

SAFE ON THE ROAD



VOLVO



OUR GUIDING LIGHT SINCE 1927

With more vehicles on the road and a faster tempo of traffic there is a greater risk of accidents. As one of the world's biggest manufacturers of large buses and coaches, with a long, strong tradition in road safety, Volvo has an important role to play in making traffic environments safer. Our primary responsibility is ensuring that our products maintain a high level of safety for drivers and passengers. But a bus in traffic is part of a bigger picture. That's why we also try to improve safety for other road users, both through our product development and by sharing knowledge that will help make safer roads, safer drivers and safer bus stops. This brochure presents Volvo Buses' view on safety, what motivates us, how we work, what we've achieved so far and the safety solutions that could become reality on the next generation of buses.

Safety based on experience

According to statistics, travelling by bus and coach is the safest form of road transport. There is a very low accident rate compared to

most other forms of transport. But if a bus full of people has an accident the outcome could be very serious, because so many people are involved at the same time.

The safety efforts of Volvo Buses are based on facts gathered from real-life accidents. Using Volvo's accident investigations and our own accident investigation groups that have existed since the mid 1970s, we have access to more than 30 years of accident data involving heavy vehicles. This is a unique knowledge bank, which together with safety tests and external research has given us a very good insight into the causes of accidents and injuries and what can be done to prevent them.

Because we are part of the Volvo Group we also have access to expertise in areas such as the development of transport systems for safer and more efficient public transport, and advanced technology development for a range of vehicle safety systems.

“Safety is, and must always be, the basic principle for all engineering design.”

The basic principle set by Volvo's founders Assar Gabrielsson and Gustaf Larsson 75 years ago is still our guiding star.



VOLVO BUSES' SAFETY PHILOSOPHY

- Safer vehicles mean fewer injuries and less human suffering.
- Fewer injuries mean less need for expensive healthcare and rehabilitation.
- Safer buses and bus stops increase safety for passengers and drivers.
- A safe driver is an efficient driver. Safe passengers are loyal passengers.

VOLVO GROUP'S SAFETY POLICY

- Volvo products are characterised by safety.
- Volvo shall provide its customers with products, which meet the highest demands on safety.
- Volvo shall be recognised as a leading producer of safe automotive and transport products, equipment and systems.

Volvo Buses is one of the world's biggest manufacturers of large buses. The product range includes buses and coaches with bodywork manufactured in-house and chassis which are bodied by independent manufacturers. To ensure that all products maintain the same high safety levels Volvo Buses provides independent bodybuilders with detailed design instructions. Engineering design, construction and equipment do however differ between the different bodywork on different markets. The examples shown and described in this brochure apply initially to buses that are entirely manufactured by Volvo Buses.



A well-trained, responsible driver is the key to any safe, secure journey.



Electronically controlled disc brakes provide excellent brake performance.



The "Hill Start Aid" prevents the bus rolling backwards when starting on hills.

ACCIDENT PREVENTION TODAY...

Our overall goal is to do as much as is possible to prevent accidents happening. Because most accidents are caused by human error, our main task is to give the driver the best possible conditions for handling the vehicle safely in all situations. This is where Volvo Buses' driver training provides a very sound base. In addition the bus itself is built upon a series of systems that all contribute to a high degree of preventative safety.

Road handling

Above all, the driver should always be able to rely on the bus or coach performing as expected. Suspension, weight distribution and steering are a few of the factors that affect road handling. But the single most important accident prevention equipment onboard is the brake system.

Electronically controlled disc brakes

Volvo's electronically controlled disc brakes (EBS) provide excellent brake performance and rapid, comfortable and controlled braking, with braking power divided efficiently between the wheels of the bus. The brake discs expand symmetrically when hot and this, in combination

with EBS, helps to minimise uneven wear. The latest generation of EBS brakes also allow a number of other safety and comfort features. Features include "Hill Start Aid", which prevents the bus rolling backwards when starting on hills. The brakes do not release until there is enough power to the drive wheels to enable the bus to move forwards. Other safety features include the ability to engage the differential lock at low speed, continual monitoring of the condition of the brake pads and disc brakes' temperature.

ESP – Electronic Stability Program

As a complement to the electronic brake system, Volvo Buses has introduced an electronic stability program (ESP) on a number of models. ESP significantly reduces the risk of the coach rolling over or driving off the road, both in normal and slippery road conditions. Using a sensor the ESP can read the movement of the vehicle and measure parameters such as side acceleration, steering wheel angle and yaw rate. An advanced anti-skid system is also included. If the coach tends to act out of the ordinary then the brake system will be applied automatically. Each wheel brakes individually to stabilise the coach while reducing power to the drive wheels.



Three-piece rear-view mirrors provide very good visibility to the rear and the area immediately in front of the coach as well as by the front door and front wheels.



Cameras above the exits and rear of the bus are an excellent complement to the rear-view mirrors. The camera view is shown on a display on the instrument panel.



Xenon lamps provide 30-50 % brighter light than standard headlamps.

Additional brakes and Brake Blending

In addition to the brakes there is Volvo's powerful VEB engine brake and the Volvo Compact Retarder. The automatic gearboxes have built-in retarders. The additional brakes not only mean increased safety in themselves, they also help to reduce wear on the foot brakes. With the help of "Brake Blending" the additional brakes perform as much of the brake work as possible, without the foot brakes being engaged.

ACC keeps a safe distance

Adaptive Cruise Control (ACC) is a radar-assisted system that constantly measures the distance between bus and vehicles ahead. ACC works together with the normal cruise control and the additional brakes. During normal driving the speed is controlled smoothly, giving the driver enough of a safe distance ahead without the need to apply the foot brakes. If the distance to the vehicle ahead drops too much the system sounds a warning signal. When there are no slower vehicles ahead the ACC allows the bus to accelerate to the chosen speed once more.

Electronic Stability Program (ESP) means much improved safety, and reduced risk of rolling over or driving off the road.



Adaptive Cruise Control (ACC) – automatically maintains the right distance from the vehicle in front.





An ergonomically designed driver's environment and excellent visibility are crucial factors for the driver feeling safe and relaxed and being able to monitor the surrounding traffic.



Volvo Buses' recently developed dashboard for city and intercity buses have controls logically grouped together by the side of the steering wheel.

Vision

Vision is another core element of good preventative safety. In particular when getting on and off the bus and when driving in busy city traffic it's important for the driver, with the help of cameras or well-positioned rear view mirrors with integrated close-range mirrors, to get a good rear-view as well as an all-round view of the bus. Headlights obviously play a significant role. A number of Volvo's bus models have Xenon lamps, for example, that give a very bright light that is 30-50 % brighter than standard headlamps.

Drivers' environment

A alert, relaxed driver is less likely to make mistakes. This is the basis of the design of the driver's environment in Volvo's buses. Ergonomically designed controls, well-placed instru-

ments, the option of individually adapt the drivers' seat, instrument panel and steering wheel are all important ingredients of a good drivers' environment. Volvo's newly developed dashboard for city and intercity buses all have controls logically grouped and easily accessible on each side of the steering wheel. This was a solution that originated on the Environmental Concept Bus produced by Volvo in the mid 1990s.

A comfortable climate and low noise as well as the choice of gearbox are also of extreme importance in reducing stress and tiredness. An automatic gearbox or automatic gear changing system such as the Volvo I-Shift means the driver doesn't need to think about lots of things at once and can concentrate fully on driving and the surrounding traffic.



Information about how passengers should act in an emergency is available in Volvo Buses' safety folder.



A comfortable entry step, wide door openings and photosensitive cell controlled opening and closing mechanism provides safe getting on and off the bus.

Correct information

In today's increasingly complex traffic situation, bus drivers must constantly learn, interpret and handle new types of information and take rapid decisions. Electronics and communication equipment in modern buses can increase the stress that many drivers experience, because so much information is available to the driver. It is therefore important to sift through this information and give the driver the information he or she really needs in a clear and easily understandable way.

Getting on and off

To minimise the risk of accidents when getting on and off the bus, photo-sensitive cells control the doors' opening and closing mechanism. As an extra safety precaution Volvo also has pneumatically or electrically regulated door systems with a "sensitive edge", which prevents passengers being trapped in the doors.

Passenger information

The consequences of an accident can be considerably reduced if passengers know how they should handle an emergency situation. That's why Volvo Buses has produced safety information similar to information used on aircraft. The information can be found in a folder in the back of the passenger seats and in an instructional film. The information pack is available for the Volvo 9700 and 9900 tourist coaches.

Crucial maintenance

Regular, professional service and maintenance is crucial for a bus to maintain its excellent safety features over a long period of time. This applies especially to components such as brakes.



Driver Interaction Support reduces the driver's workload in tiring situations, so that he or she is exposed to less stress and finds it easier to fully concentrate on the traffic.



The driver's head movements, eye movements and blinking are monitored to prevent accidents due to drivers falling asleep at the wheel or being distracted.

...AND TOMORROW

The interaction between man and machine is the focus of Volvo's safety work for the future. Researchers at Volvo are using human behaviour as a basis for the development of a driver's environment and different systems to reduce distractions and draw attention to or warn the driver of a fault or danger.

Driver Interaction Support

Driver Interaction Support works as a personal secretary that prioritises and presents information from the vehicle's different information and safety systems and makes sure that the right information is shown to the driver at the right time and in the right way. The aim is to reduce the workload for the driver in demanding driving conditions, so that he or she is subject to less stress and can concentrate more freely on the traffic. Driver Interaction Support also prioritises how the vehicle's different safety systems act in relationship to each other.

Drowsy Driver Alert and Distraction Alert

Drowsy Driver Alert and Distraction Alert prevents accidents due to drivers falling asleep at the wheel or being distracted. Drowsy Driver Alert is mainly used to prevent single accidents, which are often due to the driver falling asleep and driving off the road. It works with the help of a number of sensors. One monitors the driver's head movements, eye movements and blinking. Another detects whether the bus is holding a steady course. A third detects the driver's steering movements. If the system detects that the driver is tired he will be asked to stop and take a break. The Distraction Alert prevents accidents caused by the driver becoming distracted. If he or she isn't concentrating on the road for long enough the system will send out a message. LEDs light up on the instrument panel to enable the driver to quickly concentrate on the road again.



Lane Keeping Support calculates the position of the coach in the road, and warns the driver if he is steering off course.



Adaptive Cruise Control is being developed for heavy vehicles in the Volvo Group. Shown here is a possible attribute: a truck's brakes are applied with full force when it risks driving into the vehicle ahead.

Lane Keeping Support and Lane Change Support

Lane Keeping Support has sensors that constantly measure where the bus is in its lane. If it unintentionally drives across a lane divide or edge of the road the driver will hear an audible warning. Lane Change Support assists the driver to change lane safely. If there is not enough room in the lane that he or she wants to change into then the system sends out a signal.

Headway Support

The risk of accidents, where a vehicle drives into another can be minimised further with the next generation of Adaptive Cruise Control using Emergency Brake Assistance. A radar constantly measures the distance to the vehicle in front and the distance is automatically regulated with the help of the buses' cruise control, electronically controlled brakes and additional brakes. The Emergency Brake Assistance applies

the brakes to the bus with full force if the system detects that the driver is approaching another vehicle too quickly and an accident is imminent. The system also facilitates driving in very slow moving traffic with constant stopping and starting. The driver does not need to regulate the distance to the vehicle ahead or stop as the system does this automatically.

Driver Visibility Support

To reduce the risk of accidents due to poor visibility, tests are being carried out on a number of different solutions, as an addition to rear view mirrors. Radar sensors and camera technology are used to help drivers detect other motorists in "blind spots" around the bus. If a risky situation arises then the driver is warned and the accident can be avoided. The camera system also allows the driver to see where he or she usually can't, e.g. immediately in front, behind and alongside the bus.



Full-scale R66 roll-over test, which evaluates the roof's strength. The bodywork should manage a roll-over without the roof collapsing.



Full-scale roll-over test, which verifies the function of 3-point seatbelts



Full-scale side impact test to see the effects of a crash between a car and a city bus.

PROTECTIVE SAFETY

If an accident should happen it is our aim to reduce, as far as is practically possible, the risk of injury to the driver and passengers. Conditions differ between different kinds of bus traffic. A bus in city traffic, that starts and stops more regularly for people to get on and off, has fast passenger flows and relatively short distances to travel at low speed, possibly with standing passengers, requires different solutions from intercity buses. Long distance tourist coaches and intercity buses generally travel at greater speeds, with all the passengers being seated and using seatbelts.

Safety tested bodywork

Volvo's bodywork meets EU bus directives meaning that the buses must withstand rolling over without crushing the roof. There is also collision protection in the front and sides fitted as standard. To verify how the construction performs in real-life conditions, Volvo Buses carries out a number of full-scale tests.

Side impact test: To test the effects of a crash between a car and a bus on a busy road, a full-scale test was performed according to the US APTA norm at Volvo Cars' Safety Center. A 1,800 kg Volvo S80 was driven at a speed of 40 km/h into the side of a low-floor aluminium bodied Volvo 5000. The crash test dummies in the bus and the car came out of the incident unscathed and the car's penetration into the inside of the bus was well below APTA requirements.

Roll-over test: To test how the 3-point seatbelts work in an accident where the coach drives off the road and rolls over, Volvo performed an authentic test where the vehicle rolls down a slope. The adult-sized crash test dummies in the test were harnessed using 3-point seatbelts, and the child-sized crash test dummies were also sitting on booster seats. After the test all crash test dummies remained in their seats. If people had been in the seats the injuries sustained are estimated to have been negligible or very minor. A similar test using 2-point seatbelts was performed as far back as 1988.



Front Impact Protection (FIP) effectively spreads the force of an impact into the frontal structure in the event of a head-on collision. FIP dramatically reduced the risk of injury to driver and guide.

Injury reducing interior

The interior of Volvo's buses and coaches is made of soft materials and is free from protruding or sharp items.

Seatbelts and child booster cushions

Seatbelts save lives. All Volvo's touring coaches and intercity buses are available with 2 or 3-point seatbelts for driver and passengers. Volvo was the first bus manufacturer to introduce child booster cushions in 2000, which are of the same type used in Volvo cars.

Front Impact Protection

To further improve protection for the driver and guides Volvo is the first bus manufacturer

to introduce Front Impact Protection (FIP). It is a frontal collision protection, which effectively spreads the force of an impact into the frontal structure. Both computer simulation and full-scale tests show that FIP considerably cuts the risk of serious personal injury.

FIP's construction is a further development of the collision protection used by Volvo according to earlier Nordic safety requirements. Tests have been performed based on the same principles given in directives for trucks (R29). The first model to be launched is the 9700 model, which manages energy levels in excess of the truck requirements by 50 %.



In addition to making our buses safe in traffic we also work in other ways to improve safety for drivers and passengers. Fire safety is one area we prioritise as well as accident prevention and injury prevention. The pictures above show a safety equipped Volvo 9700.

- 1 Electronically controlled disc brakes with ESP.
- 2 Retarder.
- 3 Rear-view mirrors for all-round visibility.
- 4 Rear-view camera.
- 5 Camera at the exit.
- 6 Lighting by exit.
- 7 Xenon headlights.
- 8 Safety doors.
- 9 Front Impact Protection (FIP).
- 10 Roll-over protection.
- 11 ACC.
- 12 "Soft", injury reducing interior.
- 13 3-point driver's seatbelt.
- 14 3-point guide's seatbelt.
- 15 2- or 3-point passenger seatbelt.
- 16 Children's booster cushion.
- 17 Seatbelt reminders.
- 18 Separate central locking.
- 19 Automatic extinguisher system in engine compartment.
- 20 Emergency exit, door.
- 21 Emergency hammer.
- 22 Emergency exit, skylight.

VOLVO

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