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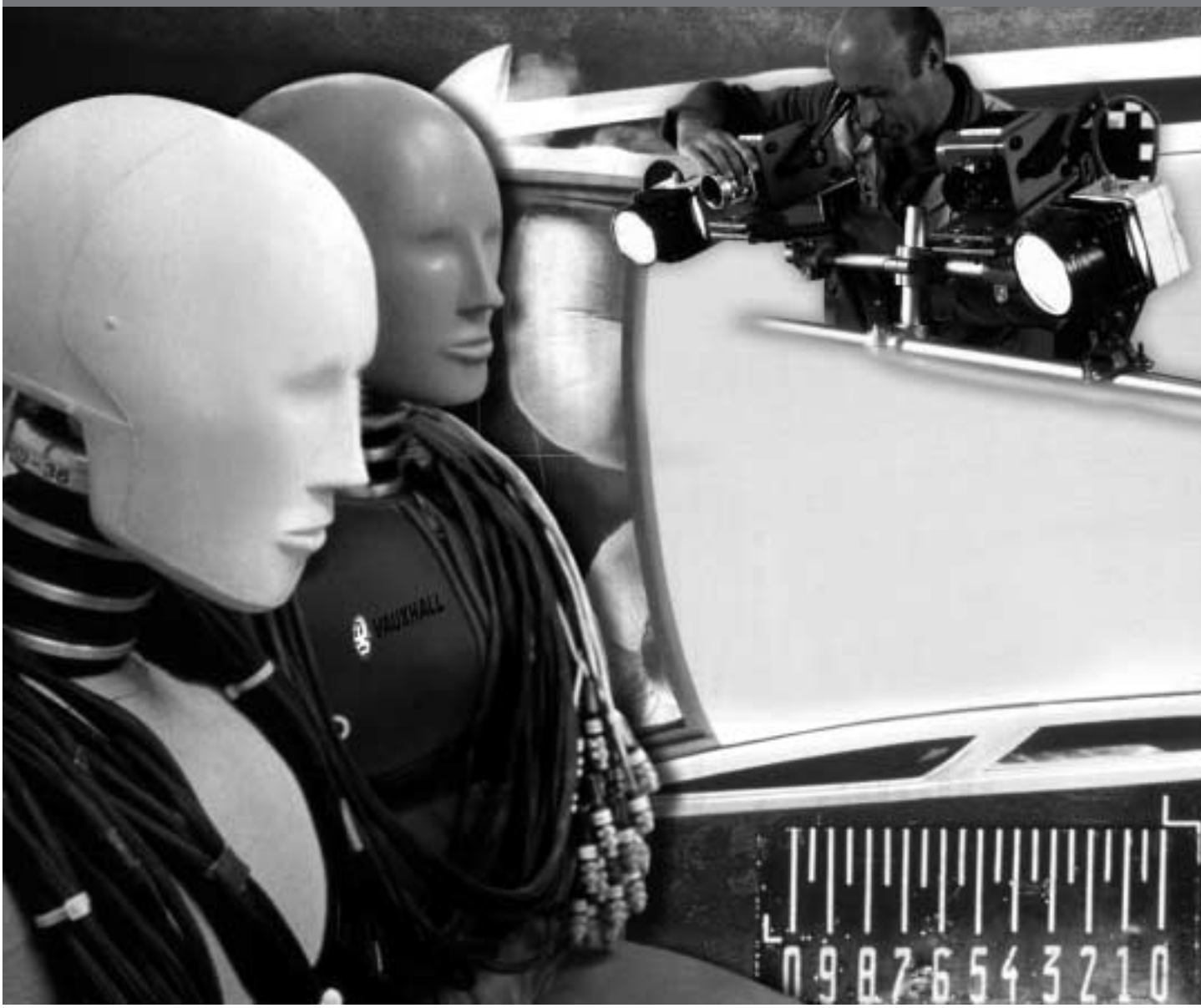
Vehicle Safety

A publication from Vauxhall's Education Service



VAUXHALL
Raising the Standard

Three paths - one goal

Three factors form the cornerstone of Vauxhall's vehicle safety programme - passive safety, active safety and fitness for safety.

Three paths
The entire range of Vauxhall vehicles is noted for offering the best possible level of occupant safety. All models from the Corsa through to the Omega are supplied with complete safety equipment such as standard full-size airbags. This is the best evidence that for Vauxhall, safety is not a question of money, size, or class.

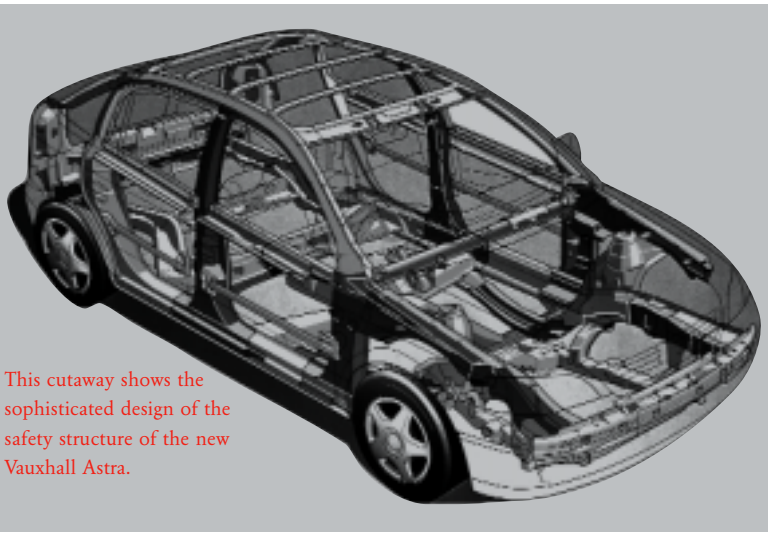
Vitally important, is the reliable operation of all safety-relevant equipment in the car. This is ensured by extensive practical trials and exhaustive rig tests often using crash test dummies. A significant part of the development process involves computer simulations using state-of-the-art computers.

The goal of optimum safety for car occupants is being addressed in three areas: active safety, passive safety and fitness for safety.

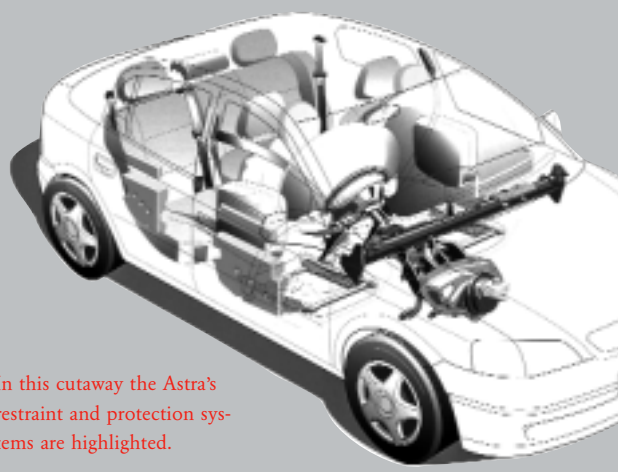
Prototype Omegas were tested in a wide range of frontal, side and offset impacts.

Passive Safety
The protection of passengers and vulnerable road users from the harmful effects of an impact is one of the greatest challenges facing automotive designers. Advanced structural design is combined with innovative safety equipment in all Vauxhall vehicles to form a range of passive safety features. At the core of Vauxhall body design is an immensely strong passenger safety cell. Further protection from front and rear collisions is afforded by deformation zones that are designed to progressively absorb the energy of an impact.

Impacts to the side of the vehicle are potentially the most hazardous as there is less room for deformation zones. Because accident statistics show that 72 per cent of all side impacts occur at 30 degrees to the front, Vauxhall vehicles offer a high degree of safety for the occupants in side impact situations. The bodyshell



This cutaway shows the sophisticated design of the safety structure of the new Vauxhall Astra.



In this cutaway the Astra's restraint and protection systems are highlighted.

incorporates reinforced pillars and sills as part of the 'safety cell'. These features combine, with steel beams mounted in each door, to give exceptional impact protection.

'Anti-submarine' seats prevent the passenger from sliding under the seat belt during a collision. Vauxhall cars also feature sophisticated self-tensioning seat belts that pull the driver and passenger back into their seats. This feature combines with front and side airbags to provide optimum levels of protection to the occupants.

Consideration must also be given to the safety of other road users. Vauxhall cars feature rounded body mouldings, integral water channels and fold-back door mirrors, all of which reduce the risk of injury to cyclists and pedestrians.

Active Safety

Active safety features are the elements of the car's design and operation that are intended to prevent an accident.

Great emphasis is placed on road holding and handling characteristics. Car designs such as the Astra and Vectra demonstrate these virtues with optimum wheel position and advanced suspension technologies that give unparalleled comfort and safety.

Active safety is further enhanced by power steering which significantly improves low-speed handling and overall vehicle control.

The ability to stop quickly and in full control is paramount to vehicle safety. Vauxhall recognises this need and many models now feature electronically controlled, four-channel anti-lock brakes as standard equipment.

This dramatic water test was conducted to establish the straight-line stability of the prototype Vauxhall Astra passing through heavy surface water. This test simulates conditions far worse than most drivers would ever experience.

Vauxhall designers also pay great attention to the aerodynamics of the body, influencing both the efficiency and stability of the car.

Fitness for safety

Fitness for safety is an essential part of active safety and is the term used to describe those features which reduce the forces on a vehicle's occupants in an accident situation. Fitness for safety is enhanced by excellent all-round visibility, clear instrumentation which keeps the driver informed and good ventilation which reduces fatigue.

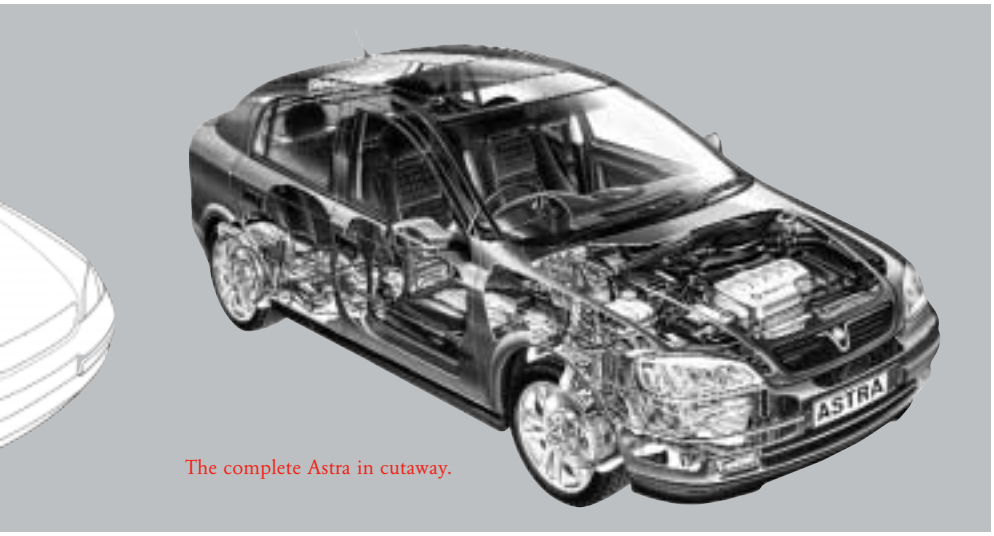
There are many other safety features which demonstrate the fitness for safety of Vauxhall cars, some of which are taken for granted, such as heated rear screens and laminated front windscreens. Even the shade band at the top of the windscreen contributes to safety by reducing glare.

A special test dummy is used to establish the optimum seating design for occupant comfort.

Headlights that can be adjusted to the load being carried are featured on many Vauxhall cars where they reduce glare to other road users.

Fire is the great fear of many drivers in an accident. Vauxhall takes great care with the positioning of the fuel tank to ensure its integrity in the event of a collision.

All Vauxhalls have fuel cut-off valves that engage if a heavy impact is detected. Door locks unlock automatically to enable passengers and driver to escape.



The complete Astra in cutaway.

Passive safety systems

Seat belts

It is easy to understand why the wearing of a seatbelt is both wise and a legal requirement. A collision at only 10 km/h can result in severe injury to an unbelted person striking the fascia or windscreen.

At speeds approaching 30 km/h, the human body can suffer injury equivalent to falling from a height of six metres. Even in a moderate crash, an unrestrained baby's effective weight increases from 20 to approximately 400 kgs. A responsible driver has, therefore, no option but to ensure the proper and continuous use of all seat restraints.

A three-point seat belt has long been the basis for passenger protection in Vauxhall vehicles. Vauxhall designers have, in recent years, considerably improved a system that has proved its ability to save lives in countless accidents.

Research has shown that up to 20 per cent of all injuries in frontal collisions result from impact with the fascia or steering wheel. This risk can be dramatically reduced with Vauxhall's height adjustable seat belts with the 'Body-Lock' system, an innovative pre-tensioner which, when activated, can remove almost 16 cm of slack from the belt in just 0.22 seconds. This slackness in the belt occurs when occupants wear thick clothing and can significantly reduce the effectiveness of the restraint system. Body-Lock operates well before the body even starts to move after an impact.

The launch of the Vauxhall Omega marked the introduction of the web clamp. A steel claw, fitted inside the inertia reel assembly completely stops un-spooling of the seat belt that naturally occurs during heavy braking or a collision. There are two types of pre-tensioners currently in use on Vauxhall vehicles: a pyrotechnic system, which eliminates any slack by means of a propellant charge and a mechanical system aided by a pre-tensioned spring.

The Body-lock activates in under 0.22 seconds.

Active head restraints

Active head restraints were first featured on 1999 model year Vectras. This 'intelligent' system significantly reduces the risk of whiplash injuries in rear-end collisions. A pressure pad in the seat acts on a lever system if the body is forced back into the seat. The mechanism then moves the headrest upward and forward to restrain the head as it jerks backwards. This design can reduce the strain on the spine by up to 50 per cent.

Active head restraints significantly reduce the risk of whiplash injuries in rear-end collisions and reduce the strain on the spine by up to 50 per cent.

This test demonstrates the effectiveness of three-point seat belts, Vauxhall's Body-Lock system and anti-submarine seats.

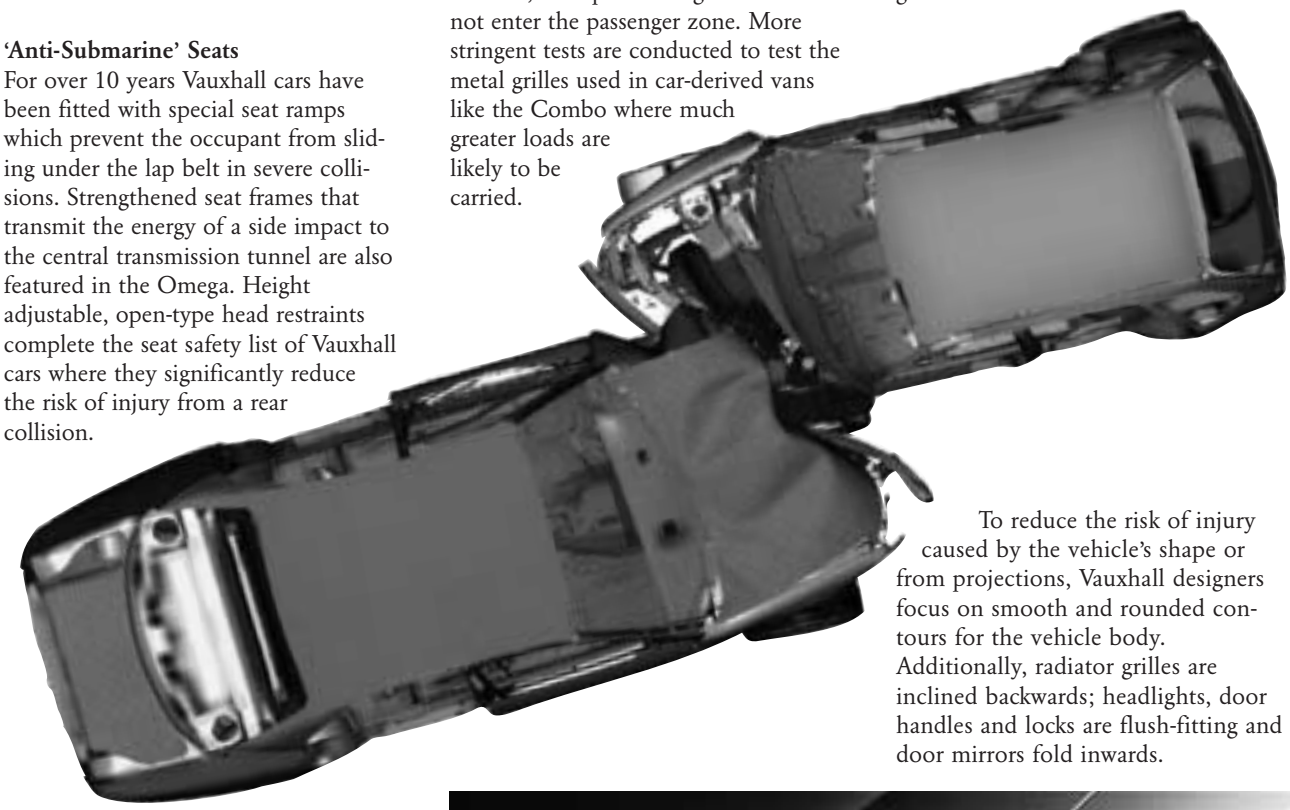
'Anti-Submarine' Seats
For over 10 years Vauxhall cars have been fitted with special seat ramps which prevent the occupant from sliding under the lap belt in severe collisions. Strengthened seat frames that transmit the energy of a side impact to the central transmission tunnel are also featured in the Omega. Height adjustable, open-type head restraints complete the seat safety list of Vauxhall cars where they significantly reduce the risk of injury from a rear collision.

for children. The system, which employs a rigid anchoring mechanism to secure a specially designed child safety seat to the vehicle, virtually eliminates the dangers that can result from improper installation.

Moving loads
Vauxhall's safety experts pay great attention to accidental movement of loads during an impact. The integrity of load areas is tested by propelling a test car into a solid wall at 50 km/h. In this test, two special 18kg loads must not enter the passenger zone. More stringent tests are conducted to test the metal grilles used in car-derived vans like the Combo where much greater loads are likely to be carried.

Form and function
Vauxhall designers ensure that as great a degree of safety as possible is afforded to other road users and pedestrians by using considerate design.

Research has shown that occupants of smaller vehicles suffer greater injury in impacts with larger vehicles. Vauxhall has taken this into consideration for many years. Design techniques are used which ensure that the larger vehicle dissipates proportionally more of the energy that results from an impact by greater deformation.



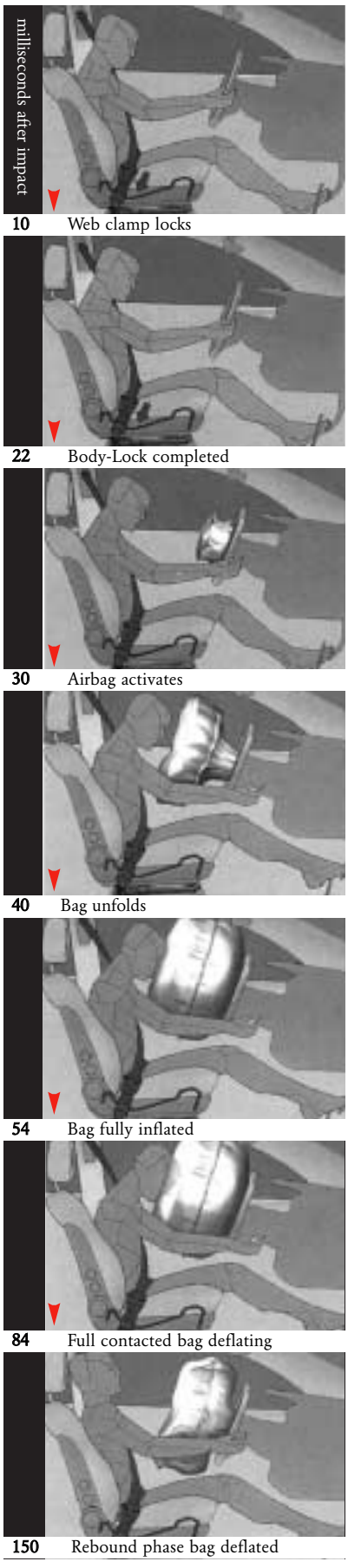
This computer simulation shows the larger vehicle absorbing proportionally more of the impact energy.

To reduce the risk of injury caused by the vehicle's shape or from projections, Vauxhall designers focus on smooth and rounded contours for the vehicle body. Additionally, radiator grilles are inclined backwards; headlights, door handles and locks are flush-fitting and door mirrors fold inwards.

De-coupling foot pedals
Vauxhall's patented pedal release system ensures that injuries to the driver's feet and lower legs are significantly reduced in severe frontal impacts. In a head-on collision, the pedals slip from their mounts and drop down out of the way.

Vauxhall-Fix seat system
The modular Vauxhall-Fix child seat system ensures a high level of safety

The Vectra's smooth contours improve fuel consumption and pedestrian safety.



Airbags

Since 1993, airbag passive safety systems have been available on Vauxhall vehicles. These provide optimum protection for the head and upper chest of the front-seat occupants, considerably reducing the risk of injury from impact with the fascia or steering wheel.

Vauxhall uses only full-size airbags that are deployed from the centre of the steering wheel during a frontal collision. Additional protection can be afforded to the front seat passenger from a fascia-mounted airbag.

Great care is taken with airbag design so that it only activates in an accident situation. Other passive safety features, like seat belt pre-tensioners and 'anti-submarine' seats, protect occupants up to 30 km/h. Above this speed they are supplemented by the airbag which deploys in less than half the time that it takes to blink an eye.

Once triggered by the special, centrally-mounted control unit, the bag starts to inflate in under 25 milliseconds, reaching full inflation within 50 milliseconds.

Research has shown that optimum protection occurs after 80 milliseconds, when the bag begins a controlled deflation that further softens the impact to the driver. The complete cycle is over in 150 milliseconds; the bag is fully deflated and the driver returns to a near normal sitting position.

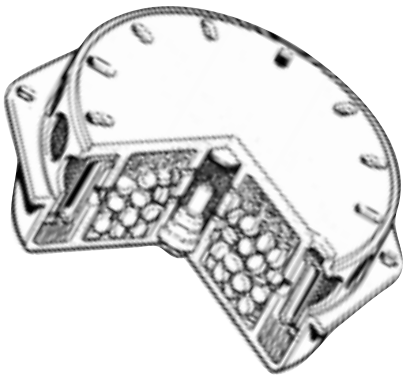
The control unit is specially tuned to the crash characteristics of each model and variant so that it cannot be triggered by conditions found in normal driving. Tests are carried out over extreme terrain and conditions to ensure that false triggering does not occur.

Burning the solid propellant sodium azide generates the inert gas nitrogen used to inflate the airbag. An electrical charge from the control unit ignites the propellant which then produces exactly the right amount of gas.

Before it reaches the bag it is filtered and cooled to remove some of the heat and particles from the combustion process. Nearly 140 litres of gas is required to inflate a large passenger airbag like those fitted to Vauxhall vehicles.

A high-speed camera records an airbag being deployed.

The standard airbag gas generator. The small round pellets are the solid propellant; at the centre is the ignition capsule.

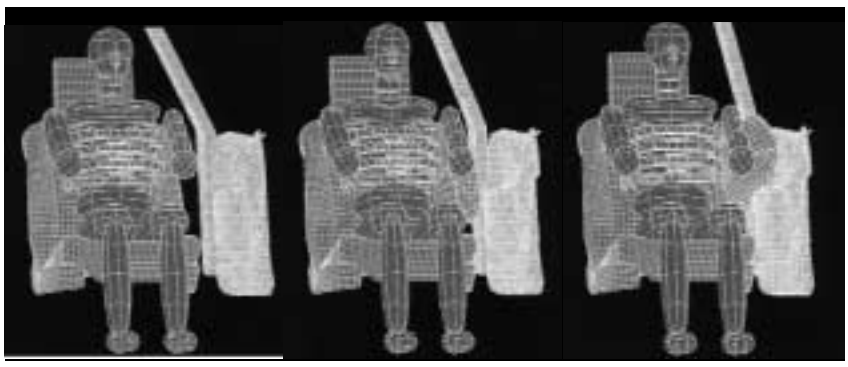


The Hybrid bag
The Vectra is the first volume-production car to use the latest hybrid technology that requires only 15 per cent of the previous amount of pyrotechnic chemicals. In the hybrid bag, Argon gas used to inflate the bag is stored in a steel container in the steering wheel or fascia panel. The gas at a pressure of 240 bar, is released into the bag by the breaking of a glass panel. This panel gives access to an electronically regulated propellant with priming charge. The Argon rapidly expands and cools due to its sudden release from the pressure container. The expansion of the gas is then rapidly accelerated when it is heated by the pyrotechnic charge. This system provides for more even inflation, less residues and heat as well as more consistent operation in low ambient temperatures.

Side airbags
More people are injured in side impacts than in any other accident. Therefore, Vauxhall has made side airbags available on the Vectra, Astra and Zafira ranges. Side airbags afford protection to the 'soft' areas of the torso where the risk of injury is greatest and reduce the side-to-side motion of the head.

Integrated into the seat frame these 12 litre airbags are able to move with the seat; this ensures they are always in the optimum position. They are also designed to work in conjunction with the padded doors and side impact bars. During the development phase, Vauxhall's designers had to establish a completely reliable trigger mechanism, as the airbags' conventional sensors were not sufficiently sensitive.

This computer-generated model shows how the side airbag deploys and the additional protection that the system gives to occupants.



To overcome this problem, pressure sensors integrated electronically to the main airbag controls were developed. The sensors and electronics ensure that the side bags operate only when the distinctive pressure of an impact is detected.

Curtain airbags
Vauxhall's comprehensive passive safety package, has been enhanced still further, with the addition of full-size curtain airbags. This new feature is available as an option on the Zafira, Astra and Corsa ranges.

Curtain airbags are fitted to both sides of the vehicle and provide additional protection from side impacts. Inflating in less than 30 milliseconds, occupants heads are cushioned from lateral impact and protected form shattered glass.

A sectioned view of the hybrid airbag

Diagram shows the curtain airbag system fully deployed.

The system is fitted inside a plastic tube and the inflation gas is generated by a unit secured behind the rear headlining. Sensors built into the sides of the vehicle trigger a control device. In a typical side impact, the airbag will deploy within 10 milliseconds to protect the chest. 10-15 milliseconds later, the head is cushioned by the 150 millimetre thick air cushion.

In tests carried out using NCAP criteria, a car equipped with curtain airbags reduced the risk of head injury by 90 per cent. In these tests, vehicles are propelled sideways into a rigid pole at 18 mph.

Active safety systems

Suspension
Capable suspension is a decisive factor in determining a car's ability to hold the road. A vehicle must always respond in a predictable manner, particularly in demanding situations such as heavy braking and collision avoidance.

The designer's task at Vauxhall is to 'tune' the various forces that act on a car and create the best possible handling characteristics. This objective is achieved through exhaustive testing, both practical and computer simulated.

Many new Vauxhalls now feature DSA (Dynamic SAfety) suspension. DSA is a self-stabilising front suspension system that is particularly stable during rapid direction changes and when there are different levels of road adhesion on each wheel - a situation encountered in poor weather conditions. Front wheels naturally tend to veer away from areas of low grip. DSA operates by applying a counter-steering force that keeps the vehicle in a straight line.

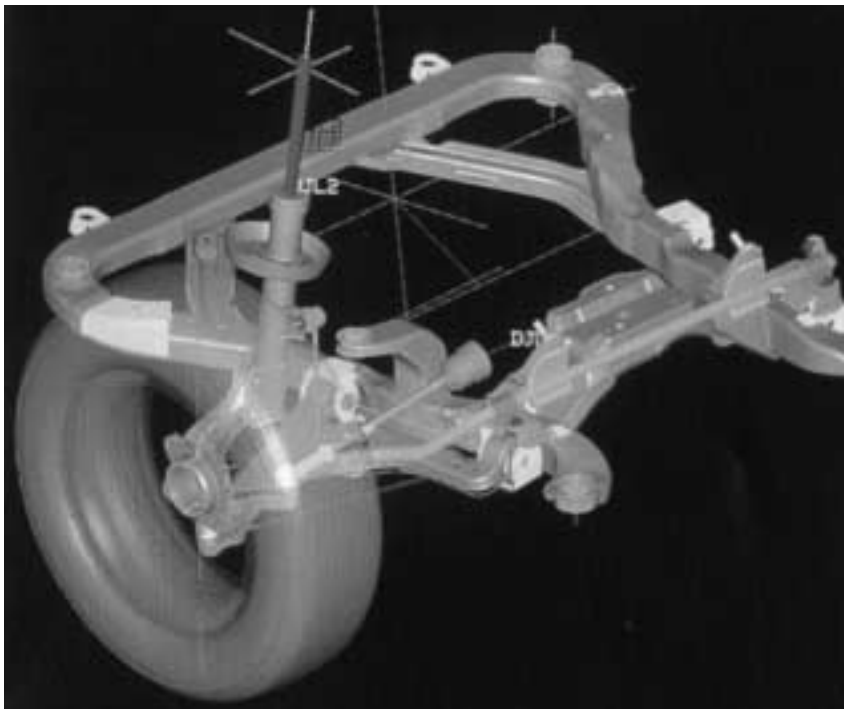
Brakes and ABS
Braking systems convert the motion of a vehicle or its kinetic energy, into heat energy by means of friction. Special pads that are pressed under hydraulic power against a metal disc or drum create this friction and temperatures as high as 800 degrees Centigrade are generated. The demands of modern driving conditions, as well as the need to strive for better and safer braking systems are the challenges that face vehicle designers.

Vauxhall has made dramatic steps forward in brake system performance with such developments as ventilated discs to help dissipate the heat as well as anti-lock and power assistance systems to improve control.

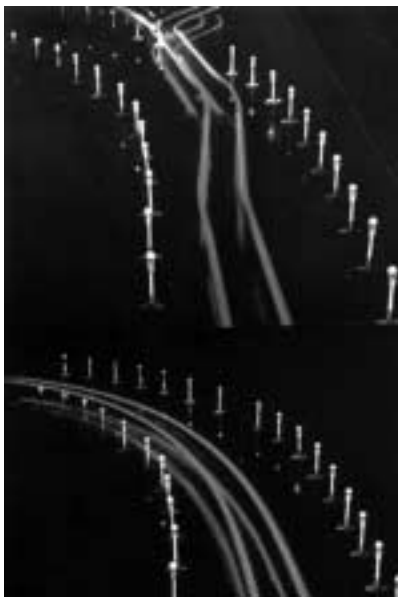
Powerful braking systems are one of the most important safety systems on a modern road vehicle. Not only must they perform consistently but must be able to bring the car to a controlled stop in as short a distance as possible, regardless of road and weather conditions.

During severe braking and heavy acceleration, the road wheels can slip, reducing the driver's control over the vehicle. When braking heavily, or in an emergency, ordinary brakes are powerful enough to stop the road wheels rotating. When this happens, the wheels slide, road adhesion is reduced and stopping distance increased.

A disc brake assembly.



This computer model is used to explore the handling characteristics of suspension and chassis components.



The lower picture clearly shows the advantages of ABS braking when cornering.

Research revealed that momentarily reducing the braking force as the wheels begin to lock, considerably reduces stopping distances and improves vehicle control. A system known as anti-lock or ABS employs this effect by rapidly "pulsing" the brakes on and off if wheel-lock is detected.

Although mechanical anti-lock systems exist, Vauxhall has opted for an electronically controlled installation that is faster to respond and more sensitive to road conditions. Four-channel, electronically controlled anti-lock brake systems are featured across virtually all Vauxhall's range of passenger vehicles. Sensors mounted on each wheel feed back information to the control unit that initiates the anti-lock system.

Braking is further improved with ECOTEC V6-engined, Vectra and Omega models where the ABS is linked to the electronic traction control system and fuel supply to provide a fully-integrated system - a first for Vauxhall and the industry.

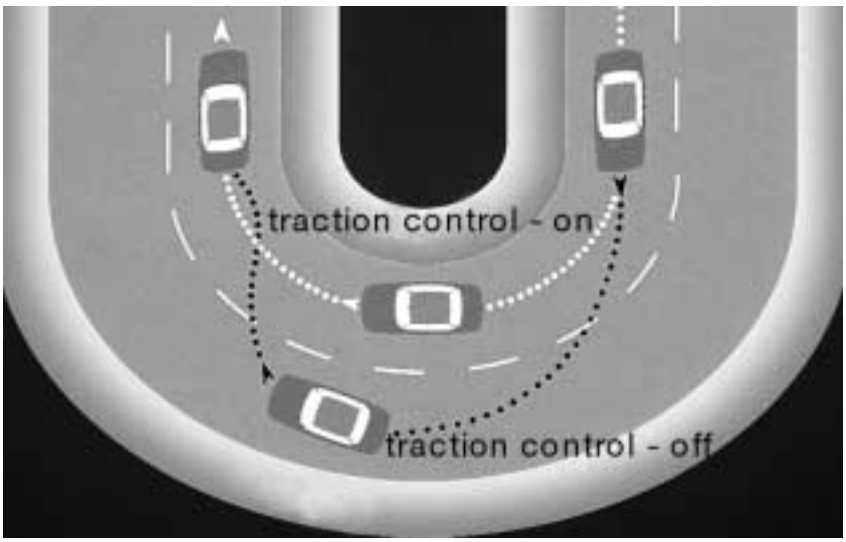
Traction Control
Vauxhall's traction control (TC) system borrows heavily from race experience where it provides Formula 1 drivers with improved control during extreme acceleration and manoeuvring.

First fitted to the Astra GSi, this switchable system moderates throttle openings and momentarily applies individual brakes to give controlled acceleration and improved directional stability without wheel-spin even on slippery surfaces.

Aerodynamics
The class-leading aerodynamics of Vauxhall's range of vehicles contributes to fuel economy and safety. The result of good aerodynamics is reduced sensitivity to crosswinds and lower lift forces which improves directional stability. A smooth flow of air over the body also ensures that rain and dirt flow freely over the vehicle so that visibility is improved.

Using state-of-the-art wind tunnel testing Vauxhall's designers have developed a windshield surround which deflects rain away from the side windows and a integrated spoiler for the outside mirrors to keep them clean.

Exhaustive wind tunnel testing of models and full-size mock-ups has significant environmental and safety benefits.



This diagram clearly shows the benefits of traction control.

Human error
Around 90 per cent of accidents can be attributed to driver error. This appears as aggression, lack of attention, distraction, tiredness or simple inexperience. The vehicle designer can help in many of these cases. Good design can provide relaxed and stress-reduced driving through good ventilation and air-conditioning.

Comfortable and correctly adjusted seating relaxes the driver, and easy to see and use controls reduce distraction inside the car.

As long ago as 1991, Vauxhall introduced an aerodynamic windscreen surround which helped to keep the side windows clear in bad weather.

Fitness for safety

Being fit for safety is an essential part of active safety. A vehicle with a comfortable and convenient interior, pleasant acoustics and good visibility reduces the strain on the driver, who is then able to master the complex task of negotiating modern traffic safely and for longer periods.

Comfort
Accommodating the wide range of human physical characteristics is a complex task. Vauxhall uses special dummies like that seen on page 4 to reconcile these variations so that the majority of occupants experience the optimum driving position. Steering wheels that can be adjusted for reach and rake further improve comfort levels.

Pollen filters improve occupant comfort.

A pleasant climate inside the car can improve the driver's level of concentration. Vauxhall cars feature powerful heating and ventilation systems that can replace the air in the passenger compartment four times per minute. To ensure that the air coming into the car is as clean as possible all Vauxhall cars feature an electrostatically charged dust and pollen filter.

Research conducted by Vauxhall in Death Valley, showed that air-conditioning has very definite safety benefits. During a one-hour journey without air-conditioning the temperature in the car exceeded 50 degrees Celsius and the driver's pulse rose to 125 beats per minute. When the medically-supervised test was run again with the air-conditioning on, the driver's heart rate remained 'normal' at 83 beats per minute. Importantly, the driver's concentration, co-ordination and reactions remained normal despite the extreme outside conditions. In 'normal' conditions the dehumidifying effect of this system further improves comfort and reduces 'fogging' on windows in wet and cold weather.

Visibility
Good all-round visibility is vital if the driver is to know what is happening around the vehicle. This complex design process is accomplished by ensuring that roof pillars are as narrow as possible reducing 'blind spots' The optical quality of the glass must also satisfy high standards of light transmission and be distortion free.

The value of good lighting in night driving and adverse weather conditions is very well understood. Vauxhall lighting systems easily exceed all legal requirements.

The headlights used on the Vectra have special parabolic reflectors which make it possible for high and dipped beams to be used together to improve overall road illumination. To ensure that the optimum light pattern has been obtained, Vauxhall uses special equipment to measure the light values in as many as 50,000 different points.

Even the best headlights are only as good as the light bulbs used. From mid-1999 all new Vauxhall vehicles could be specified with the latest Xenon bulbs which are 20 per cent brighter that conventional halogen units.

Some models also feature dynamic beam levelling, a system which automatically adjusts the height of the beam from information given by sensors on the front and rear axles. Whether the car is accelerating, braking or stationary the headlights give optimum illumination and reduced glare to oncoming traffic.

Noise and vibration
Acoustic quality is an essential element of active safety and demonstrates the principles of fitness. It is well known that noise reduces a driver's levels of concentration and increases fatigue. A special robot test rig with hearing similar to that of a human ear is used by Vauxhall to identify and measure sound levels during the design phase. Tests are conducted inside an anechoic chamber; a special room designed to eliminate external sounds. Using this facility, technicians are able to optimise sound insulation and 'tune' engine and suspension mountings.

Noise factors are largely influenced by the car itself, however vibration is decisively influenced by the road quality. To overcome some of the difficulties associated with measuring vibration, Vauxhall uses an ultra-modern holographic test facility. Because this method uses reflected laser light to detect vibrations rather than mechanical sensors that affect the readings, more accurate results are obtained.

The anechoic chamber eliminates external sounds so only the sound from the car is measured.

Research and development

New models are developed by a combination of extensive practical trials, exhaustive rig tests and computer simulations - a perfected process that will later ensure reliable operation of all safety-relevant equipment on the production vehicle.

The International Technical Development Centre (ITDC) in Germany, is the focus for all European-built Vauxhall and Opel vehicle design and testing. One function of the ITDC is the collation and analysis of information from real accidents from around Europe. The statistics produced allow Vauxhall designers to devise test rigs and accurately simulate accident situations. Accidents are then recreated in computer simulations and actual crash tests. This research forms a vital part in the development of Vauxhall vehicles.

The electronic age of design

In the past, car designers worked with drawing boards, slide rules and more recently, pocket calculators.

This all changed dramatically in 1985 with the installation of the first Cray supercomputer at the ITDC. This machine, which was capable of 166 million calculations per second, made possible the first computer simulations.

The Cray C90 supercomputer.

Today, the Centre has the latest generation Cray C90 which performs an astonishing 4 billion operations per second. This degree of sophistication allows designers to develop passive and active safety features with the utmost reliability and predictability.

Modern methods such as CAE (Computer Aided Engineering) accelerate the entire development process whilst generating multiple alternatives which lead to an ideal solution.

Computer 'crashes'

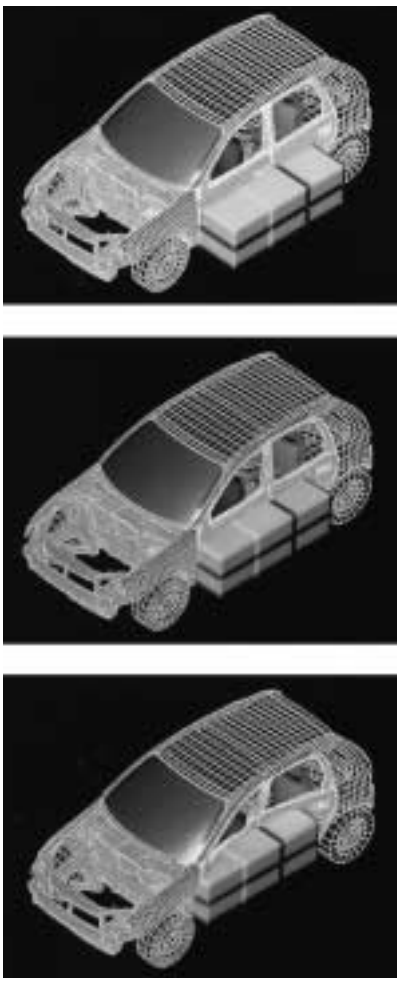
European regulations stipulate minimum levels of protection that are greatly exceeded by Vauxhall. These virtues are well demonstrated by the latest Astra and Vectra models which have state-of-the-art safety features unequalled by other cars in their classes.

The bodyshells of Vauxhall cars are designed and crash-tested inside the company's Cray super-computer. The computer models, which can be made up of more than 11,000 individual elements are able to perfectly simulate the real car. In the case of the Astra, its computer model was subjected to around 80 full crash tests that were derived from the crash statistics compiled by the International Technical Development Centre.

Within hours, results, which would have taken weeks using conventional computers, are ready. Necessary modifications are then made and the simulation re-run.

Crashes for real

Hundreds of individual component tests are also carried out with the aid of the computer before a 'real' car is subjected to the rigorous programme of actual crashes. Many of these tests form part of the legal requirement of all motor manufacturers. In one of the most dramatic tests a car was propelled into a wall at 50 km/h and another completely rolled over.



A simulated crash which required the high performance computer to make as many as 350 million calculations per second.

Dummies, which exactly duplicate average adult and infant bodies, are used in the crash tests. The results of these tests, which included dummies fitted in child restraint systems, were recorded on high-speed cameras so that the effect on occupants and the car could be fully assessed.

Designers study a front impact computer simulation.

Worldwide testing

Despite the immense value of development work done with computers, practical tests in the laboratory and on test tracks around the world are still needed to decide on the approval of a new safety-relevant feature on a production car.

The testing begins in the laboratories of the ITDC. Here, raw materials are tested for strength, stability and behaviour. Engineers then design specific test benches for all the finished components of the car. Safety relevant equipment is subject to round-the-clock tests to simulate many years of operation.

The laboratory work is complemented by a series of test drives with prototype vehicles that are fitted with state-of-the-art measuring equipment. Prototypes vehicles cover millions of test kilometres on routes around the world and are exposed to the most severe climatic conditions possible from the hot and arid Death Valley in California, to the polar conditions of Scandinavia.

Even with the sophisticated systems available to the test drivers and designers, some 1,200 criteria such as ride quality and noise levels have to be judged subjectively by the test drivers.

The torture continues

The test centre in Germany is a continuous torture track for experimental vehicles and prototypes. During the 50,000 kilometres of tests, vehicles endure every conceivable road surface and driving condition. Because the tests are conducted in as short a time as 5 months it is the equivalent of driving 150,000 kilometres on public roads. This is referred to as a compression factor of 3. For tests of the suspension, in which the car is subject to the most extreme abuse, the test compression factor can be as high as 75.

Brake systems come under particular scrutiny using highly accurate electronic measuring equipment to record brake performance in extreme and continuous high-speed tests. The objective of such tests is to ensure that the driver can confidently expect the brakes to slow or halt the vehicle under full control in even the most arduous situations.

During this round of testing the airbag and seat belt pre-tensioner systems are tuned to ensure that they operate only when needed.

Electromagnetics

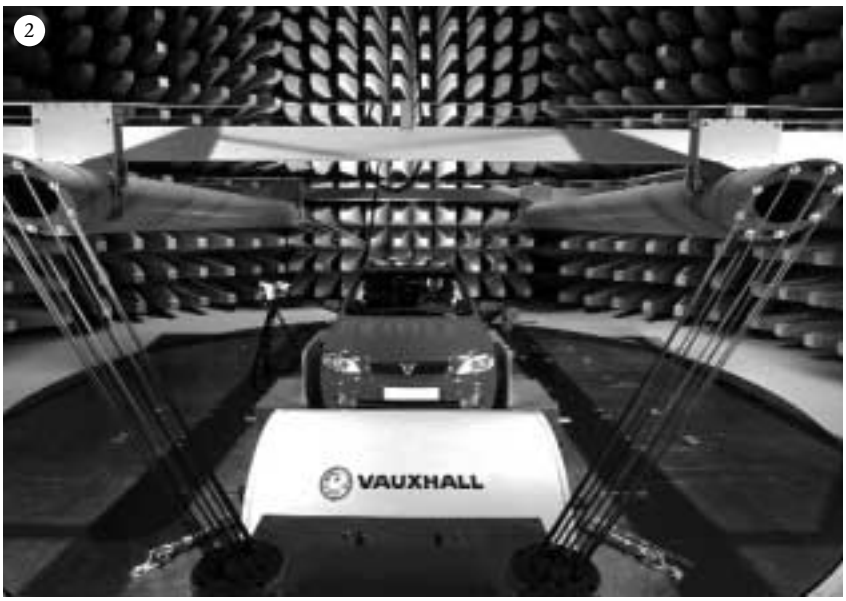
There are as many as 12 microprocessor systems and 2,000 other electronic components in a modern Vauxhall car, so electromagnetic compatibility has become an important issue. So much so, that in 1996, the European Union established the first EMC standard.

All electronic systems generate electromagnetic waves and are susceptible to their effects. This is particularly so in the case of sensitive safety equipment such as ABS braking systems. Vauxhall engineers once again use the anechoic chamber to subject components and whole vehicles to varying levels and frequencies of electromagnetic radiation. The chamber ensures that test are screened from outside electronic interference. The tests ensure that electronics systems in the car do not affect each other and have optimum immunity to external sources.

Braking systems were tested to extreme on this mountain pass. Test Vectras with a full load of passengers and luggage easily coped with this demanding terrain.

1 - The Astra was subjected to the rigours of a Scandinavian winter .

2 - This optical-electronic measuring rig has sensors which register the movements of the wheels precisely during a test run.



1 - Electronic vehicle components such as this speedometer assembly must function reliably even when subjected to intense electromagnetic radiation. Legislation requires that test components are unaffected by an electromagnetic field density of 30 volts per meter - Vauxhall's test standard is 120 volts per metre which is the equivalent of that given out by a television transmitter.

2 - The whole vehicle can be tested by this special rig inside the anechoic chamber which eliminates outside electromagnetic interference as well as sound.

3 - Vauxhall vehicles were spared nothing in tests runs through the jungle tracks of South America.

Crash testing

Crash tests allow a near authentic simulation of the most common types of accident.

High-speed cameras record every moment of test collision.

Vauxhall's crash test programme for improving passive safety has been extended well beyond the requirements called for by legislation. These additional tests included vehicle-to-vehicle collisions and airbag misuse tests that simulate situations when airbags should not be triggered. The tests also include collisions with model animals, road obstructions and irregularities.

Safety experts at the ITDC have analysed the most frequent forms of accidents and developed a test programme based on the data collected. This process makes it possible to create specific accident situations. One such test involves a vehicle hitting a solid concrete wall at 50 kph. As only half of the vehicle hits the wall it is known as the offset frontal test and simulates the 'real-life' collision between two oncoming vehicles. This is a particularly demanding test, as the impact energy has to be absorbed by one side of the vehicle.

The programme also includes typical accidents at junctions, where one vehicle runs into the side or rear of another. Side impact tests are the second most common accidents and form the basis for the next group of tests. These tests are particularly important for occupant safety because there is only a limited amount of deformation space available to dissipate the impact energy. As only around 4 per cent of accidents are at right angles the tests also include acute angle impacts.

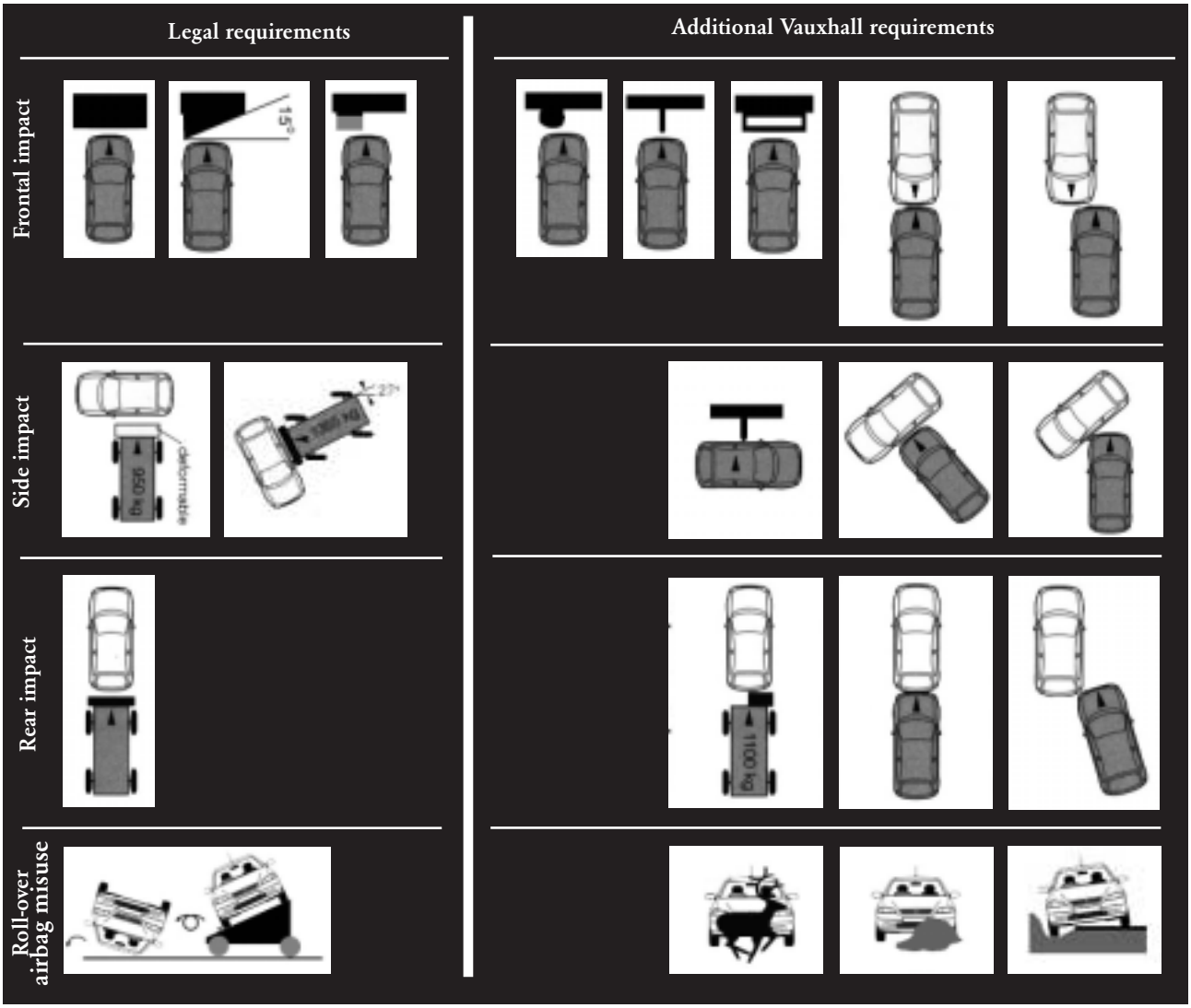
The next simulations involve collisions to test rear deformation zones and the fuel tank's integrity. Finally, passenger zone integrity is tested by rolling the vehicle onto its roof at 50 kph. A special rig carrying the car sideways at the test speed is abruptly stopped, causing the vehicle to be propelled from the rig and onto its roof. Each vehicle must survive this and all other test scenarios with minimal intrusion into and deformations of the passenger zone. Whilst the doors must remain closed during the test it is vital that they can also be opened so that occupants can escape or be rescued after an accident.

The off-set front impact test is one of the most severe forms of real life collision.

In most side collisions the impacting vehicle rams at an acute angle. Vauxhall vehicles have been developed to deal with this frequent accident scenario.

Vauxhall has a whole crash test dummy family on hand to record the effects of crashes on a wide range of human statures. Each dummy is fitted with sensors which register the loads encountered during the tests. Important areas such as the head, neck and upper torso can be equipped with up to 100 sensors. Additionally, different dummies are used for each type of accident test and for the variations in legislation between countries. The dummies are not only capable of registering deceleration but torques and body intrusions. The technician in this picture is applying a special gel which is used to detect abrasion and impact areas. From the data collected it is possible to draw conclusions about the likely severity of injuries in real-life accidents and to develop new protection systems.

Vauxhall's crash test programme goes way beyond legal requirements with a range of demanding vehicle-to-vehicle and barrier impacts. Technicians also use various animal models to simulate collisions with wild animals.



Accident statistics

Vauxhall's engineers base their work in passive safety on reality. This chart shows the frequency of various car-to-car collisions as a percentage of total accidents that occur in Europe.

Statistics issued by the Department of Transport show that fatalities caused by road accidents have continuously declined in the past 10 years despite an additional 4.8 million vehicles on the roads. Interestingly, road users were at greater risk in London during the 1850s, when there were more road deaths.

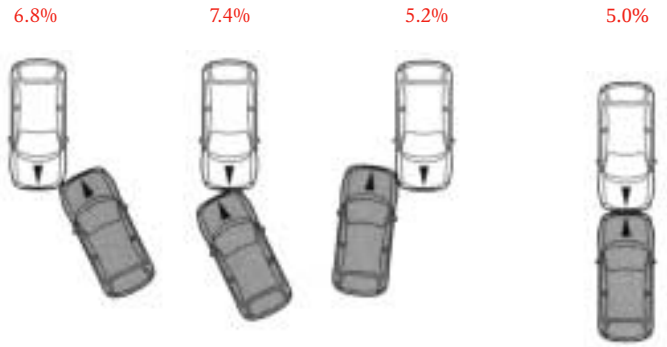
The Government set year 2000 as the target date to achieve a reduction in all road accidents of more than 30 per cent, compared to the yearly average of 321,912 recorded between 1981 to 1985.

The overall improvement seen in recent years is believed to be the result of improved car design and the regular use of front and rear seat belts.

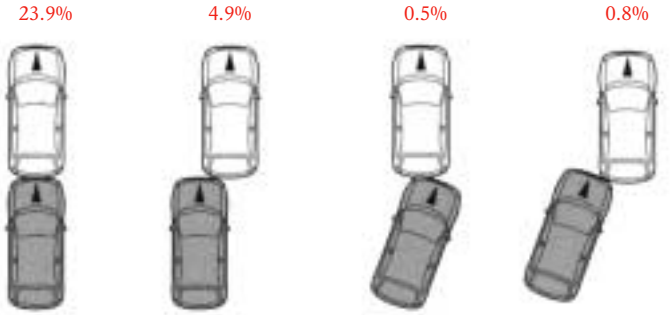
Every driver can help to improve road safety by improving his or her road-craft. The majority of recorded accidents result from driver error, either through inexperience, poor technique or simple impatience.

Less than 10 per cent of accidents are due to mechanical failure. Of these, many are the result of poor maintenance. Modern roads have contributed considerably to improved safety standards. Even the much-maligned motorway is, according to statistics, the safest type of road to use. The likelihood of an accident in a built-up area is 10 times greater than on a motorway.

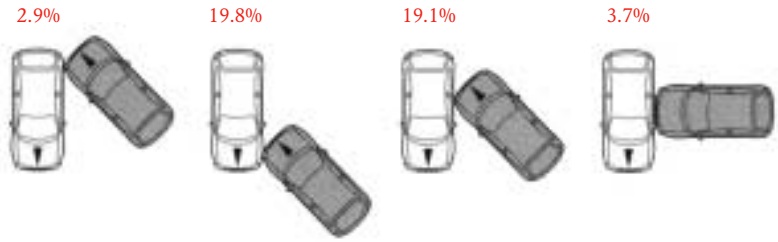
Frontal



Rear-end



Side



Every effort was made to ensure that the contents of this publication were accurate and up-to-date at the time of publication.

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