FreightBestPractice

Department for Transport

Quick Guide to Truck Aerodynamics

Quick Guide

Contents

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1 Introduction to Aerodynamic Styling

1.1 Who Should Use This Guide?

If you are responsible for acquiring or managing goods vehicles weighing over 3.5 tonnes gross vehicle weight (GVW) then this guide is for you.

1.2 How This Guide Can Help

You could save fuel and money by specifying or fitting an aerodynamic kit to your commercial vehicle fleet. This guide will help you to decide what you can do by:

- Providing a brief introduction to aerodynamic styling and its benefits
- Showing how to select and maintain aerodynamic equipment
- Listing the aerodynamic features available
- Helping to maximise fuel saving
- Pointing to further information, to save even more
- Offering some general top tips

If you require more detailed information on aerodynamic styling, its theory and how it can cut your fuel bills, see the **FREE** Freight Best Practice publication **Aerodynamics for Efficient Road Freight Operations**.
This can be ordered via the Hotline **0845 877 0 877**, or alternatively downloaded from the website **www.freightbestpractice.org.uk**

1.3 What Is Aerodynamic Styling for Goods Vehicles?

Aerodynamic styling involves adapting the shape of a vehicle to reduce the drag it creates as it moves through the air. Aerodynamics is the study of forces acting on objects moving through the air.

When a vehicle moves, the air exerts a force on the vehicle that resists its motion. This force is the **aerodynamic drag** and it has a significant effect on the fuel consumption of vehicles.

Aerodynamic drag is affected by vehicle shape, frontal area and speed.

The greater the frontal area of a vehicle or the higher its speed, the greater the aerodynamic drag will be.

Figure 1, below shows an example of a poor aerodynamic design with extensive regions of turbulence which create drag. Figure 2 shows the air-flow pattern around a more streamlined truck.

Figure 1 Typical Airflow Pattern around a Non-aerodynamic Truck

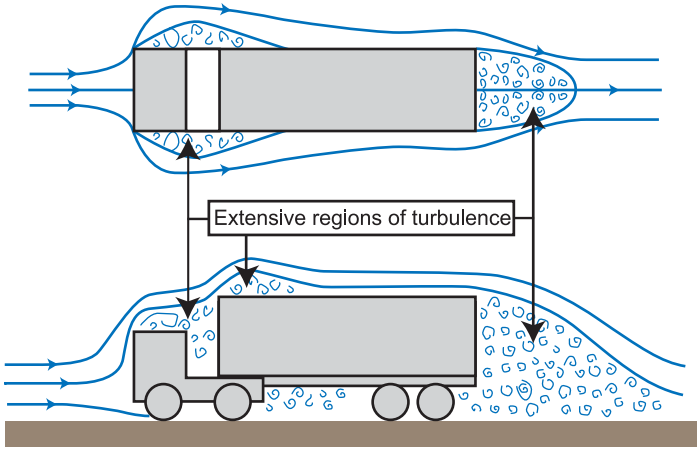
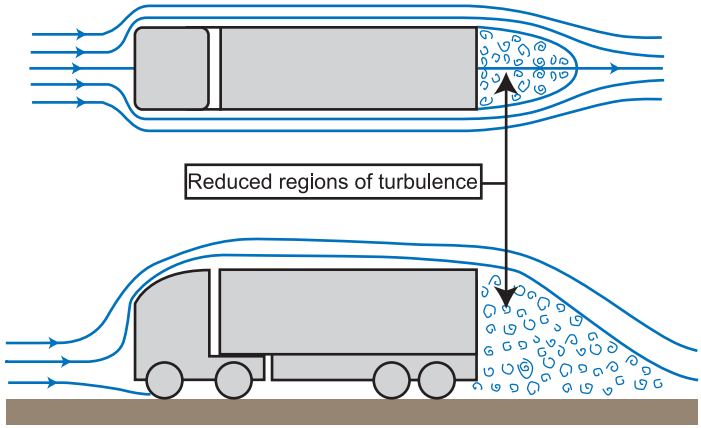


Figure 2 Typical Airflow Pattern around an Aerodynamically Effective Truck



Substantial improvements in airflow around the vehicle can be achieved by relatively small modifications such as a modest curving to the front and side edges of the cab.

1.4 Benefits of Aerodynamic Styling

The primary benefits of aerodynamic styling are:

- Reduced fuel consumption and therefore lower running costs
- Lower vehicle emissions

Other benefits include:

- Spray reduction
- Improved vehicle handling
- Reduced sensitivity to side winds, increasing vehicle stability
- Improved vehicle appearance
- Reduced build-up of road film and dirt

1.5 How Much Can I Save?

This depends very much on a series of factors; in essence, the faster and further a vehicle travels, the greater the potential savings.

High-speed Travel

Approximately half of the energy used by a truck travelling at 50 miles per hour (mph) is needed simply to move it through the surrounding air. At 60 mph, approximately two-thirds of the energy is used to cut through the air.

Large Frontal Area

The larger the frontal area of the vehicle, the greater its aerodynamic drag will be. At the time of specifying and purchasing a vehicle, avoid excessive body size, choose a small cab if possible and think how the load might affect size and shape.

Poor Initial Aerodynamic Design

A poor initial aerodynamic design increases the overall drag on a vehicle. Substantial improvements can be readily achieved by using add-on aerodynamic features.

Case Study 1

By sheeting its tipper trailers and making its tractor units more streamlined, Online MBT has reduced fuel consumption by between 5% and 14%, depending on vehicle and trailer types.

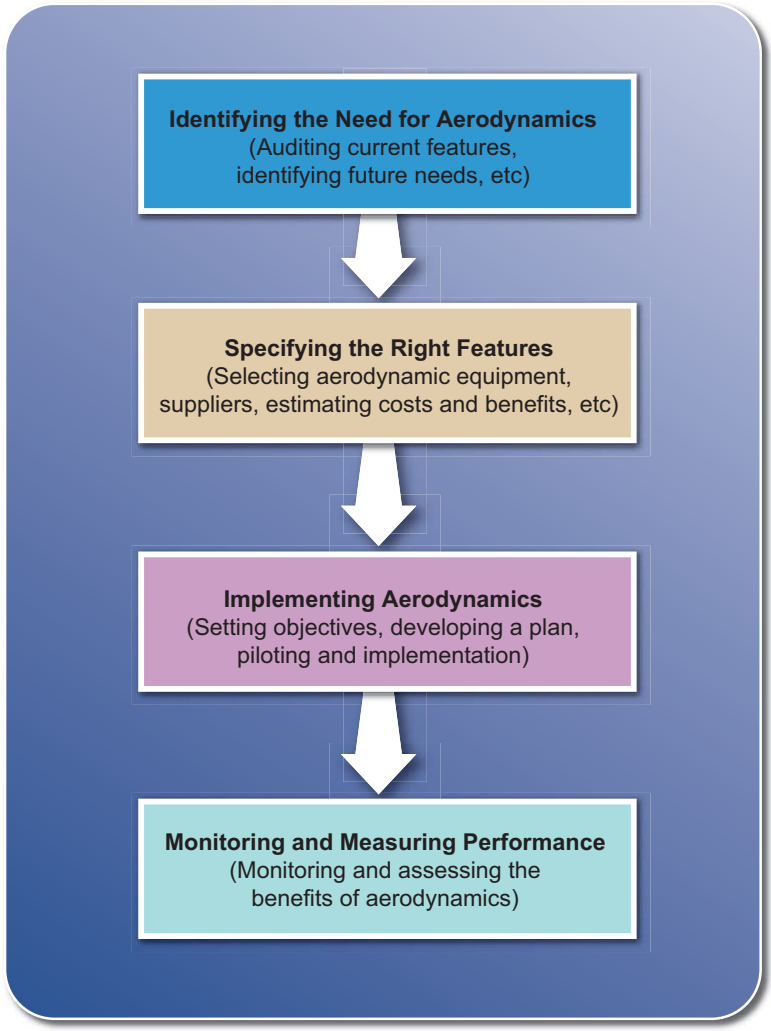
Over a five-year period, this could save the company up to £470,000.

2 Selecting and Maintaining the Right Aerodynamic Equipment

2.1 Decision-making

For the best results, follow the basic steps shown in Figure 3 and talk to others who have fitted and monitored aerodynamic equipment.

Figure 3 Aerodynamics Decision-making Process



2.2 Specifying the Right Features

Use the downloadable spreadsheet-based aerodynamic assessment tool from Freight Best Practice (see Section 5.2 for more information).

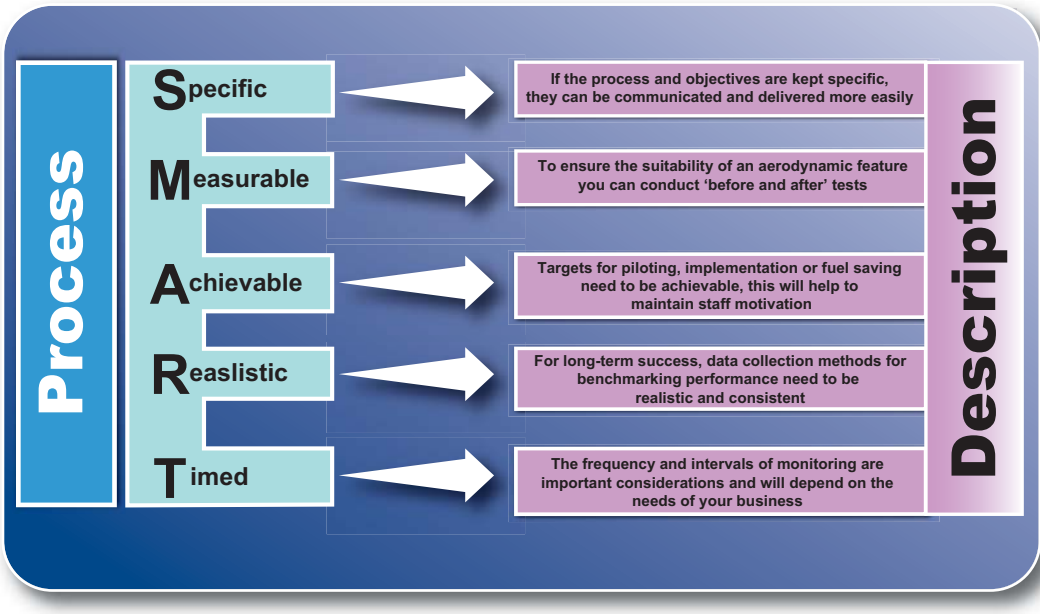
Do not take manufacturers' claims of fuel saving benefits at face value. Check whether they have used systematic and verifiable test procedures rather than anecdotal evidence.

Talk to other fleet operators who have fitted similar styling kit and find out what savings they have achieved.

2.3 SMART Implementation

The implementation process should be SMART – Specific, Measurable, Achievable, Realistic and Timed (see Figure 4).

Figure 4 SMART Implementation Process



2.4 Monitoring and Measuring Performance

The more you understand about the factors that affect fuel efficiency, the more control you will have over them.

The performance of aerodynamic equipment can be measured as a component part of a fuel management programme. The 'Fleet Performance Management Tool (FPMT)', which is a FREE software tool developed by Freight Best Practice, can help you. It produces weekly, monthly and annual reports and charts showing clearly how the main aspects of your operation are performing. The results will indicate whether improvements could be made that will reduce your costs and improve efficiency.

If you require more detailed information on aerodynamic styling, its theory and how it can cut your fuel bills, see the **FREE** Freight Best Practice publications:
Fuel Management Guide
Fleet Performance Management Tool
Small Fleet Performance Management Tool (SFPMT) Helps A1 Paper Improve Efficiency
These can be ordered via the Hotline **0845 877 0 877**, or alternatively downloaded from the website
www.freightbestpractice.org.uk

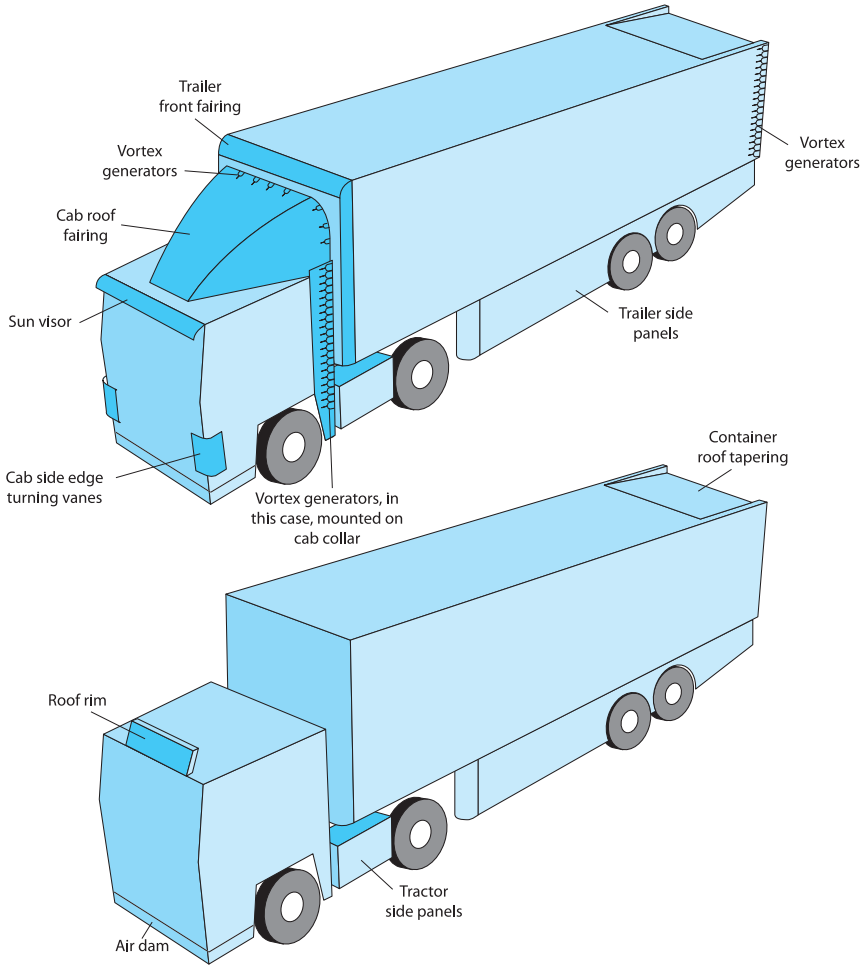
2.5 Maintaining and Adjusting Aerodynamic Features

Maintaining and ensuring that aerodynamic features are correctly adjusted will positively affect the amount of fuel used. Drivers should inspect aerodynamic equipment as part of their daily vehicle checks. Training drivers and helping them to understand the function of the aerodynamic features used on your vehicles will help you get the most out of this process.

3 Aerodynamic Equipment Shopping List

This section includes a brief description of the various aerodynamic components available. The generic term ‘container’ refers to the body (either fixed, such as a rigid body, or removable, such as an ISO container) within which the load is carried. Ensure that the features you choose are appropriate to the vehicle design and complementary to one another. Figure 5 highlights some of the most common features found on articulated and rigid vehicles.

Figure 5 Common Aerodynamic Features



3.1 Basic Vehicle Features

Basic features that influence the aerodynamics of a vehicle may be determined by vehicle specification, and must be considered when acquiring new or used vehicles.

Cab/Container Gap Minimisation

Minimising the gap between the cab and trailer on articulated/drawbar vehicles is a simple way to improve aerodynamic performance. A large gap between an articulated tractor and trailer unit turns air downwards into the gap. This causes a change in pressure, increasing the total drag of the vehicle.

Cab Front Edge Rounding

Vehicle drag can be reduced by rounding the front edge of the cab. The reduction you achieve will depend on the shape of the vehicle. With modern cabs, the side edges below windscreen level tend to be rounded.

Cab/Container Height Equalisation

A closer match between cab and container heights will reduce the drag. Heights can be equalised by using deflectors or fairings, or by changing the body. Drag can be decreased further if a lower body is used, as this reduces the frontal area of the vehicle.

3.2 Truck Cab Features

Cab Roof Deflector

Fitted to a cab roof, this flat or contoured plate can be set at different angles to suit the body and is probably the most effective single add-on for vehicles using bodies of varying heights.

The more the body extends, the more a well-adjusted deflector can offer potential benefits to reduce drag. If a trailer is not used, the drag on the cab will be much higher unless the deflector is lowered to its horizontal position.

Cab Roof Fairing

This is the single most effective roof add-on when sized appropriately for the body, and may or may not be adjustable. Roof fairings are three-dimensional mouldings which fit on the cab roof and, if adjustable, can allow maximum savings with a range of differing body heights.

Available as new or retrofit, fairings work by presenting the airflow with a smooth transition from the cab roof to the container.

Cab Collar and Roof Fairing

This is either a fixed piece mounted on the front of the body or a rearward extension to a specific fixed roof fairing, available as new or retrofit.

A collar makes the most effective transition between the cab and the body when used in conjunction with a suitable roof fairing, and it bridges the gap between the cab and the body along both sides and the roof.

Cab Side-edge Turning Vanes

Usually located on the cab front edges below the windscreen level, these small extension pieces can reduce drag if they cover sharp edges and also help to reduce the build-up of road film and dirt. The feature needs to be specified when ordering a vehicle from new.

Air Dam

Most modern vehicles come fitted with air dams, but they can also be retrofitted.

Instead of allowing air to pass through the rough under-body, air dams divert air around the sides of the truck, thereby reducing the contribution of the vehicle under-body to the drag.

Cab Side-edge Fairings

Cab side-edge fairings bridge the gap between the cab and body so are effective in reducing drag. Located at the sides of the rear cab edges, these fairings are available as new or retrofit.

3.3 Chassis Features

Tractor Side Panels

Tractor side panels cover the gap between the front and rear tractor wheels and can be fitted as new or retrofit. The panels reduce under-body drag by limiting the interaction of the airflow along the vehicle side with the vehicle chassis.

Tractor Chassis Filler Panels

Tractor chassis filler panels have most effect on trucks with a large gap between the chassis members behind the cab. Available as new or retrofit, the panel is attached to the upper surface of the tractor chassis behind the cab.

Chassis/Trailer Side Panels

These side panels cover the gaps next to the under-body on rigid vehicles or articulated trailers. Drag is reduced by limiting the interaction of the airflow along the vehicle side with the vehicle chassis. The panels are available as new or retrofit.

3.4 Body Features

Gap Seals or Vortex Stabilisers/Generators

A gap seal or vortex stabiliser/generator has the most impact on trucks with a large gap between cab and body. A gap seal is mounted on the front face of the body, extending forwards almost to the cab and vertically from the base of the body to the height of the cab. A vortex stabiliser is similar, but runs to just three-quarters of the cab height. Vortex stabilisers/generators can also be mounted on the cab collars. These features offer an effective alternative to cab side fairings on articulated vehicles.

Container/Trailer Roof Tapering

Drag caused by the rear of a vehicle can be reduced by tapering the rear of the container or trailer.

Trailer Roof Height Reduction

Drag can be reduced if the trailer height on articulated vehicles is lower than the tractor. However, the fuel efficiency benefit must be weighed against any loss in revenue resulting from having a smaller load space.

Container Front Fairing

Container front fairings are mouldings around the edge of the front of the body or drawbar trailer. Fairings either are located around the perimeter of the container front or cover the entire container front above the level of the cab.

The fairings encourage the airflow to stay attached at the front of the body roof and sides, thus reducing drag.

Aerodynamic Sloping Front Roof Trailer

The aerodynamic sloping front roof trailer has been designed to improve the aerodynamic profile of articulated vehicles. The maximum potential internal load height is usually around 3.3 m, hence the lower foredeck is generally used for loose loads.

These trailers usually come fitted with aerodynamic large radius cappings and glass reinforced plastic (GRP) skirts. An aerodynamic sloping roof needs to be specified when ordering a new trailer.

3.5 Ancillary (Add-on) Features

Cab Roof Rim

This is a raised piece extending vertically from the front roof edge, and will be mainly beneficial for cabs which have sharp front roof edges. It also provides a good location to advertise an operator’s name, which is usually one of the main reasons for purchase.

Cab Sun Visors

Sun visors can be specified in two designs and are added for driver comfort. One design extends out from just in front of the cab roof and, despite slight rounding of its edges, will increase the drag in nearly all circumstances.

The second design is more rounded and extends over the top of the cab windscreen. This design rounds the front roof edge and can improve the aerodynamics of cabs with sharp front roof edges.

Low-drag Mirrors

Rounding the front face of the mirrors can reduce drag, and the mirrors can also give the truck a smarter appearance.

Additional Lights and Horns

These items will generally increase the drag of the truck, and are normally used only for cosmetic purposes. However, the negative impact can be limited if they are positioned back from the front edge of the cab.

4 Maximise Your Savings

To maximise the savings available, you will require an awareness of the other factors that indirectly impact on vehicle performance.

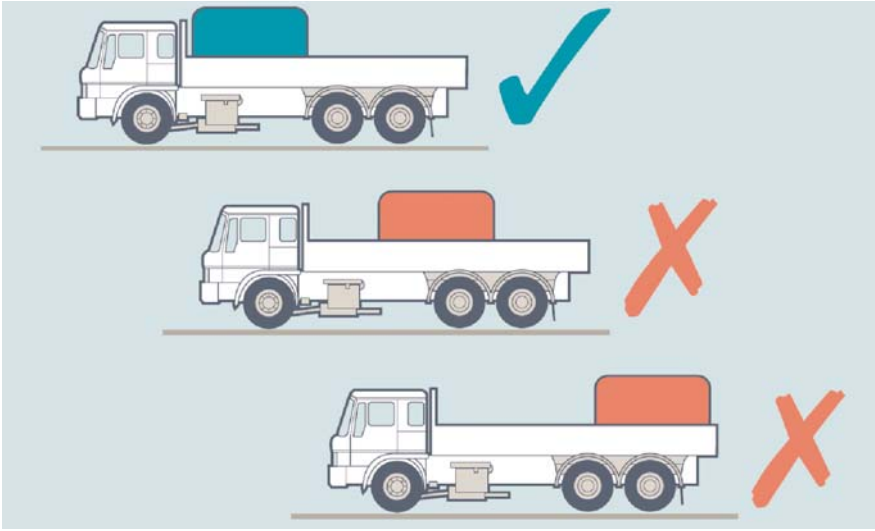
The three main factors are the position of the load, the gear ratios and driver training.

4.1 Position of the Load

Correct location and orientation of the load can help to save fuel (see Figure 6). Some key pointers - which should be communicated from management to drivers - are as follows:

- Arrange the load so that it protrudes as little as possible beyond the perimeter of the cab when viewed from the front, thus minimising the frontal area of the vehicle and typically reducing aerodynamic drag
- Locate the load as close as possible to the rear of the cab, without exceeding legal axle weights. This has the same effect as reducing the gap between the cab and trailer on articulated vehicles
- If the load is irregular in size, position the larger end nearest to the cab

Figure 6 Correct Positioning of the Load on a Flatbed Vehicle



Remember - Exceeding legal axle weights

- Can effect the steering of your vehicle
- Causes extra wear and tear to the roads
- Damages your vehicle
- Adversely affects the safety of other road users
- Increases aerodynamic drag

4.2 Gear Ratios

Combining a correctly specified vehicle and appropriate aerodynamic features is one of the keys to operational efficiency.

Decreasing aerodynamic drag reduces the power that a vehicle must produce to move at a constant speed. Therefore, after aerodynamic improvement, further fuel savings can be obtained by a corresponding change to the vehicle gearing.

The engine manufacturer should be able to provide you with the information necessary to re-specify the gearing.

4.3 Driver Training

Management can initiate training specifically for the adjustment, maintenance and driving standards that are required to achieve the most from aerodynamic features. This will develop better driving practices to maximise fuel saving and increase safety on the roads.

5 Further Information

Aerodynamic styling should not be a fuel-saving technique used in isolation. Other useful practical advice and solutions can be found through the references in this section, and should be used in conjunction with Freight Best Practice specific aerodynamic publications.

5.1 Relevant Freight Best Practice Publications

For further information, which directly relates to aerodynamic styling, see the **FREE** Freight Best Practice publications:

- Aerodynamics for Efficient Road Freight Operations (with aerodynamic assessment tool spreadsheet)
- Smoothing the Flow at TNT Express and Somerfield Using Truck Aerodynamic Styling

For further information which should be used in conjunction with the specific aerodynamic publications, see the **FREE** Freight Best Practice publications:

- Fuel Management Guide
- Fleet Performance Management Tool
- Truck Specification for Best Operational Efficiency
- 'Save It!' DVD
- Fuel Saving Tips - Your Essential Pocket Guide to Saving Fuel and Money

These publications can be ordered via the Hotline **0845 877 0 877**, or alternatively downloaded from the website **www.freightbestpractice.org.uk**

5.2 Spreadsheet Explanation

The downloadable spreadsheet-based aerodynamic assessment tool from Freight Best Practice will enable you to gain a more quantitative understanding of the possible 'real-world' benefits of aerodynamic modifications on commercial transport vehicles. The programme takes the details of the typical journey parameters for a particular fleet vehicle and estimates the potential savings. The tool has to be downloaded and primarily accompanies the 'Aerodynamics for Efficient Road Freight Operations' guide.

You can download the **FREE** software from **www.freightbestpractice.org.uk**, together with more detailed instructions on how the spreadsheet works and how to interpret the results.

6 Top Tips

A fold out section at the back of this guide overleaf contains some valuable 'tips' and illustrates some of the key issues surrounding aerodynamics. It is designed to move through a range of topics in relation to aerodynamic styling, including identifying the need for equipment, selecting features, implementing the equipment, monitoring progress and performance, and maintaining and using the equipment.

TOP TIPS

Aerodynamic Styling top tips

The Top Tips below illustrate some of the key issues surrounding aerodynamics. They are designed to move through a range of topics in relation to aerodynamic styling, including identifying the need for equipment, selecting features, implementing the equipment, monitoring progress and performance, and maintaining and using the equipment.

Identifying

- The main benefits of aerodynamic styling are financial; however, reducing fuel consumption also lowers vehicle emissions, demonstrating environmental awareness
- Aerodynamic styling should not be a fuel-saving technique used in isolation
- The potential for fuel savings is greatest in cases of high-speed travel, large vehicle frontal area and poor initial aerodynamic design

Selecting

- The specification of vehicles in relation to your operation must be correct when adding to your truck fleet. Get it right first time!
- Select aerodynamic features that are compatible with one another and that are most suitable for your operation
- Keep overall body height as low as possible (Remember the potential operational efficiency benefits of operating double-deck trailers with aerodynamically styled sloping front roofs)

Implementing

- When purchasing or implementing aerodynamic equipment, make it a project with a clearly defined programme
- It is important to always evaluate manufacturers' claims. Always try to talk to others who have implemented similar aerodynamic equipment
- Implementation of aerodynamic equipment must be specific, measurable, achievable, realistic and timed (SMART)

Monitoring

- Monitor and measure performance, as the more you understand about the factors that affect fuel efficiency, the more control you will have over them
- Be aware of indirect impacts on vehicle performance, such as the position of the load and gear ratios
- Consider certain issues associated with aerodynamic features. In some cases (e.g. gap seals or vortex generators), they might mean that a truck exceeds legal width
- Ensure that all aerodynamic equipment is maintained and adjusted correctly for appropriate tasks; daily checks will help the process
- Training drivers and helping them to understand the function of the aerodynamic features used by your business will help you maximise fuel savings

Maintaining

- Incorrectly set equipment, additional lights and horns, and other cosmetic accessories increase aerodynamic drag and reduce fuel efficiency
- Promptly repair body damage, such as nicks and tears in curtains
- Keep the tractor and trailer gap as narrow as possible(Take care not to exceed axle weight limits)
- Make sure that curtain straps and buckles are kept taut

Freight Best Practice publications, including those listed below, can be obtained FREE of charge by calling the **Hotline** on **0845 877 0 877** or by downloading them from the website **www.freightbestpractice.org.uk**

Saving **FUEL**

Fuel Efficient Truck Drivers' Handbook

This pocket guide provides information for truck drivers on fuel efficient driving techniques, details of the SAFED course and useful forms for daily use.

Performance **MANAGEMENT**

Fleet Performance Management Tool

This tool has been designed to help fleet operators improve their operational efficiency using key performance indicators (KPIs) to measure and manage performance. KPIs include costs, operational, service and compliance.

Developing **SKILLS**

Safe Driving Tips

Written especially for commercial vehicle drivers, this pocket-sized guide provides essential safety hints and tips on all aspects of driving safely.

Transport Operators' Pack **-TOP**

TOP provides practical 'every day' support material to help operators implement best practice in the workplace and acts in direct support of tasks essential to running a successful fuel management programme.

Equipment & **SYSTEMS**

Aerodynamics for Efficient Road Freight Operations

This guide offers practical information on aerodynamically effective styling for trucks including appropriate add-on features.

Case **STUDIES**

Smoothing the Flow at TNT Express and Somerfield using Truck Aerodynamic Styling

This case study shows how TNT Express and Somerfield made significant fuel savings by specifying and fitting aerodynamic equipment to their fleets.

April 2009.

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