gearboxes. In order to better determine the respective abilities of both the I-shift and manual gearboxes to respond efficiently to more variable road situations, further extended in-use fleet evaluations are recommended.

TEST No 4

Participant: Centrica/AA.

Objective: To determine the respective fuel efficiencies of a 10 Tonnes recovery truck and a 12 Tonnes recovery truck.

Test Type: High-speed and stop-start tests using two drivers.

Vehicle Type (1): Renault Midium 180.10 rigid (10 Tonnes vehicle).

GVW: 8,340 kg.

Vehicle Type (2): Renault Midium 220.12 rigid (12 Tonnes vehicle).

GVW: 9,800 kg.

Discussion and notes to test: The 180.10 vehicle was plated at 10 tonnes gvw and was fitted with a five-speed gearbox. The 220.12 vehicle was plated at 12 tonnes gvw and was fitted with a 6-speed gearbox. The rear of the 12 tonnes vehicle was also fitted with an under-slung spectacle-lift. Both vehicles carried matching Ford Transits.

Overall, the 10 tonnes vehicle proved to be 5.7 % more fuel-efficient, with a greater advantage (6.7%) at high speed.

NB: It was intended that detailed vehicle and driver operating data would be obtained during this test from on-board telematics systems fitted to both vehicles. Unfortunately, due to the late instillation of equipment and problems of calibration, it was not possible to download or obtain any meaningful data from the telematics systems.

10 Tonnes Vehicle MPG Results

	High Speed	Stop-Start
	Mpg	Mpg
Driver A	18.17	14.39
Driver B	16.91	17.77

12 Tonnes Vehicle MPG Results

	High Speed	Stop-Start
	Mpg	Mpg
Driver A	16.12	16.78
Driver B	16.75	13.94

Comparative MPG Results

VEHICLE	Average MPG		
	Overall	Stop-start	High speed
10 Tonnes	16.81	16.08	17.54
12 Tonnes	15.90	15.36	16.44

Recommendations: The 10 Tonnes vehicle exhibited better fuel consumption than the 12 Tonnes vehicle. However, fuel consumption forms only one element of the whole decision-making process when purchasing fleet vehicles. In-use fleet trials would provide much greater opportunity to measure operational efficiency issues, such as vehicle productivity (as well as fuel efficiency), over an extended time period.

TEST No 5

Participant: Ringwood Brewery.

Objective: To determine the effects on fuel consumption of using vehicle cruise control.

Test Type: High-speed test plus an additional test consisting of 15 laps at a constant speed of 85 km/h.

Vehicle Type: Volvo FL180 15 Tonnes rigid dray

GVW: 10,690 kg.

Ringwood Brewery - testing fuel consumption using vehicle cruise control

Discussion and notes to test: It is widely assumed that vehicle cruise control systems improve fuel economy, as they help to reduce speed 'yo-yoing'. Conversely, it has also been suggested that an experienced driver may be capable of achieving better results than a cruise control system, as he can read the road ahead and adjust the accelerator pedal accordingly. This trial was undertaken to provide some further insight into this subject.

Results for the high-speed test indicated a 3.2 % improvement in fuel consumption when cruise control was not in operation.

This outcome could partly be the result of the driver becoming increasingly familiar with the banked high-speed MIRA track and improving his driving style as a result.

An additional run consisting of 15 laps at 85km/h was conducted. This fixed speed run was intended to further highlight the potential benefits of cruise control in reducing speed "yo-yoing". However, the results indicated only a 0.7 % improvement when cruise control was employed.

Overall, therefore, the two sets of results appear contradictory and this test must be considered inconclusive.

Ringwood Brewery test vehicle

Comparative MPG Results

	High Speed
	Mpg
Cruise Control Active	13.24
Cruise Control Inactive	13.67

Comparative MPG Results (85km/h only)

	85km/h
	Mpg
Cruise Control Active	12.84
Cruise Control Inactive	12.75

Recommendations: The potential impact of the human factor involved in this test must not be ignored. Drivers taking part in the trials may exert greater effort in maintaining consistency under test conditions than would otherwise be the case in their normal daily driving. In order to fully appraise the potential benefits of cruise control systems, further in-fleet and off-road evaluations should be undertaken.

TEST No 6

Participant: Exel Logistics.

Objective: To determine the impact on fuel consumption of the use of in-cab air conditioning systems.

Test Type: Non-standard high-speed.

Vehicle Type: Daf XF95.430 articulated road tanker.

GTW: 41,750 kg.

Exel - Daf XF95.430 articulated road tanker

Discussion and notes to test:
There is limited data available relating to the effects on fuel efficiency of a modern in-cab air-conditioning system.

A non-standard test was devised and used for this trial, initially requiring the vehicle to lap the high-speed circuit for 60 minutes without the air-conditioning in operation. This run was then repeated with the air conditioning in operation. The two-part test cycle was subsequently repeated on a further two occasions (six individual runs in total).

Test cycles one and three indicated that the use of air-conditioning had no significant impact on fuel economy.

The second run produced a result suggesting that the use of air-conditioning actually reduced fuel consumption by 6.5 %. This result was due to a heavy rain shower during the second test and should be ignored. By omitting this second run, the consolidated data below indicates that engagement of the air conditioning system causes minimal overall deterioration in fuel consumption.

Due to the specialised nature of the tanker involved in this test (normally used to carry acid products and fitted with an array of safety equipment) it was decided that the gravimetric fuel measurement system was inappropriate and results were taken from the vehicle's OBC.

Exel - Daf XF95.430 articulated road tanker under test

Comparative Results for 3 runs

	Air Con	Distance	Fuel	Time taken	Mpg
		Km	Litres	hh:mm	
Run 1	Off	81.3	32	0:56	7.18
Run 1	On	81.3	32	0:57	7.18
Run 2	Off	81.4	33	0:57	6.97
Run 2	On	81.4	31	0:57	7.42
Run 3	Off	81.2	31	1:00	7.40
Run 3	On	81.1	31	0:58	7.39

Consolidated Data for Runs 1 and 3

Air Con	Distance	Fuel	Time taken	Av. MPG
	Km	Litres	hh:mm	
Off	162.5	63	1:56	7.29
On	162.4	63	1:55	7.29

Exel road tanker used for trial

Recommendations: Air-conditioning systems can improve the amenity of the vehicle cab and the results from runs 1 and 3 indicate that their use has little or no effect on fuel consumption. However, in view of the possible greater impact of climatic conditions and seasonality on these results, longer-term in-use fleet evaluations should be undertaken.

TEST No 7

Participant: Somerfield.

Objective: To determine the impact on fuel consumption of the use of in-cab air conditioning and to identify any differences in the results measured by the gravimetric method and those measured by OBC systems.

Test Type: High-speed and stop-start.

Vehicle Type: Volvo FM12.340 articulated vehicle.

GTW: 32,700 kg.

Somerfield - Volvo FM12.340 articulated vehicle

Discussion and notes to test:

The results below (measured using the gravimetric system) indicate a deterioration of 4.8 % on the high-speed section when the air conditioning system was engaged.

During the stop-start section an improvement in fuel economy was recorded when the air-conditioning was switched on.

Other variables, such as cab temperature at the start of the trial and outside ambient temperature, may have had an effect on the test results.

Comparative MPG Results (measured by the gravimetric system)

	High Speed	**Stop-Start**
	Mpg	Mpg
Air Con Active	8.94	6.43
Air Con Inactive	9.39	6.12

Comparison between the OBC figures and those derived from the gravimetric system indicate that the OBC reports a higher mpg and therefore a better fuel consumption figure.

Comparative MPG Results (measured by OBC)

	High Speed	**Stop-Start**
	Mpg	Mpg
Air Con Active	9.9	7.1
Air Con Inactive	10.2	6.8

Recommendations: Results from the high-speed and stop-start elements of the test are contradictory. The test must therefore be deemed inconclusive. To examine the longer-term impact of air-conditioning on fuel consumption, it is recommended that further in-fleet evaluations should be undertaken.

Comparison between the OBC fuel figures and the gravimetric system indicate that the OBC produces a higher mpg figure. The origins of this discrepancy also require further investigation.

TEST No 8

Participant: Somerfield.

Objective: To determine the effects on fuel consumption of having both the driver and passenger side windows open.

Test Type: High-speed and stop-start.

Vehicle Type: Volvo FM12.470 articulated vehicle.

GTW: 29,840 kg.

Somerfield - Volvo FM12.470 articulated vehicle

Discussion and notes to test:

The objective of this test was to determine the effect on fuel consumption of running with open driver and passenger side windows.

The vehicle undertook two test runs. The first with the cab windows open and the second with the windows closed.

The results suggest no significant effect on fuel consumption of running with open windows on the stop-start section.

On the high speed test, the inferior aerodynamic efficiency of operating open windows resulted in a 7.0 % deterioration in fuel consumption.

Comparative MPG Results

	High Speed	Stop-Start
	mpg	Mpg
Windows open	9.18	6.57
Windows closed	9.87	6.52

Recommendations:

The results indicate that aerodynamic efficiency is reduced (and fuel consumption therefore increases) when a vehicle is operated with its windows open. However, fuel efficiency is only one element to be considered within the entire vehicle operation and the health, safety and comfort of the driver are also vital issues. Operators therefore need to consider alternative means of controlling the cab environment if windows are to remain closed during normal vehicle operations.

TEST No 9

Participant: J Sainsbury/TDG.

Objective: To evaluate the respective fuel efficiencies of tractor units with semi-trailers of different specifications (4.2 metres and 4.7 metres height).

Test Type: High-speed and stop-start tests.

Vehicle Type: Volvo FM12.380 tractor and 4.2m trailer combination.

GTW: 27,700 kg.

Vehicle Type: Volvo FM12.420 tractor and 4.2m trailer combination.

GTW: 27,700 kg.

Vehicle Type: Volvo FM12.380 tractor and 4.7m trailer combination.

GTW: 25,490 kg.

Vehicle Type: Volvo FM12.420 tractor and 4.7m trailer combination.

GTW: 25,490 kg.

J Sainsbury/TDG – vehicle specification testing

Discussion and notes to test:

The purpose of this evaluation was to measure the impact on fuel consumption of running a 4.7m high double-deck semi-trailer compared to a more conventional 4.2m semi-trailer.

It was also intended to determine whether it was more fuel efficient to run these semi-trailers with a 380hp tractor unit or a 420hp model.

As a result of high operator demand on both tractor units and semi-trailers, it was not possible to obtain the ideal combination for this series of tests.

Direct comparability was compromised, to some extent, due to a number of key differences between tractor units: the 420hp model had a Globetrotter cab and I-shift transmission, while both of these features were absent on the 380hp unit.

Due to time constraints and unavailability of vehicles in advance of the test, it was decided to take measurements from the vehicles' OBCs.

Operation of the 4.7m high semi-trailer resulted in deterioration in fuel consumption in all instances. The penalty was up to 13.4% on the high speed element of the test and up to 17.5% on the stop-start section.

There was insufficient evidence to draw conclusions on the respective fuel efficiency merits of the 380hp and 420hp tractor units.

Comparative MPG Results

	High Speed	**Stop-Start**
	mpg	Mpg
4 2 metre & 380hp	9.70	7.03
4.7 metre & 380hp	8.57	5.80
4 2 Metre & 420hp	10.09	6.52
4.7 Metre & 420hp	8.74	6.18

Recommendations: A number of discrepancies within this test, such as different tractor unit cabs and gearboxes, have affected direct comparison of vehicle types. This means that sound conclusions concerning the respective fuel efficiency merits of the 380hp and 420hp tractor units cannot be drawn.

The fuel efficiency results from the 4.7m high semi-trailer vehicle combinations on each of the separate test elements indicate increased fuel consumption resulting from the use of semi-trailers of this height. The 4.2m high semi-trailer vehicle combinations exhibited better fuel consumption in all instances.

However, it must be acknowledged that overall fuel consumption for a vehicle combination should be only one of the operational issues considered when selecting fleet vehicles.

Increased productivity, derived through the increased capacity of a higher double-deck semi-trailer, could help offset its respective reduced fuel efficiency. Fuel consumption per tonne, or per cubic meter, or per pallet moved perhaps, might be more appropriate ways to measure overall fuel efficiency for the purposes of operational fleet selection.

Accurate data for both the semi-trailer height and tractor unit horsepower evaluations could be derived from longer term in-fleet trials. These in-use evaluations would enable further operational issues, such as improvements in productivity through increased vehicle capacity, to be evaluated in a more robust manner.

TEST No 10

Participant: Harsh.

Objective: To determine the effects on fuel consumption of enclosing a tipper body when empty.

Test Type: Non standard high-speed test. Three runs were carried out, the first with the body sheeted and closed, the second with the body unsheeted and open, the third with the body sheeted and closed again.

Vehicle Type: Volvo FM12.340 8x4 rigid tipper.

GVW: 11,700 kg.

Harsh - Volvo FM12.340 8x4 rigid tipper

Discussion and notes to test:

The high specification of the test vehicle suggested that truck aerodynamics was already of considerable concern to this particular vehicle operator.

The vehicle was fitted with a smooth-sided body, closely fitted to the rear of the cab with a clearance of 50mm between the air intake stack and the body.

The vehicle was fitted with an electrically-operated Harsh sheeting system.

The trial was restricted to only the high speed test element to evaluate potential savings at speed under dual carriageway and motorway driving conditions.

The results indicated a fuel-saving of 6.9% on the first run when the empty body was sheeted compared with the second run when the body was unsheeted. The third run, which was sheeted, indicated a fuel-saving of 10.7% when compared with the unsheeted second run. These improvements, averaged over the two sheeted test runs, equate to savings of 8.8%.

Comparative MPG Results

	High Speed
	Mpg
Sheeted	14.25
Un-sheeted	13.33
Sheeted	14.76

Recommendations:

The trial, involving a non-standard test of three runs, indicated that a correctly sheeted empty tipper body could yield improvements in fuel consumption of over 8%. It is clear that tipper operators could therefore benefit from ensuring that the vehicle body is sheeted at all times. Long-term in-fleet trials could further validate these initial conclusions under operational conditions.

TEST No 11

Participant: Volvo/Hartshorne.

Objective: To determine the impact on fuel consumption of setting the cab roof-mounted air deflector too low.

Test Type: High-speed test only.

Vehicle Type: Volvo FL Urban Artic.

GTW: 19,700 kg.

Discussion and notes to test:

The primary function of truck aerodynamic devices is to reduce the vehicle's coefficient of aerodynamic drag, thus reducing fuel consumption and ultimately operating costs.

In previous independent testing, the cab roof deflector has been proven to be one of the most effective aerodynamic devices. A well-adjusted cab roof deflector can significantly reduce the overall drag coefficient of the vehicle and therefore provide a substantial saving in the fuel used.

However, poorly or incorrectly adjusted cab roof deflectors may have a detrimental effect on vehicle fuel consumption.

The main function of this trial was to attempt to illustrate the possible consequences on fuel consumption of an incorrectly adjusted cab roof deflector.

As it was thought to be likely that the impact on fuel consumption would be greater at higher speeds, the trial involved the test vehicle completing the high speed test element only.

The vehicle completed the first run with the cab roof deflector correctly adjusted. The test was then repeated with the deflector fixed at a low and incorrect setting.

The test actually revealed a fuel saving of 1.4% when the cab roof deflector was incorrectly set. This was an unexpected result and, as weather conditions varied considerably during the period of the test, results must be deemed inconclusive.

Comparative MPG Results

	High Speed
	Mpg
Correct setting	11.54
Low setting	11.70

Recommendations:

It is widely acknowledged within the road freight industry that a well-adjusted cab roof deflector can lead to a saving in the fuel used by the vehicle. The results gained from this test do not actually support this assumption but it must be recognised that weather conditions did vary within the test period.

In order to confirm the potential benefits, or otherwise, of these types of aerodynamic devices, extended in-fleet trials under varying and diverse operating conditions should be undertaken.

TEST No 12

Participant: Autoserve.

Objective: To determine the effects on fuel consumption of use of the Fuel Consumption Optimiser (FCO) device.

Test Type: High-speed test only for the Nissan Micra. High-speed and stop-start for the Opel Vectra.

Vehicle Type (1): Nissan Micra.

Fuel: Petrol.

Vehicle Type (2): Opel Vectra.

Fuel: Petrol

Discussion and notes to test:

As a result of the ever-increasing use of car derived vans in logistics operations, technical fuel consumption evaluation of small petrol driven vehicles is of interest to many vehicle operators. Hence the inclusion of such vehicles in what is primarily an evaluation event for heavy commercial vehicles.

The FCO device is claimed to control the airflow to the engine, thus ensuring the optimum air/fuel ratio and thereby providing an increase in power and an improvement in fuel efficiency.

The test was intended to investigate whether or not use of the FCO could actually lead to improvements in fuel consumption.

The results for the high speed testing of the Nissan Micra indicate deterioration in fuel economy of 3.9% when the FCO device is in operation. Due to time constraints, the Nissan Micra did not undergo stop-start testing.

The results for the Opel Vectra show an improvement in fuel consumption of 3.4 % during the high speed test but deterioration in fuel consumption of 23.7% on the stop-start test.

Nissan Micra Comparative MPG Results

	High Speed
	mpg
Inactive	61.31
Active	58.95

Opel Vectra Comparative MPG Results

	High Speed	Stop-Start
	mpg	Mpg
Inactive	51.09	28.04
Active	52.85	21.40

Recommendations:

Small amounts of fuel, relatively short test distances, the lack of in-vehicle recording devices and the influence of the vehicles’ drivers may all have affected the accuracy of this test. Further extended in-fleet evaluations and more comprehensive test procedures to address these issues are required.

TEST No 13

Participant: Hiclone.

Objective: To determine the effects on fuel consumption of fitting the Hiclone Swirl Generator.

Test Type: High-speed and stop-start tests.

Vehicle Type (1): Scania 124.470 rigid vehicle.

GVW: 25,460 kg.

Vehicle Type (2): MAN 25.400 Noge tri-axle coach.

GVW: 16,080 kg.

Measuring the effects on fuel consumption of fitting the Hiclone Swirl Generator

Discussion and notes to test:

The Hiclone Swirl Generator device comprises a stainless-steel collar with perforated, static vanes intended to induce swirl in the inlet air. It is fitted in the intake tract after the turbocharger, close to the induction manifold. The increased air circulation is alleged to improve fuel economy.

The Hiclone device fitted to the Scania vehicle made no difference to fuel economy on the high-speed test. An improvement of 8.3 % was achieved on the Scania vehicle during the stop-start test. Due to operating constraints, this vehicle was not fitted with the gravimetric system and results were taken from the vehicle's OBC.

The gravimetric system results obtained from the MAN coach suggest a minimal deterioration in fuel economy during the high-speed test when the Hiclone device was installed. It was noted that speed control by the driver during this element of the test was poor and might have led to inaccuracy within the results.

The stop-start section results for the MAN coach showed that fuel consumption improved by 2.1 % when the Hiclone device was fitted.

Scania Comparative MPG Results

	High Speed	Stop-Start
	mpg	mpg
With	11.48	9.13
Without	11.48	8.43

TABLE 23 - HICLONE – MAN COACH

	High Speed	Stop-Start
	mpg	mpg
Without	12.20	8.97
With	12.12	9.16

Recommendations:

Improvements in fuel consumption were evident in some elements of the test when the swirl generator was active. There may be some indication that the device is more effective at low engine speeds and may be suited to vehicle operations involving regular stopping and starting. This could include urban multi-drop activities, for example.

To investigate the potential benefits of this device in a variety of vehicle operations, further longer-term in-fleet evaluations are recommended.

TEST No 14

Participant: PD5.

Objective: To determine the effects on fuel consumption of the PD5 fuel conditioner.

Test Type: High-speed and stop-start tests.

Vehicle Type (1): Mercedes Benz 2 axle 1018-3 car transporter.

Mercedes Benz 2 axle 1018-3 car transporter

GVW: 6,380 kg.

Vehicle Type (2): Mercedes Benz 2 axle 1017-3 car transporter.

Mercedes Benz 2 axle 1017-3 car transporter

GVW: 6,110 kg.

Vehicle Type (3): Volvo FL618 rigid tipper.

GVW: 14,710 kg.

Volvo FL618 rigid tipper

Discussion and notes to test:

PD5 is a fuel additive. It is alleged to be a chemical-free solution of ionically-charged aqueous droplets, suspended in low concentrations (10ml per 40 litres) within the vehicle fuel tank. It is described by its manufacturers as a fuel conditioner which can be added to all types of fossil fuels to provide an increase in fuel economy and a reduction in vehicle emissions.

The results for the Mercedes Benz transporter 1018-3 indicated a marginal deterioration in fuel efficiency when PD5 was used on the stop-start section.

The results for the Mercedes Benz transporter 1017-3 also indicated a marginal (2.5%) deterioration in fuel efficiency when PD5 was used on the stop-start section.

The results for the Volvo FL 618 Tipper, however, indicated an improvement in fuel consumption of 4 % on the high speed section and 6.5 % on the stop-start section with PD5 active.

Mercedes Benz 1018-3 Comparative MPG Results

	High Speed	**Stop-Start**
	mpg	Mpg
Without conditioner	18.57	20.60
With conditioner	18.57	20.14

Mercedes Benz 1017-3 Comparative MPG Results

	High Speed	Stop-Start
	mpg	Mpg
Without conditioner	18.57	22.66
With conditioner	18.57	22.11

Volvo FL618 Comparative MPG Results

	High Speed	Stop-Start
	mpg	Mpg
Without conditioner	13.14	11.05
With conditioner	13.67	11.77

Recommendations:

The test results for the Mercedes Benz vehicles indicated a deterioration in fuel economy when PD5 was used. The test results for the Volvo tipper, however, showed improvements in fuel efficiency on both the high speed and stop-start sections when PD5 was in use. These results are contradictory and the overall test must therefore be deemed inconclusive.

In order to establish consistency in the results, longer term in-fleet operational testing should be undertaken to fully determine the potential benefits, or otherwise, of the conditioner.

TEST No 15

Participants: FTA/TDG Driver Training.

Objective: To determine the impact on vehicle fuel consumption of driver training.

Test Type: Stop-start test only.

Vehicle Type: Daf 85 Tractor and semi-trailer.

GTW: 23,660 kg.

Daf 85 Tractor and semi-trailer

Discussion and notes to test:

It was intended that this test would show the value of driver training in improving vehicle fuel efficiency.

Unfortunately, both test drivers submitted for this test were actually driver trainers rather than the originally intended one driver trained in a fuel efficient driving style and one driver untrained in such a driving style.

In addition, only the stop-start section of the test was satisfactorily completed. The results of the test were therefore subject to an unacceptable bias, as much larger improvements in fuel efficiency would be expected from a trained driver in the stop-start section of the test rather than in the constant high-speed test.

Unfortunately, therefore, no meaningful conclusions can be drawn from these results.

Comparative MPG Results

	Stop-Start
	mpg
Driver (Trainer) 1	7.43
Driver (Trainer) 2	8.55

Recommendations:

It is widely accepted that good quality training in safe and fuel efficient driving techniques can produce considerable savings in the amount of fuel used and, in the longer term, can lead to improvements in driver safety records.

Unfortunately, due to major discrepancies throughout the testing process, this particular test must be deemed void and the results disregarded.

A more appropriate test would involve two novice drivers taking part in both the high speed and start-stop tests and then undergoing appropriate driver training. Once training was completed, the drivers would repeat both sections of the test for a second time. Results before and after training could be compared and sound conclusions could be drawn.

Alternatively, one novice driver could receive training and one could remain untrained. Results for the two drivers could then be directly compared.

GENERAL DISCUSSION

Improving fuel efficiency is vitally important, in terms of both reducing the environmental impact of road transport and in increasing the profitability of commercial vehicle operations.

Some major points relating to vehicle fuel efficiency and technical evaluations, arising from the 2003 BTAC/IRTE Technical Evaluation Event, are summarised as follows:

- The gravimetric system of fuel measurement is still considered to be the most appropriate and accurate method for the type of testing employed at the event.
- It should be noted, however, that in the case of certain vehicles, as a result of technical and operational practices and constraints, the gravimetric system may not prove the most practicable method of fuel measurement and OBC measurements may be used instead.
- It should be noted that some OBC applications make no provision for measuring the consumption of fuel in units less than one litre. Whilst there is an increasing trend to rely on OBCs and telematics systems for measurement and reporting of fuel consumption data, careful consideration should be given to the accuracy of the equipment employed.
- As a result of the ever-increasing use of car derived vans in a range of operations, including local collections and deliveries, evaluation of small petrol-driven vehicles is of interest to many operators.
- Measuring speed and time becomes an issue with small or light vehicles due to the absence of tachograph recording equipment. In order to reduce the impact of these difficulties, and to obtain robust data, a system of in-fleet trials and evaluations specifically for small or light vehicles should be developed.
- Where relatively small amounts of fuel are consumed, the effects of climatic conditions at the time of testing may significantly influence results. This is particularly relevant to smaller and lighter vehicles. In-fleet testing over a longer time period might help to reduce this negative impact on test results.
- Longer-term in-fleet trials would also be of great benefit in the evaluation of fuel efficiency in heavy goods vehicles. It is acknowledged that the BTAC/IRTE event has its limitations. The annual event provides a short time window within which testing must take place. There is little or no time to deal with anomalies in the testing or discrepancies in the results. In-fleet testing over a much longer time period would enable more accurate and robust data to be collected and more sound conclusions to be drawn. The concept of extensive future in-fleet testing should be given serious consideration.
- Claims made by manufacturers and their agents concerning so-called fuel saving interventions should always be treated with caution. Interventions can be sensitive to specific technical and operational variables. It is therefore essential that independent testing be carried out to minimise the

effect of these variables, such as driver behaviour, to produce reliable test data.

- Testing of fuel saving interventions is an intensive and complex issue which demands rigorous and transparent procedures in order to obtain robust data.
- This report highlights many of the problems, which exist in relation to the technical testing of commercial vehicles.

APPENDIX 1 - TECHNICAL GLOSSARY

Aeroquip Self-Sealing Coupling: Quick-release coupling allowing the fuel tank to be removed without fuel spillage.

Air Conditioning: System of filtering air and maintaining a desirable temperature and humidity level within the vehicle cab.

Air Deflector: Contoured panel mounted on the cab roof to improve airflow between cab and body and thus reduce aerodynamic drag.

Automatic Transmission: Geared transmission unit in which gear ratios are automatically selected and engaged without the need for driver intervention.

Cruise Control: Automatic control adjusting engine output and selecting gears in an automatic gear change system to maintain a constant pre-selected speed.

Fuel Consumption Optimiser (FCO): An intervention, claimed to offer fuel savings, submitted for evaluation.

Fixed Pedal Test: A test in which the travel of the accelerator pedal is restricted to a predetermined point.

Fuel Intervention: A product or service claimed to improve vehicle fuel efficiency.

Fuel Conditioner: Products designed and claimed to reduce emissions, improve fuel consumption and extend the life of both the engine and fuel system.

Fuel Efficient Tyres (Energy Tyres): Tyres designed to provide a lower rolling resistance on the road surface and intended, as a result, to reduce vehicle fuel consumption.

Gravimetric System: Method in which the amount of fuel used is determined by weight, rather than volume.

High-Speed Test: A test conducted on the MIRA high speed test track, consisting of a total of 15 laps.

Hydrometer: Calibrated float.

Intake Tract: A section of the engine's induction system.

Manifold: System of ducts or pipes that divide the flow and conduct it to more than one point of delivery or that unite a flow from a number of sources for delivery at one point.

Manual Transmission: Transmission in which gears are selected by a driver operated mechanism.

OBC: On-Board Computer.

PD5: Chemical-free fuel conditioner claimed to improve fuel consumption. An intervention submitted for testing.

Specific Gravity: The density of a substance relative to the density of water.

Stop-start Test: A test conducted on the MIRA test track consisting of 10 laps, requiring the vehicle to stop at predetermined points.

Swirl Generator: A device designed to induce increased air swirl within the induction system. An intervention submitted for evaluation.

Tachograph: Instrument that records vehicle usage data using a time base, usually by stylus on a paper disc.

Telematics: The combination of telecommunications and computing. Data communication between systems and devices.

Turbocharger: A centrifugal compressor or supercharger driven by exhaust gas energy, extracting more power from an engine of a given capacity.

APPENDIX 2

BTAC/IRTE TECHNICAL EVALUATION EVENT

<u>RECORDING SHEET FOR HIGH SPEED AND STOP-START TESTS</u>

Vehicle Running No ..……………………... Vehicle Reg No …………………
Company…………………………………… Date……………………………….
Driver…………………………………..…… Observer………………………..……

<u>No 1 – HIGH SPEED CIRCUIT – ODO RECORDS</u>

<u>Laps 1-5 : 60 km/hr (37mph)</u>

LAP 1	LAP 2	LAP 3	LAP 4	LAP 5

<u>Laps 6 – 10 : 80 km/hr (50mph)</u>

LAP 6	LAP 7	LAP 8	LAP 9	LAP 10

<u>Laps 11 – 15 : 96 km/hr (60mph)</u>

LAP 11	LAP 12	LAP 13	LAP 14	LAP 15

<u>No 2 – LOW SPEED and STOPPING CIRCUITS – ODO READINGS</u>

<u>Laps 1-5 : 50 km/hr (31mph) – One stop per lap</u>

LAP 1	LAP 2	LAP 3	LAP 4	LAP 5

<u>Laps 6-10 : 32 km/hr (20mph) and 48 km/hr (30mph) – Six stops per lap</u>

	LAP 6	LAP 7	LAP 8	LAP 9	LAP 10
Stop from 32 kph					
Stop from 32 kph					
Stop from 48 kph					
Stop from 48 kph					
Stop from 48 kph					
Stop from 48 kph					

NOTE: Fill in odometer reading in appropriate box as you pass the exit point for the high speed circuits, and the stopping points for the low speed circuits. Use a separate sheet for low and high speed runs.

Enquiries to: The Society of Operations Engineers,
22 Greencoat Place, London, SW1P 1PR Tel: 0207 630 1111,
Fax: 0207 630 6677, Email: sarah.prest@soe.org.uk

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APPENDIX 3

IRTE A PROFESSIONAL SECTOR OF THE SOCIETY OF OPERATIONS ENGINEERS

BTAC/IRTE TECHNICAL EVALUATION EVENT

No 1 – HIGH SPEED CIRCUIT

Vehicle Running No ..…………………….... Vehicle Reg No …………………
Company…………………………………… Date……………………………….
Driver………………………………….…… Observer……………………..……

LAP CHART

Laps 1-5 : 60 km/hr (37mph)

LAP 1	LAP 2	LAP 3	LAP 4	LAP 5

Laps 6 – 10 : 80 km/hr (50mph)

LAP 6	LAP 7	LAP 8	LAP 9	LAP 10

Laps 11 – 15 : 96 km/hr (60mph)

LAP 11	LAP 12	LAP 13	LAP 14	LAP 15

NOTE: Fill in odometer reading in appropriate box as you pass the entry point for the high speed circuit.

	FUEL WEIGHT Kgs Note 1	**TIME hh:mm:ss**	**ODOMETER Miles/Kms** Note 2
START			
FINISH			
DIFFERENCE			

Note 1: Please ensure that the weight tickets are attached to this form

Note 2: Please indicate whether odometer is in miles or kilometres
Note 3: Please ensure that the appropriate tacho chart is handed in with this form

Test Fuel Specific Gravity ……………………………………………………………

Start Temperature……………………Finish Temperature………………………

CHECK REQUIRED	RESPONSIBLE OFFICIAL	SIGNATURE
Fuel Data	Fuel Marshal	
Time Data	Start/Finish Marshal	
Results OK	Results Marshal	

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APPENDIX 4

BTAC/IRTE TECHNICAL EVALUATION EVENT

No 2 – STOP/START CIRCUIT

Vehicle Running No ..……………………... Vehicle Reg No …………………
Company………………………………… Date……………………………….
Driver……………………………….…… Observer………………….……

LAP CHART

Laps 1-5 : 50 km/hr (31mph) – One stop per lap

LAP 1	LAP 2	LAP 3	LAP 4	LAP 5

Laps 6-10 : 32 km/hr (20mph) and 48 km/hr (30mph) – Six stops per lap

	LAP 6	LAP 7	LAP 8	LAP 9	LAP
Stop from 32 kph					
Stop from 32 kph					
Stop from 48 kph					
Stop from 48 kph					
Stop from 48 kph					
Stop from 48 kph					

NOTE: Fill in odometer reading in appropriate box at the stopping points for the low speed circuits.

	FUEL WEIGHT Kgs [Note 1]	TIME hh:mm:ss	ODOMETER Miles/Kms [Note 2]
START			
FINISH			
DIFFERENCE			

Note 1: Please ensure that the weight tickets are attached to this form
Note 2: Please indicate whether odometer is in miles or kilometres
Note 3: Please ensure that the appropriate tacho chart is handed in with this form

Test Fuel Specific Gravity ………………………………………………………
Start Temperature ………………………Finish Temperature…………………

CHECK REQUIRED	RESPONSIBLE OFFICIAL	SIGNATURE
Fuel Data	Fuel Marshal	
Time Data	Start/Finish Marshal	
Results OK	Results Marshal	

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