BTAC (SATURDAY 2nd and SUNDAY 3rd) JUNE, 2001
UNIVERSITY OF HUDDERSFIELD
FUEL EFFICIENCY AND TECHNICAL EVALUATION REPORT

The aim of this test was to determine the effect on fuel consumption of varying the distance between the back of the cab on a tractor unit and the front of the trailer through the use of a sliding fifth wheel. **Funded by the Energy Efficiency Best Practice Programme (EEBPP).**

Introduction

The effect on fuel consumption of varying the size of the gap between the back of the cab on a tractor unit and the front of the trailer (Figure 1) is of particular interest to the industry. This test was specified to quantify the effect on fuel consumption and on axle weights. When the fifth wheel setting is changed the impact on axle weights can be substantial and is one reason why operators are concerned about altering the fifth wheel settings. It has to be noted that this test was restricted to part one (high-speed) of the Type one test (*see additional notes*). This is because it was an aerodynamic-based test, so only the high-speed part of the Type one test was required.

Figure 1. Example of cab gap on one of the test vehicles.

Courtesy of Transport Engineer

Technical note on fuel measurement

Fuel efficiency is evaluated using two separate types of measure and some confusion can arise when they are compared against each other. The first is volume used, which is measured in litres or gallons. The second is the volume of fuel used for a given distance and is normally expressed in litres per 100 kilometres (L/100km) or miles per gallon (MPG). By way of example consider the following. A vehicle travels 1,000 miles and uses 25 gallons of fuel therefore the MPG is 40 (1,000/25). An intervention is then applied and the vehicle travels the same 1,000 miles but uses only 23 gallons of fuel, the MPG is now 43.478 (1,000/23). The change in fuel efficiency, as measured by MPG is 8.70% ((43.478-40)/40). The change in fuel efficiency as measured by the volume used is 8.0% ((25-23)/25). Many organisations report changes in fuel efficiency in MPG or L/100km but they purchase litres of fuel. **It is not intended here to suggest which measure an organisation should use but to avoid confusion when expressing a change in fuel consumption the type of measurement must be stated**.

Equipment

Two identical DAF tractor units with matching trailers were supplied by TDG. The vehicles, training vehicles, both had on-board fuel consumption meters. They were modified to accept removable fuel tanks to permit gravimetric fuel consumption measurement.

Test sequence

A robust test procedure was drawn up to ensure accuracy and repeatability. To reduce the impact of 'order effect' the drivers and observers and their vehicles did at least two laps on the high-speed track on the Saturday evening. On Sunday, both vehicles started with their cab gaps set to the mid-point and then each vehicle had its cab gap adjusted in opposite directions as shown in Table 1 to mitigate any meteorological changes. The vehicles ran 'back to back'.

Table 1. Test sequence.

Vehicle 1 (M185)	Vehicle 2 (M186)
Mid point	Mid point
Minimum gap	Maximum gap
Maximum gap	Minimum gap

Additionally, on Saturday, the individual axles were weighed at the different cab gap settings to determine the impact on axle weights. Also the drivers agreed the road speed, engine speed and gear selections they would use on the test (Table 2).

Table 2. Road speed, gear selection and engine speed settings.

Road Speed MPH	Gear	Engine Speed RPM
37	LOW 8	1250
50	HIGH 8	1450
56	HIGH 8	1550

Establishing the settings in Table 2 reduced the chances of distortions in the data between the two vehicles and aided the production of robust data. It has been noticed on previous occasions that drivers need to operate the vehicles identically, specifically with reference to gear selection and engine speed, otherwise the fuel consumption between vehicles can differ by more than 10%.

The cab gaps are defined as the distance from the centre (horizontal) of the rear of the cab to the centre (horizontal) of the rear of the trailer and are indicated in the second column in Table 3

Table 3. Effect upon axle weights.

Vehicle	**Distance**	**Tonnes**					
	Centimetres	Front Axle	Drive axle	Front trailer axle	Middle trailer axle	Rear trailer axle	Gross
M185							
Minimum gap	113	5.92	7.23[1]	2.94	2.99	2.98	22.00
Mid point	135	5.58	7.23	2.86	2.95	2.95	21.50
Maximum gap	155	5.28	7.58	2.91	2.95	2.95	21.70
M186							
Minimum gap	113	5.84	6.49	3.07	3.09	3.05	21.5
Mid point	135	5.62	6.95	3.09	3.05	3.07	21.8
Maximum gap	155	5.17	7.23	3.06	3.01	3.07	21.5

[1] Figure needs checking (see additional notes 2) also the gross weight seems high.

Whilst neither vehicle was fully loaded the effect upon axle weights can be seen. It should be remembered that vehicles tend to run out of load space, 'cube out', before they reach their maximum permissible weight, 'weigh out'.

Test Results

On Sunday the vehicles were tested 'back to back'. However, a breakdown meant that one vehicle was 1 hour behind the other. Analysis of the results calculated by the use of the gravimetric method (Table 4) indicates that there are savings to be made.

Table 4. Fuel consumption (MPG) using the gravimetric method.

Vehicle	**Fuel Consumption MPG**	**Average Speed MPH**
M185		
Minimum gap	9.613	43.975
Mid point	9.481	43.277
Maximum gap	9.227	41.945
M186		
Minimum gap	9.694	42.601
Mid point	9.080	41.945
Maximum gap	8.893	41.945

The data in Table 4 indicates the savings to be made by using the fifth wheel correctly. Vehicle M185 improved its fuel consumption by 4.18% *((9.613-9.227)/9.227)* when using the maximum cab gap as the base line. Vehicle M186 improved its fuel consumption by 9.01% *((9.694-8.893)/8.893)* when using the maximum cab gap as the base line. Also shown in Table 4 is the average speed, which shows that when the cab gap was set at maximum the vehicles travelled more slowly. This will have the effect of improving fuel consumption slightly. Examination of the meteorological data revealed that when M186 had its cab gap set to maximum there was an increase in average air speed and this may explain the larger deterioration in fuel consumption.

A matrix, Table 5, shows the improvements at different settings in percentage terms. For example the difference in fuel consumption for vehicle M185 by shortening the cab gap from the maximum setting to the mid point setting is 2.75%

Table 5 Improvements in fuel consumption (MPG) in percentage terms.

M 185	Min	Mid
Min		
Mid	1.39%	
Max	4.18%	2.75%
M186		
Min		
Mid	6.76%	
Max	9.01%	2.10%

Combining the total fuel used by both vehicles at the different settings (Table 6) indicates an average fuel saving of 6.18% when comparing minimum and maximum cab gaps.

Table 6. Fuel saved (by volume) when combining both vehicles fuel consumption data.

Cab Gap	Litres
Min	42.797
Mid	44.538
Max	45.618
Fuel saved (absolute)	2.821
Fuel saved (%)	6.18%

For any operator, savings of the magnitude indicated in Table 6 are clearly desirable. It is not unusual to find tractor units with their sliding fifth wheels set to maximise the gap. One possible reason is that it provides the drivers with more room when connecting the air and electrical systems. Another possible reason is that by leaving it at the maximum setting the unit can more easily be connected to any trailer. This is especially important in fleets with varying kingpin depths. However, if it has not been pointed out to operators and drivers that fuel and money is being wasted, why should they bother to reduce the gap?

Conclusions

The test clearly indicates that fuel efficiency can be improved by reducing the cab gap. Operators and drivers need to be made aware of the benefits of reducing cab gaps to the minimum to improve fuel efficiency whilst being aware of the impact on axle weights. Where drivers are concerned about the implications of reducing the cab gap from the maximum to the minimum because of the impact on axle weights it can be seen that by reducing the gap from the maximum to the mid point (Table 5) savings of over 2% are obtainable.

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Additional Notes

1. Due to a broken down vehicle blocking the access road from the control pad to the high-speed track, M185 did not go around the control tower for the second and third runs, when the cab gap was at minimum and maximum settings. This will have had the effect of reducing the distance covered by several hundred metres. It does not affect the results with reference to comparing minimum and maximum cab gap but does have an impact when compared against the mid point setting.

2. At the time of writing, the weigh-pad report had not been received for checking.

3. The Type 1 test consists of two parts. The first part is a high-speed test conducted at three consistent speeds: 60 kph (37 mph), 80 kph (50 mph) and 90kph (56 mph). The second part consists of lower speeds and a series of stops and starts. Part one simulates operating on dual carriageways and motorways whilst part two simulates the conditions found operating in an urban environment. Full details can be found in the 'Fuel Evaluation Guide' available free from the Society of Operations Engineers (0207 630 1111).

4. As mentioned in the text cab gap has been defined as being, "…the distance from the centre (horizontal) of the rear of the cab to the centre (horizontal) of the rear of the trailer…". Some engineers prefer to use the swing clearance.

5. The air deflectors were of the fixed type and could not be adjusted.

6. To ensure accuracy, when combining the fuel consumption data (mpg and volume) for both vehicles it was decided to operate them 'back to back'. That is with a five-minute gap between them. However, due to M185 breaking down there was a one-hour gap between the two vehicles. Whilst this was not ideal its influence on the overall result should be small. Furthermore, be looking at the results for the individual vehicles it can be seen that a fuel saving is evident.