

# Safety Technologies for Heavy Vehicles and Combinations



## Acknowledgement

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## Introduction

Heavy vehicle safety is a serious issue for road transport authorities. While their numbers make up only a small percentage of motor vehicle registrations, heavy vehicles have been involved in 16 per cent of all road fatalities over the last 5 years. This is not to say heavy vehicles are always at fault, but their size and mass make any crash a serious one.

Improvements to heavy vehicle design and safety features have made a proven contribution to reducing the number and severity of crashes.

Currently there are a wide range of crash avoidance and harm minimising technologies available on the market that have the potential to improve safety.

Some technologies have additional benefits such as improving driver and passenger comfort. Some of the more advanced technologies come at a cost but many are very inexpensive and practical to install. Approximately half of these recommended features can be retrofitted to a heavy vehicle.

When purchasing your next heavy vehicle or making after-market improvements, consider the technologies described in this publication and the potential safety benefit that may be gained.

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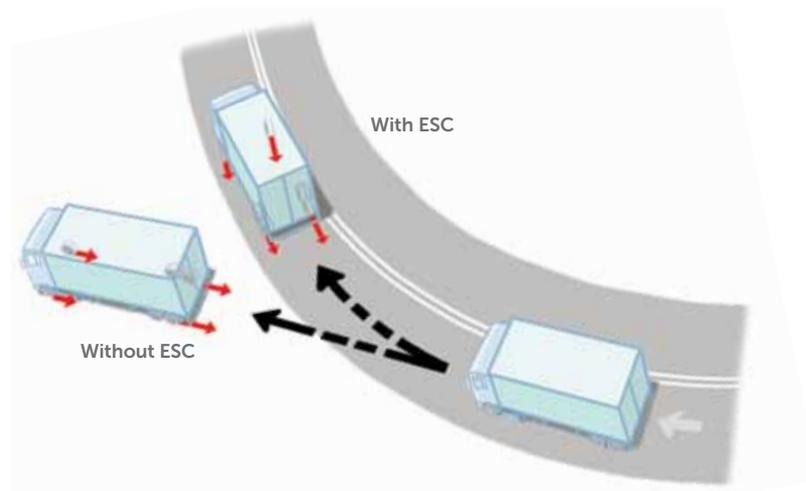
## Crash Avoidance Technologies

Crash avoidance features are safety technologies that assist the driver to reduce the likelihood of a crash. They include the following technologies you should consider when purchasing your next heavy vehicle or making after-market improvements.

### Electronic Stability Control (ESC) System

By applying braking to selected wheels (and the trailer wheels if one is being towed), an ESC system can correct a deviation from the driver's desired course. The ESC system assesses the driver's intended path and compares it with the actual direction by monitoring the driving inputs (throttle, braking level and steering angle) and the vehicle's performance (lateral deceleration, yaw deceleration and wheel speeds).

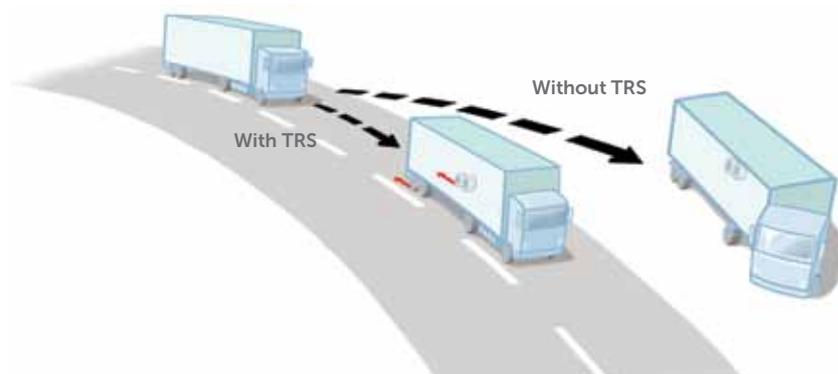
An ESC system is potentially effective in situations where there is a loss of directional control and can help avoid roll-over crashes. To minimise trailer swing when braking severely, it is recommended trailers are attached to a towing vehicle with an ESC system that also has Anti-lock Braking Systems (ABS). ESC is strongly recommended when purchasing a new vehicle as it cannot be retrofitted cost effectively.



### Trailer Roll Stability (TRS) System

A TRS system can predict a roll-over threshold and the critical speed at which this could occur by monitoring wheel speeds, weight distribution between the trailer's sides, actual lateral acceleration and air suspension pressures.

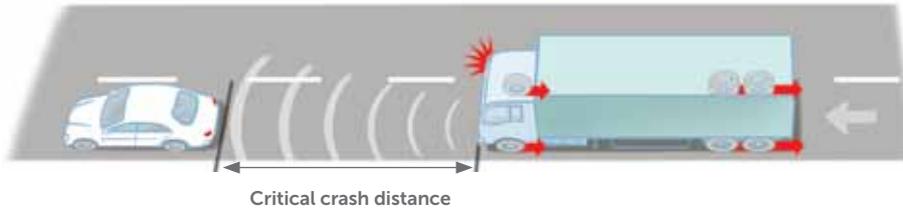
When the actual speed approaches the critical speed, the TRS system applies the brakes and slows the trailer down to prevent roll-over. The TRS system is a standard feature and can be retrofitted as one element of Electronic Brake Distribution (EBD) available for trailers in Australia.



## Autonomous Emergency Braking (AEB) System

An AEB system will apply braking when a crash threat is detected immediately in front of the vehicle. The detection system uses radar and/or optical sensors and is normally coupled with other forward sensing radar or optics vision processing technology such as Adaptive Cruise Control and Lane Departure Warning System.

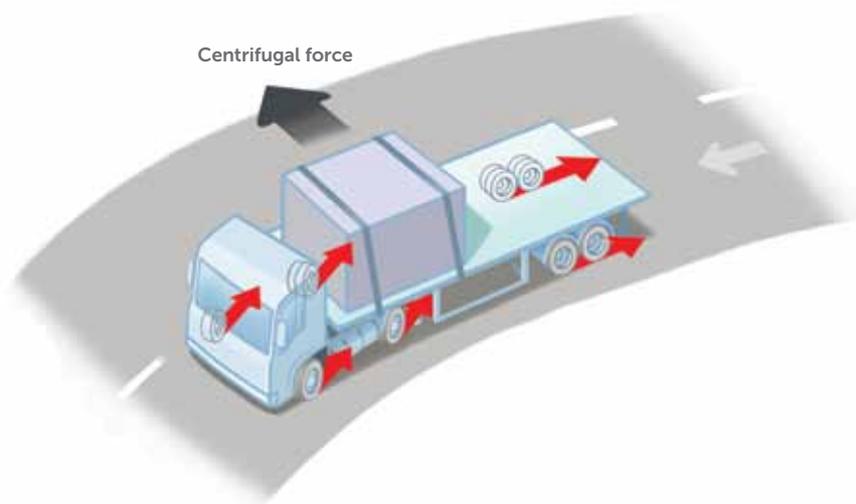
AEB technology is very effective for minimising collisions with vehicles travelling in the same direction. To avoid trailer swing when braking severely, trailers attached to a towing vehicle with an AEB system are recommended to have Antilock Braking Systems (ABS). This system cannot be retrofitted cost effectively.



## Electronic Brake Distribution (EBD) System

An EBD system provides improved braking balance by adjusting braking pressure between the front and rear axle groups according to their weight distribution. Because an EBD system operates well before wheel lock-up occurs (by monitoring the average wheel slips between sensed wheels in the axle groups), EBD technology is like an enhanced Antilock Braking Systems.

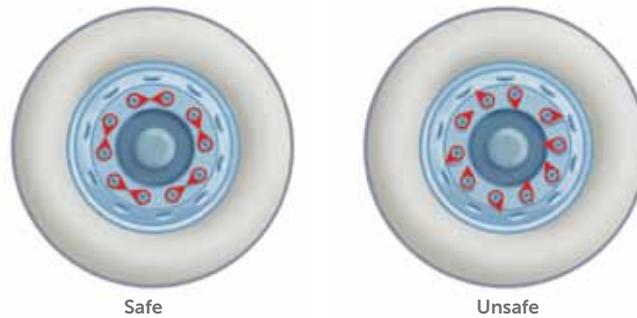
It is particularly effective when applied to an unladen trailer whose axles are prone to lock-up due to the proportionately lower axle loads if no brake balance systems are installed. It is important that a trailer attached to a towing vehicle with an EBD system has Antilock Braking Systems to avoid trailer swing when braking severely. This system can be retrofitted, but is usually more cost effective when purchased as a feature in a new vehicle.



## Wheel Nut Indicators and Locks

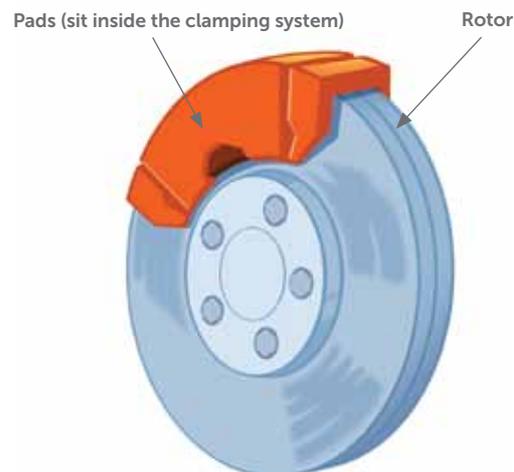
Checking that all wheel nuts are properly fastened prior to driving is good practice and highly advisable when wheels have been changed. Wheel Nut Indicators are plastic caps which can be fitted over the hexagonal heads of the wheel nuts. The way they are positioned provides a pattern which indicates whether the nuts have loosened over the course of a journey.

Wheel Nut Locks come in the form of a plastic strap which is shaped to fit over the wheel nuts and lock them in place. Even if the nuts loosen slightly they are prevented from coming off, preventing any wheel detachment. Installing Wheel Nut Indicators and Locks can reduce maintenance time and both can easily be retrofitted.



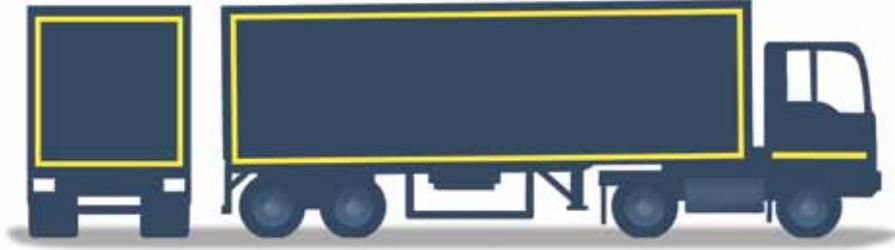
## Disc Brakes

Disc brakes produce a much higher brake force per kilogram of brake weight in comparison to drum brakes. Importantly, disc brake performance improves as the components heat up, whereas drum brakes performance deteriorates, producing potentially unbalanced braking when they are incorrectly combined on a vehicle. If used in combination with drum brakes, disc brakes tend to provide a disproportionate share of braking effort and wear out quickly, so, mixing drum and disc brakes should be avoided. While the cost of disc brake parts is generally higher, their easier maintenance and lighter weight make them a very attractive technology. Disc brakes can be retrofitted.



## Enhanced Vehicle Visibility Markings

Vehicle markings will increase vehicle visibility in low-light conditions, just like reflective clothing. When fitted, vehicle visibility markings must meet Australian Design Rule requirements. Many older heavy vehicles in Australia suffer from poor voltage flow to the rear lights and reflective markings aid vehicle visibility without the need for power. Vehicle visibility markings can be retrofitted. The Australian Trucking Association has an industry technical council advisory procedure that provides a guide to enhance vehicle visibility.



## Tyre Pressure Management Devices

Tyres have a crucial influence on the braking and stability performance of a heavy vehicle and incorrectly inflated tyres pose a safety risk for both heavy vehicle and other road users.

A number of critical factors are dependent on the inflation pressures:

- The road-tyre friction.
- The cornering stiffness.
- The contact patch of the tyre with the road.

Ensuring optimal tyre pressures reduces the stopping distance that can be achieved without losing directional control.

A Central Tyre Inflation (CTI) system manages the air pressure in all the tyres in an axle group and use a compressor or high pressure air reservoir and valve system to inflate or deflate the tyres to the selected pressure. The system issues alerts if the selected pressure levels cannot be met. CTI systems allow the driver to vary tyre pressure to accommodate different loads and conditions. A CTI system can be retrofitted, but requires an axle hub and wheel assembly compatible with the air inflation system as part of the retrofit.

Tyre Pressure Monitoring Systems (TPMS) use pressure sensors located on the rim inside the tyre. The sensors report the tyre pressure to a monitoring unit in the driver's cabin and an alert is issued if the pre-set pressure (usually set by the driver) is not met. TPMS sensors communicate via radio signals and are charged by wheel motion. TPMS can be easily retrofitted.

Also available on the market are commercial tyre management systems that monitor tyre and rim conditions, maintenance schedules, and track wear rates to predict the life of the tyres.

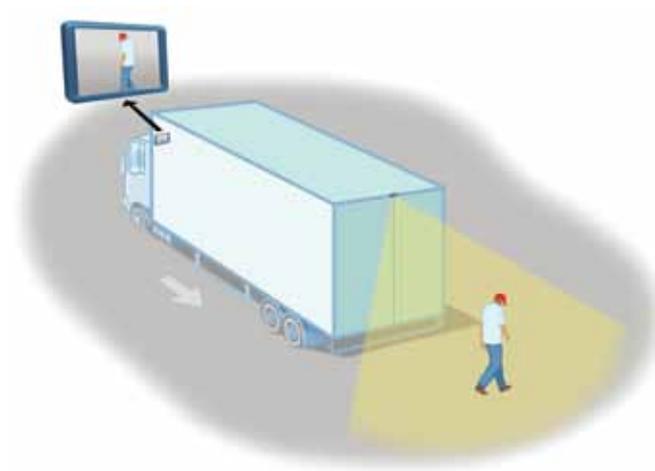
Careful management of tyre pressure can improve tyre life and improve tractive effort as well as assisting in maintaining the vehicle's braking and stability performance.



## Reversing Safety Systems

The following three technologies may assist drivers to avoid crashes when reversing heavy vehicles:

1. Reversing Buzzer – provides a warning to other road users that the reverse gear has been selected. Whilst Reversing Buzzers are common, particularly on delivery vehicles, they provide no feedback to the driver. They are seldom used on trailers because there is usually no reversing circuit.
2. Reversing Camera – provides the driver with a view of the space immediately behind the vehicle. These systems offer a potential benefit for vehicles operating in areas of high pedestrian activity such as on passenger buses, in loading docks and for garbage trucks operating in narrow streets and pedestrian areas.
3. Reversing Sensor – uses an audible alarm to warn the driver that the vehicle is close to an object at the rear.

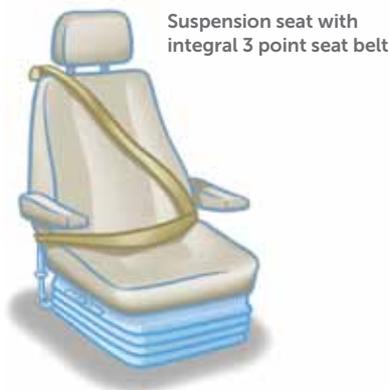


## Protective Technologies

Protective systems features are safety technologies that assist to reduce the severity of a crash. They include the following technologies you should consider when purchasing your next heavy vehicle or making after-market improvements

### Suspension Seats with Integral Seat Belts

Heavy vehicle drivers have a far better chance of surviving a serious crash when wearing a properly adjusted seat belt. A driver suspension seat with an integral seat belt provides the most comfortable driving experience because the seat belt anchors move with the seat to avoid seat belt retraction and locking. Suspension seats help reduce fatigue and back injuries, especially when operating in rough road conditions. Free-standing suspension seats can be retrofitted however require an authorised signatory (engineer) to certify the seat standard and ensure the precise engineering to anchor them correctly.



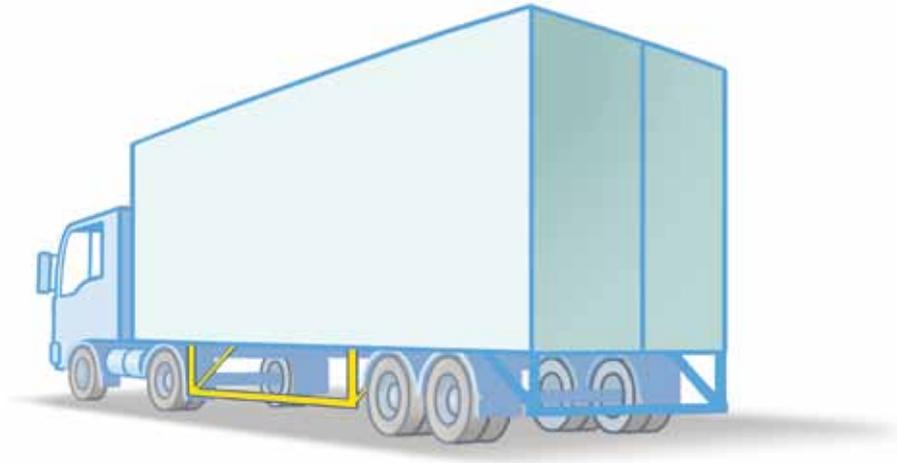
### Rear Underrun Protective Devices (RUPDs)

RUPDs prevent lighter vehicles from running under a heavy vehicle and being harmed by the heavy vehicle's unyielding structure. Additionally, if the barrier has energy absorbing properties the crash deceleration forces could be significantly reduced and the survival rates for the occupants of the lighter vehicles considerably improved. RUPDs can be retrofitted.



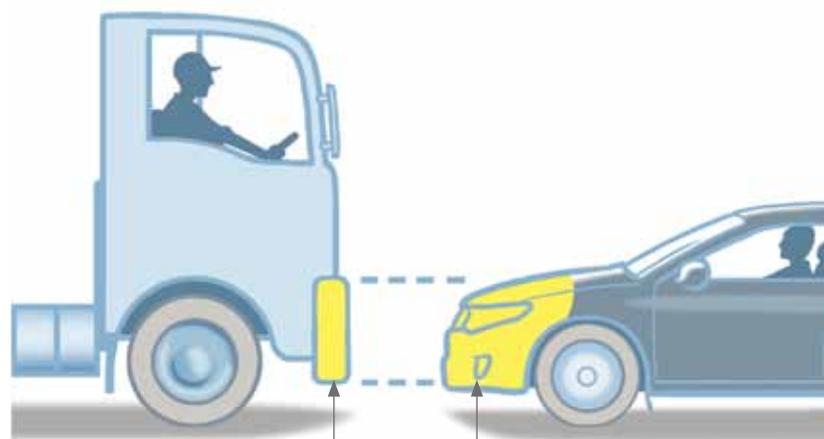
## Side Underrun Protective Devices (SUPDs)

SUPDs prevent pedestrians, cyclists and motorcyclists from entering under the sides of a vehicle and being run over by the rear wheels. SUPDs are designed mainly for low-force side crashes and can be retrofitted, however it is important the devices do not interfere with the heavy vehicle's design functions when installed (i.e. articulation clearance, fuel tank positioning, EBS, etc).



## Front Underrun Protective Devices (FUPDs)

FUPDs act in two ways to minimise the severity of collisions with the front of a heavy vehicle. Firstly, they assist other enclosed vehicles to survive crashes with the front of a heavy vehicle by preventing the smaller vehicle from running under the heavy vehicle, and possibly deflecting it away. Secondly, they may protect the steering and front axle components of the heavy vehicle, which could assist the heavy vehicle driver to maintain control immediately after a collision. The safety benefits of FUPDs are increased if they have energy absorbing qualities. Some FUPDs are integrated with a bull bar in their design. FUPDs can be retrofitted.



Front Underrun Protective Device

Crumple zone

## Supplementary Restraint System (SRS) Airbag System

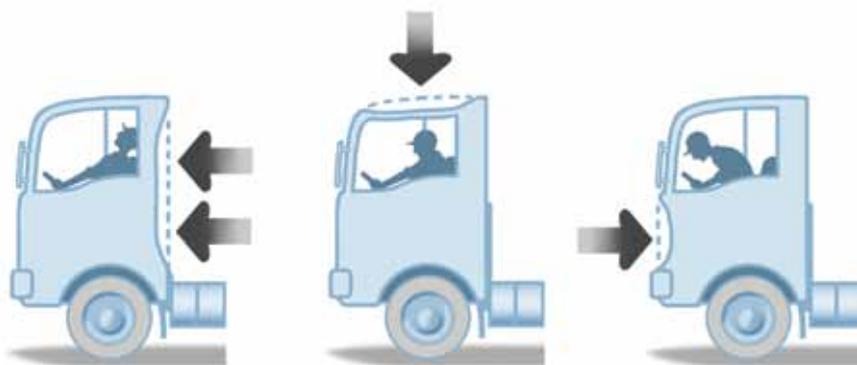
An SRS airbag protects vehicle occupants in the event of a severe crash. While SRS driver airbags are a standard feature on nearly all European heavy vehicles, this technology is not generally standard in Australian, North American and Japanese manufactured models. Safety benefits may be further gained when driver airbags are coupled with a suspension seat with an integral seat belt which can have a co-ordinated seat belt locking mechanism. Driver SRS Airbag systems cannot be cost effectively retrofitted to vehicles not originally equipped with them.



## Cabin Strength Standards

By intelligent design, heavy vehicle manufacturers can increase the strength of the cabin, along with the occupant's chance of survival in the event of a roll-over or severe crash. To protect the occupants from serious injury, a well-designed cabin must not intrude into the defined space for occupant survivability.

Original features to look for when purchasing a new vehicle, which cannot be retrofitted, include: shaped panels (roof and floor pan) to increase bending strength without adding weight, strong structural panels, triangulation of structural members and gussets between intersecting structural members.



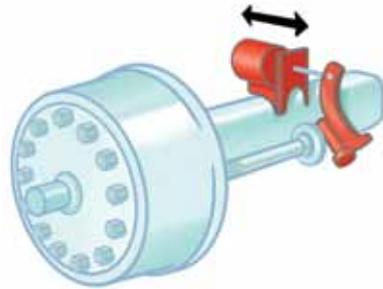
## Seat Belt Wearing Monitors

Seat belt wearing monitors provide an indication to drivers when the seat belt is unbuckled. A seat belt monitoring system may also be used to record seat belt use in a post-driving report. Many European manufactured heavy vehicles have seat belt monitors, but they are less common in Australian, North American and Japanese vehicles. Seat belt monitoring systems can be retrofitted.



## Automatic Brake Adjustment (ABA) Devices

An ABA device is an optional feature for drum brakes and a standard feature for disc brakes. A vehicle with poor brake adjustment may not meet legal stopping distance performance requirements. Poorly adjusted brakes will also affect brake wearing and can adversely impact on the performance of an ABS installation. ABA devices are readily available for retrofitting and are quite cost effective as they can assist in reducing brake adjustment downtime.



## General Safety Technologies

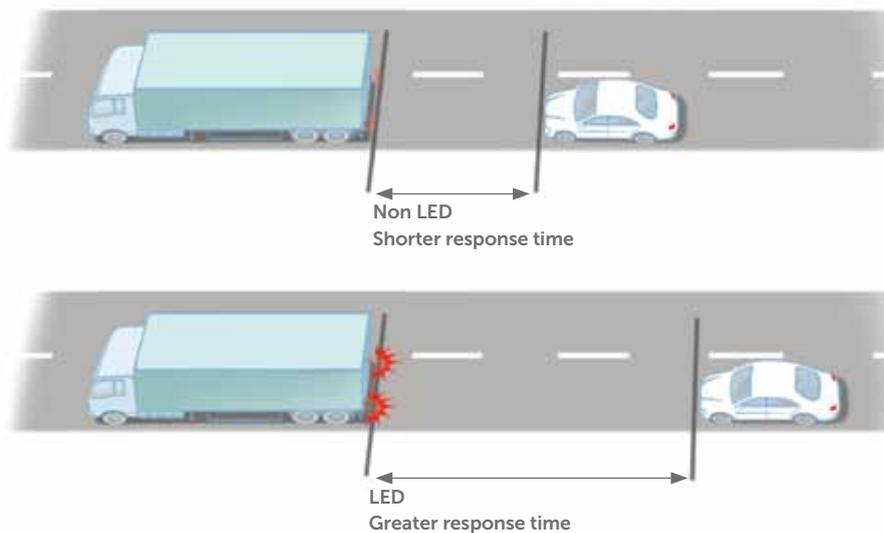
General safety technologies provide workplace safety benefits. They include the following technologies you should consider when purchasing your next heavy vehicle or making after-market improvements.

### Light Emitting Diode (LED) Lighting

LED lighting technology has delivered many road safety and efficiency benefits to heavy vehicles by offering brighter and more consistent lighting at night and enhancing their visibility. LED lamps use a fraction of the power of an incandescent bulb of comparable brightness. The substantially lower electrical current draw reduces the impact of voltage drops which results in poor rear lighting particularly in longer heavy vehicle combinations.

The circuitry design on most LED lamps is compatible with a range of supply voltages which also solves the problem of voltage incompatibility of 12V and 24V equipment. LED lamps operate faster than incandescent lamps and reduce application times by up to 0.2 of a second. At 100 km/h, a 0.2 second greater response time means a significant stopping distance reduction of about 6 metres. LED lamps have proven electrical reliability that exceeds that of incandescent bulbs. LED lamps can be retrofitted.

Care should be taken however when retrofitting too many LED lamps as it may dazzle other road users instead.

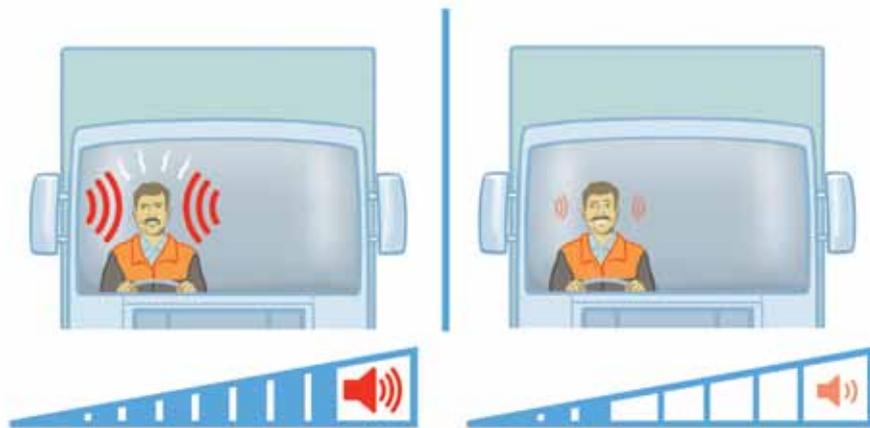


## In-Cabin Noise Quality

Cabin noise level is a significant factor to consider when purchasing a vehicle. High cabin noise levels are likely to increase the driver's stress and reduce concentration, as well as inducing driver fatigue that increases the risks of road crashes and hearing loss in the long term. High cabin noise levels result from multiple factors including the cabin's proximity to the exhaust outlet, muffler, exhaust, transmission, cooling fans and turbochargers.

Treatments and the practicality of reducing in-cabin noise levels will depend on the source/s of the noise and existing cabin design, but a number of remedies include fitting:

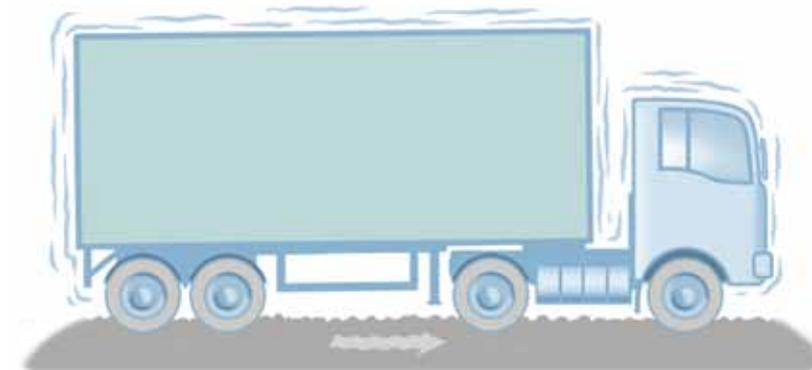
- Noise absorbing close-cell foams and padding.
- Heavy barrier layers in mats and insulation.
- Effective isolation mounts, particularly for mufflers.
- Cooling fans with a low-noise design.



## Ride Quality

The most apparent aspect of ride quality is that a comfortable vehicle leads to a more enjoyable driving experience. Poor ride quality not only affects driver comfort, but can also cause driver fatigue and long-term health problems. Ride quality should be an important consideration when purchasing a new heavy vehicle.

Small vibrations that are unnoticed on short trips can easily lead to fatigue on longer trips. In extreme cases, poor ride quality has the added safety issue of poor vehicle handling, especially when a vehicle has wandering steering and can deviate without constant driver steering input. Most poor cabin ride quality results from the inadequate isolation of the driving seat from the road, which can be greatly improved by a good choice of suspension seats, cabin suspensions, and axle suspensions.



## Ergonomic Cabin Design

An ergonomically designed cabin is crucial to driver comfort and has indirect road safety benefits through reducing driver fatigue. A detailed assessment of driving tasks and functions should consider the following inclusions and improvements in ergonomic cabin design:

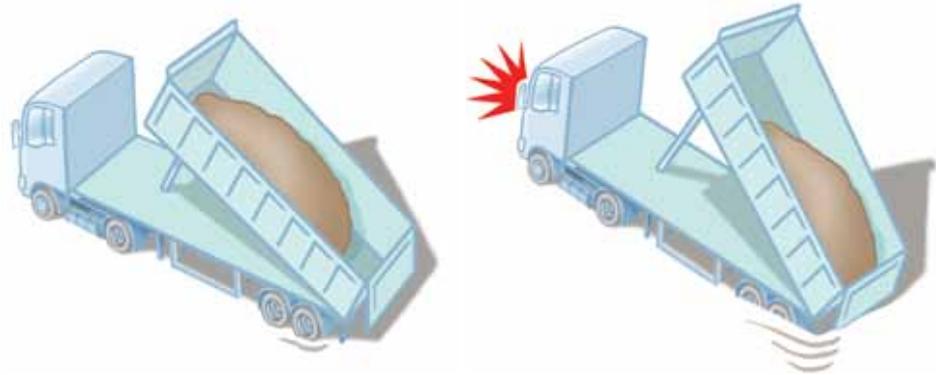
- Safe entry and access to cabin; including steps and grips.
- Seat that encourages good posture – preferably a suspension seat with an integral seat belt.
- Instruments which are easily visible and sensibly located so the most commonly used instruments are grouped together. No glare from surfaces, instruments or other cabin fittings and no unnecessary distractions.
- Switches and controls within easy reach with most commonly used at fingertip locations (no need to look away).
- Easily adjusted ventilation and climate controls.
- Comfortable pedal locations and angles.
- Wide visibility angles.
- Easily adjusted mirror to enhance road vision and tinted mirrors for night use.



## Tipping-Trailer Stability Protection System

Long rear-tipping trailer use is increasing in Australia. These trailers sometimes have to be raised to a tipping angle of greater than 45 degrees to completely unload. The longer the trailers are, the more vulnerable they are to toppling over in strong winds or if the rear axles are not on solid ground.

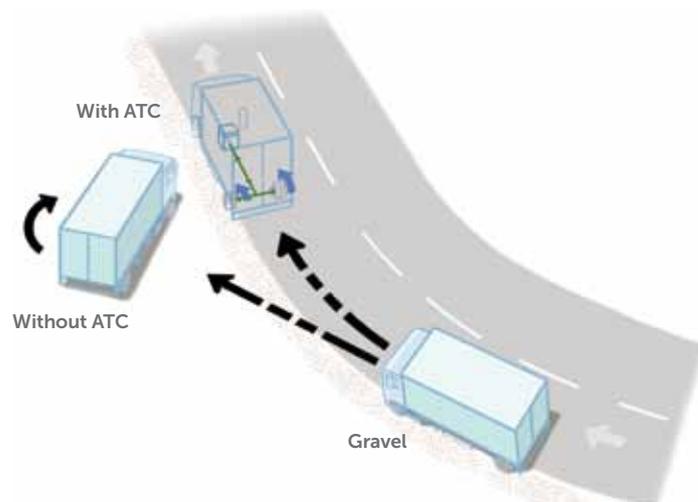
This is particularly true of tip-over axle semi-trailers because substantial weight is temporarily placed on one rear axle. Warning systems are available which sense the pressure in one air suspension bag on each side of the trailer. A warning is given if the pressures on each side of the trailer vary significantly when the lifting circuit is active.



## Automatic Traction Control (ATC) System

An ATC System complements an ABS and serves to prevent loss of traction which can result in rear-end slipping with a two-staged response. Firstly, the ATC reduces the drive torque. Secondly, it applies the service brakes on one or both sides of the driver wheels to prevent slip and to 'lock' the differential action. ATC is widely used on trucks that routinely encounter poor road conditions such as logging and construction sites.

While ATC can avoid loss of directional control under tractive effort, many ATC systems are designed to work at low speeds only. Because the anti-slip function is a standard feature of ESC systems and includes a response to events involving rear-end slipping due to a loss of traction, regardless of speed, ESC systems have a much higher safety benefit. ATC systems can be retrofitted in conjunction with ABS systems, but is usually more cost effective when purchased with a new vehicle.



## Intelligent Speed Adaptation (ISA) Warning System

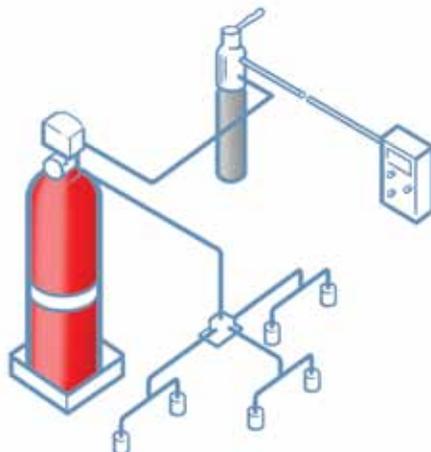
An ISA system warns the driver when the vehicle is travelling faster than the posted speed limit by comparing the actual speed with the speed limit information it determines from a Global Positioning System (GPS) road mapping system. Some ISA warning systems can be programmed to provide other useful information for a heavy vehicle driver including the location of hazardous bends, railway crossings and low bridges. ISA systems can be retrofitted but may soon be included by original equipment manufacturers as a standard vehicle navigation system.



## Fire Suppression Systems

The majority of heavy vehicle fires start in the engine compartment. Most heavy vehicles carry a fire extinguisher but they are often inadequate for suppressing an engine compartment fire.

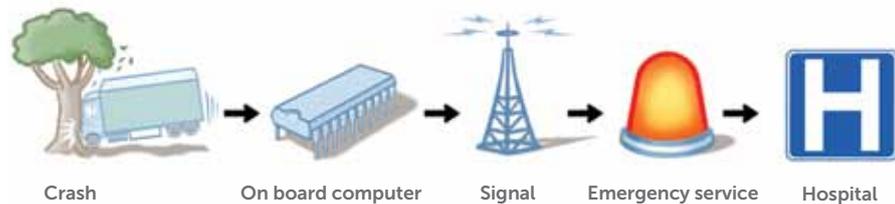
Fire Suppression Systems are commercially available that spray fire retardant chemicals or water for one to two minutes into the vehicle's engine compartment, after being automatically triggered by sensor/s sensing excessive temperatures, or by a manual switch at the driving position. Fire suppression systems need to be installed by a specialist equipment supplier who can determine the size and the suppression chemicals required for a particular vehicle.



## Automatic Incident Notification and Routine Event Reporting Systems

The intelligent transport control systems available for heavy vehicles are increasingly sophisticated. Heavy vehicles can now be monitored and directed remotely in real-time. An Automatic Incident Reporting System notes, records and reports dangerous incidents – similar to a 'black box' recorder on an aeroplane. Incidents might be identified by severe decelerations and deployment of safety systems such as ESC or an SRS airbag.

Once the vehicle's system is activated by an incident, it sends telemetric messages to a remote monitoring centre. A good system can advise the location, nature of the crash and identify the driver to facilitate a timely and appropriate emergency response. Some vehicle telematics can also help drivers to plan their routes, avoid traffic problems and receive and send business information. These systems can be retrofitted.



## Alcohol Ignition Interlocks

Alcohol ignition interlock systems require the driver to provide a breath sample before operating a vehicle. The technology assesses the blood alcohol concentration (BAC) of the driver and will immobilise the vehicle if the driver exceeds the pre-set BAC limit. Latest sensing technology is highly reliable and accurate. Alcohol interlocks for heavy vehicles are mostly supplied as an original equipment manufacturer option. Alcohol ignition interlocks can be retrofitted.

