# Rescue manual

## Information for emergency service personnel
## November 2013

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# Foreword

One of the main priorities of the products developed and realised by BMW is optimum safety under all conditions.

By taking an holistic view, the precisely-coordinated active and passive safety systems exceed the requirements set down by law.

They also take into account the technical requirements for emergency crews. This approach also includes providing specific information about how to work with the BMW restraint and safety systems as well as tips for using emergency equipment.

**This booklet is intended as a user guide for trained emergency crews. Knowledge of the function and operating principle of the safety systems and vehicle characteristics is also needed.**

For emergency crews, the foremost priority is to save the lives of persons who have been involved in accidents without exposing the victims or themselves to additional danger.

This rescue manual contain information on how rapid and safe access to accident victims can be made easier.

We recommend using state-of-the-art emergency equipment as the materials and production engineering used in the automotive industry are subject to ongoing developments.

This rescue manual was been drawn up in cooperation with the BMW fire brigade in Munich.

As a rule, this rescue manual is updated twice a year.

**Additionally, model-specific emergency services cards with detailed information are available.**

The latest version can be found at https://oss.bmw.de/index.jsp.

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**BMW fire brigade Munich**

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# Essential information

Both the medical and technical side of the emergency operation must be coordinated and the two aspects must dovetail.

# Medical aspects

The first thing is to gain access (support opening) to the (locked in or trapped) people. As with all other measures, the patients should be treated with all due care.

All efforts should be made to avoid dragging people out. The casualties should initially be left in the vehicle if they and emergency services are at no immediate risk.

Immediate life-saving measures and the initial examination (basic check) are usually carried out inside the damaged vehicle. The medical treatment administered in the vehicle should be restricted to absolutely essential care. Depending on the injured person's condition, this may however be very extensive. The emergency doctor or rescue personnel must be provided with access to the injured person (support opening) so that immediate life-saving emergency measures can be carried out. Depending on the pattern of injuries, persons who have been involved in accidents should essentially be immobilised, i.e. provided with appropriate splinting before they are extracted from the vehicle (rescue opening). The rescue opening should be of an adequate size and reflect the overall situation.

The casualties should receive continuous medical care during the technical stage of the rescue. As much of the technical emergency work as possible should be prepared while medical treatment is being given.

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**Exceptions which require a crash rescue.**

- Immediate risk from acute threat, e.g. fire or other accidents following the initial one
- Medical reasons

# Technical aspects

- Identification of the vehicle type
- Visual inspection to see what restraint and safety systems are fitted
- Special features on the vehicle body which may influence the use of hydraulic emergency equipment

# BMW Assist emergency call

BMW vehicles with an activated BMW Assist emergency call system and valid service contract can automatically or manually establish an emergency call. This is normally directed to a BMW call center, which handles the telephone call and if necessary notifies the responsible rescue coordination center.

When the crash sensors register a significant accident, the system activates an emergency call.

With advanced emergency calls, data including details about the accident severity is transmitted automatically to the BMW call center. BMW automatically analyses this data based on medical and accident research and generates a simple-to-understand evaluation for the rescue coordination center, who can therefore more easily determine the most appropriate rescue support.

Based on the GPS data transmitted from the vehicle, the BMW call center determines an exact address which, together with information about access to the accident site, they can pass on to the emergency services. Further customer and vehicle details are also available to the BMW call center, which can be passed on to help the rescue authorities if required.

This emergency call system works independently from the customer's mobile phone.

If there is no BMW call center for the location, or no connection can be established on the reserved GSM network, the system may attempt to establish an emergency call via the emergency call number (112).

# Response of the restraint and safety systems after an accident

**If a vehicle is stationary, the restraint systems will not normally be triggered.**

**Exceptions**

- If the solid propellant in the gas generator (airbag) heats to above 200 °C
- If the airbag modules are subject to immense mechanical loads (sawing, drilling, grinding welding)
- If the electric cables short circuit to activate the ignition squibs
- If a stationary vehicle is struck by another vehicle (if the triggering criteria are satisfied, the restraint systems are triggered)

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**Using radio transceivers**

It is perfectly safe for walkie-talkies to be used close to restraint systems that have not been triggered.

# Notes for using emergency equipment

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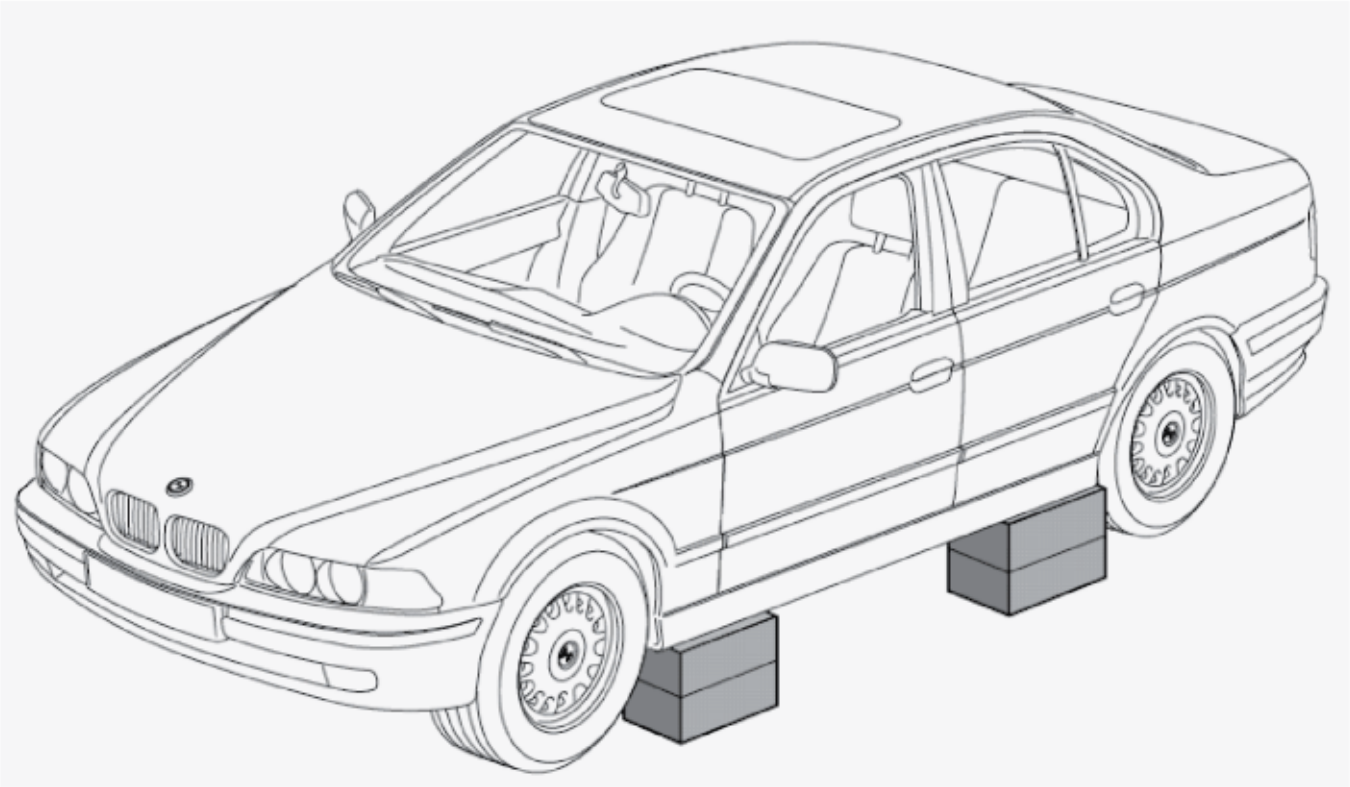
# Propping up vehicles



Example: Propping up vehicles

The vehicles can be propped up from underneath the whole of the side sill. The precise position and number of prop points must be determined as a function of the situation in hand.

Ideally, the mounting points for the jack should be used.

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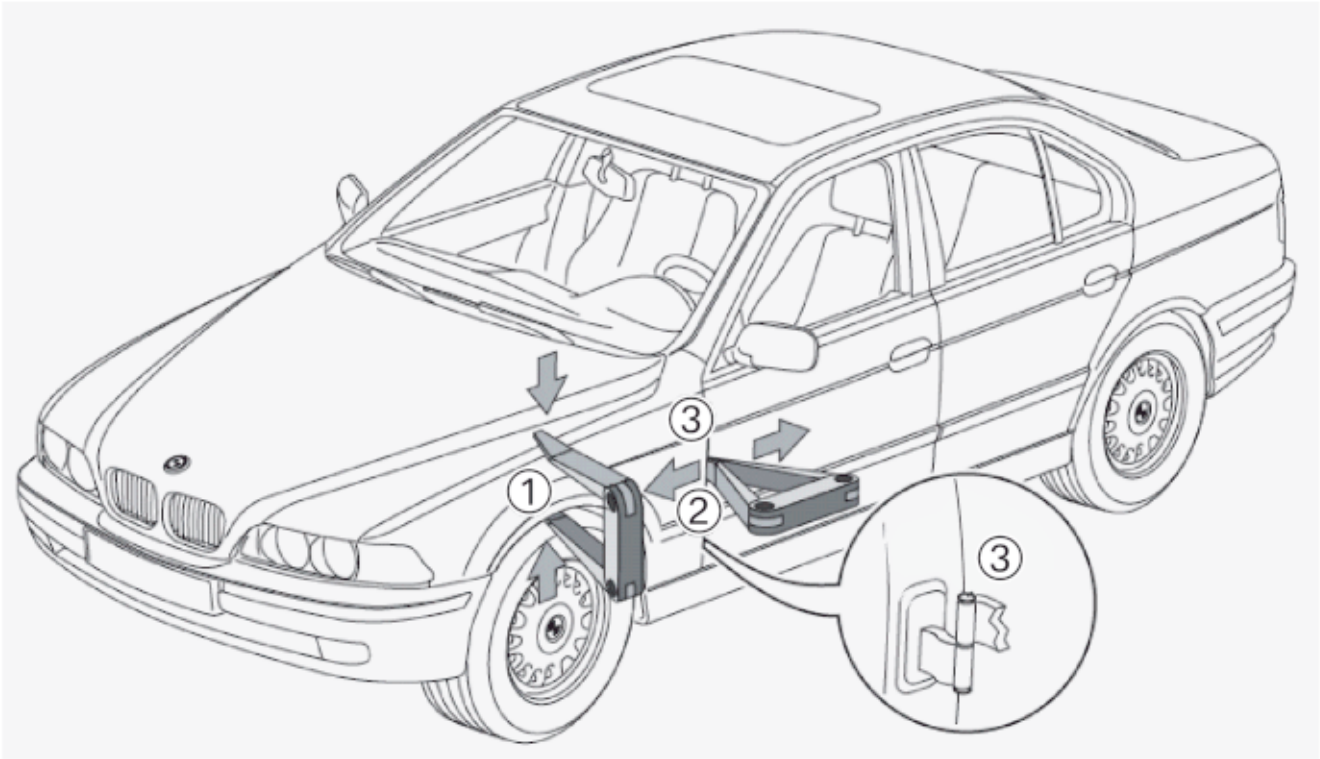
# Opening doors

Version 1




Starting points for opening the doors on the A-pillar

1. Use the hydraulic emergency spreader to crush the front side panel. This produces a large gap between the front side panel and the front door.
2. Use the emergency spreader to increase the gap at the same height as the hinges.
   The precise position of the hinges for each vehicle is drawn on the emergency services cards,
3. Use the hydraulic cutter to cut off the hinges and open the door. Alternatively, the hinges and/or bolts can also be forced open using the emergency spreader.

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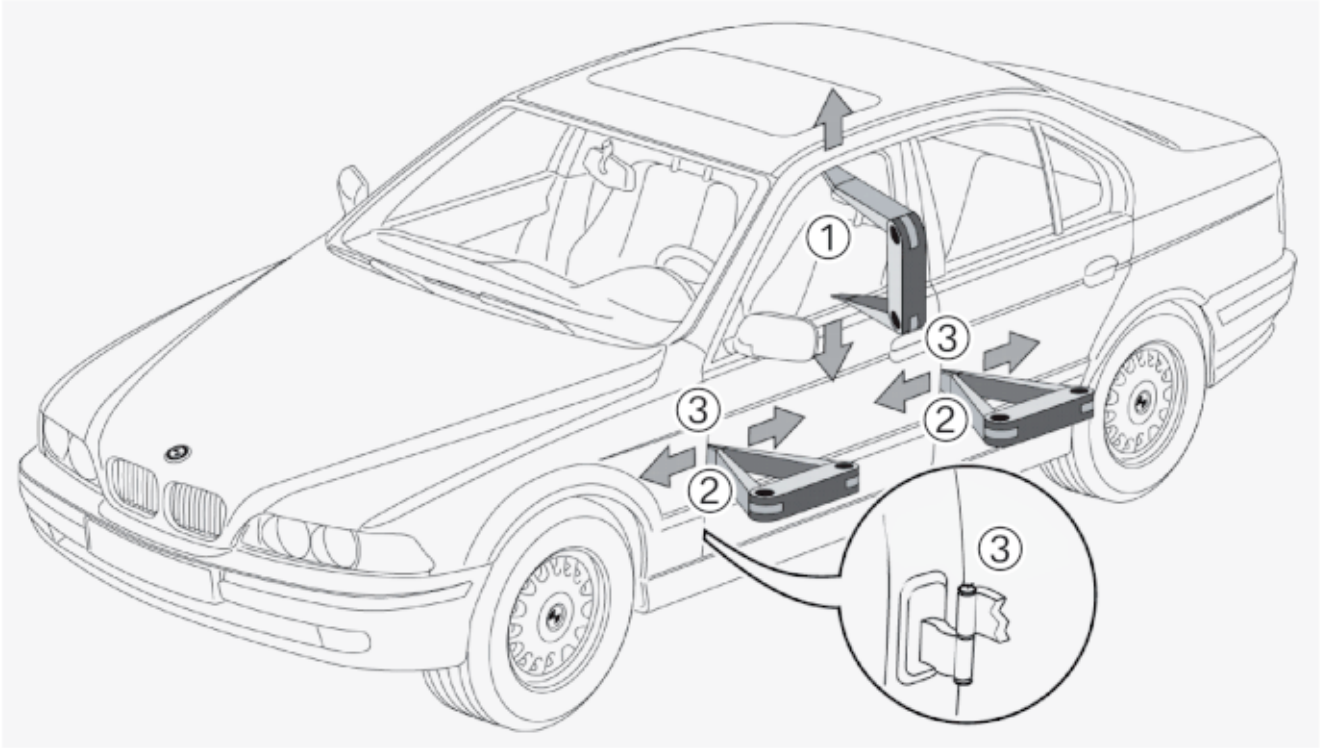
Opening doors

Version 2




Starting points for opening the doors on the A-and/or B-pillar

1. Use the hydraulic emergency spreader to force the window apart. This produces a large gap between the front door and B-pillar and/or between the front side panel and front door.
2. Use the emergency spreader to increase the gap at the same height as the hinges.
   The precise position of the hinges for each vehicle is drawn on the emergency services cards,
3. Open the door on the side of the hinges or lock (use the lock side for vehicles without horizontal side impact protection).
   The precise position of the hinges, door locks and side impact protection for each vehicle is drawn on the emergency services cards,

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# Forcing dashboard forwards

There are various ways of pushing the dashboard forwards.
The method to be used depends in part on the:

- Mechanism of the accident
- Presence of a dashboard support

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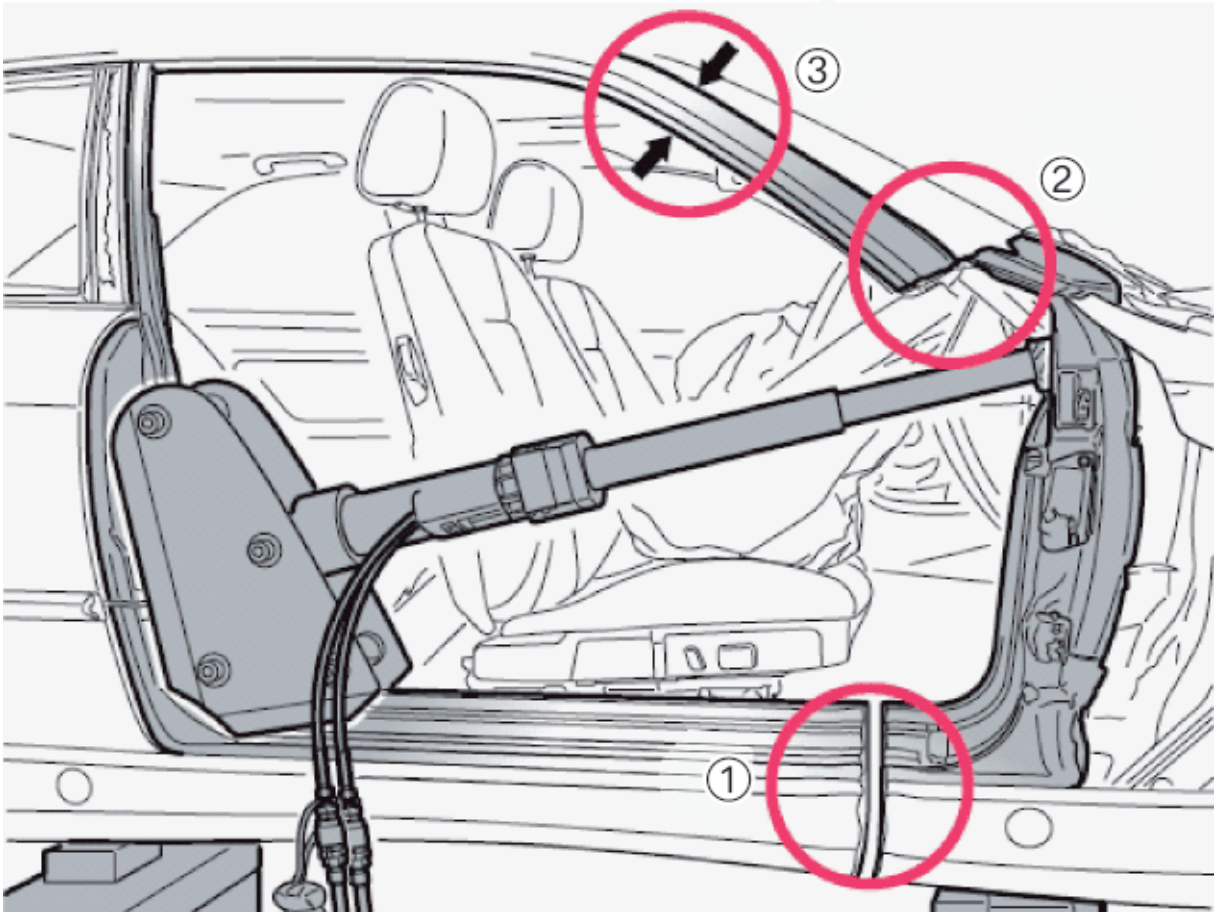
**Version 1**




| | |
|---|---|
| Important! | Danger of injury!<br>Emergency equipment may slip or slide. |

1. Place material under the vehicle floor to prevent the base from caving in.
2. Carry out glass management (including cutting through the front windscreen horizontally in area **2** or **3** ).
3. Use hydraulic shears to cut off door at its hinges.
4. Use hydraulic shears to cut through the side sill **1** away from the occupants towards the vehicle underbody.
5. Use hydraulic shears to cut through both A-pillars in the lower section **2** or in the upper section **3**.
6. Attach support angle to the B-pillar as shown.
   **Note:**
   If the emergency cylinder is too short, insert the support angle horizontally.
7. Where possible, insert the emergency cylinder between the central mounting and the dashboard.
8. Push the front end away.

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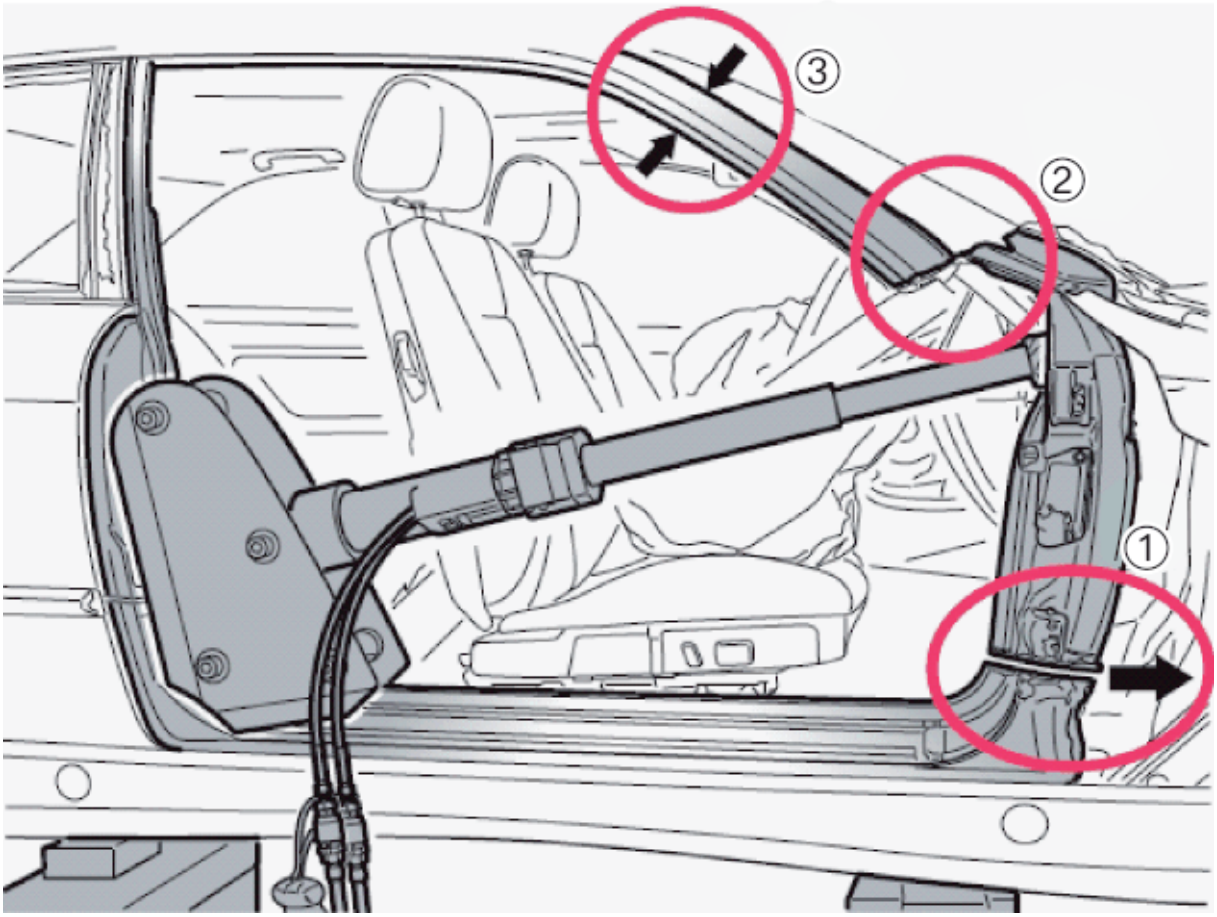
**Forcing dashboard forwards version 2**




| | |
|---|---|
| Important! | Danger of injury!<br>Emergency equipment may slip or slide. |

1. Place material under the vehicle floor to prevent the base from caving in.
2. Carry out glass management (including cutting through the front windscreen horizontally in area **2** or **3** ).
3. Remove the (front) doors on both sides of vehicle.
4. Use hydraulic cutters to cut through both side sills **1** away from the occupants towards the front end. To achieve the desired effect, it may be necessary to continue the cut into the front wheel arch ("nibbling technique").
5. Use hydraulic shears to cut through both A-pillars in the lower section **2** or in the upper section **3**.
6. Attach support angle to the B-pillar as shown.
   **Note:**
   If the emergency cylinder is too short, insert the support angle horizontally.
7. Where possible, insert the emergency cylinder between the central mounting and the dashboard.
8. Push the front end away.

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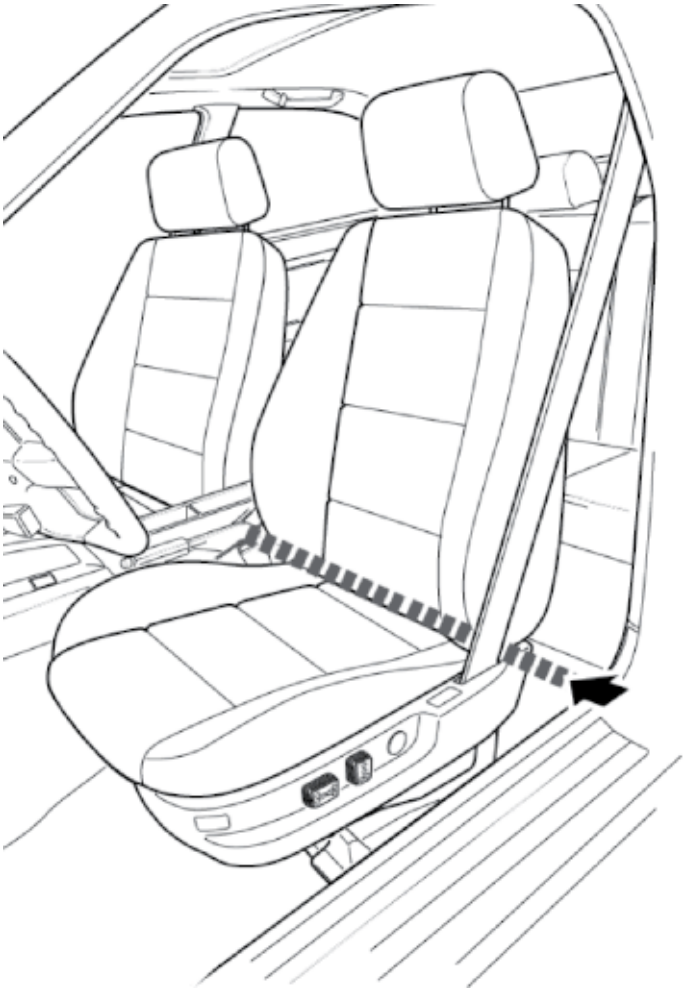
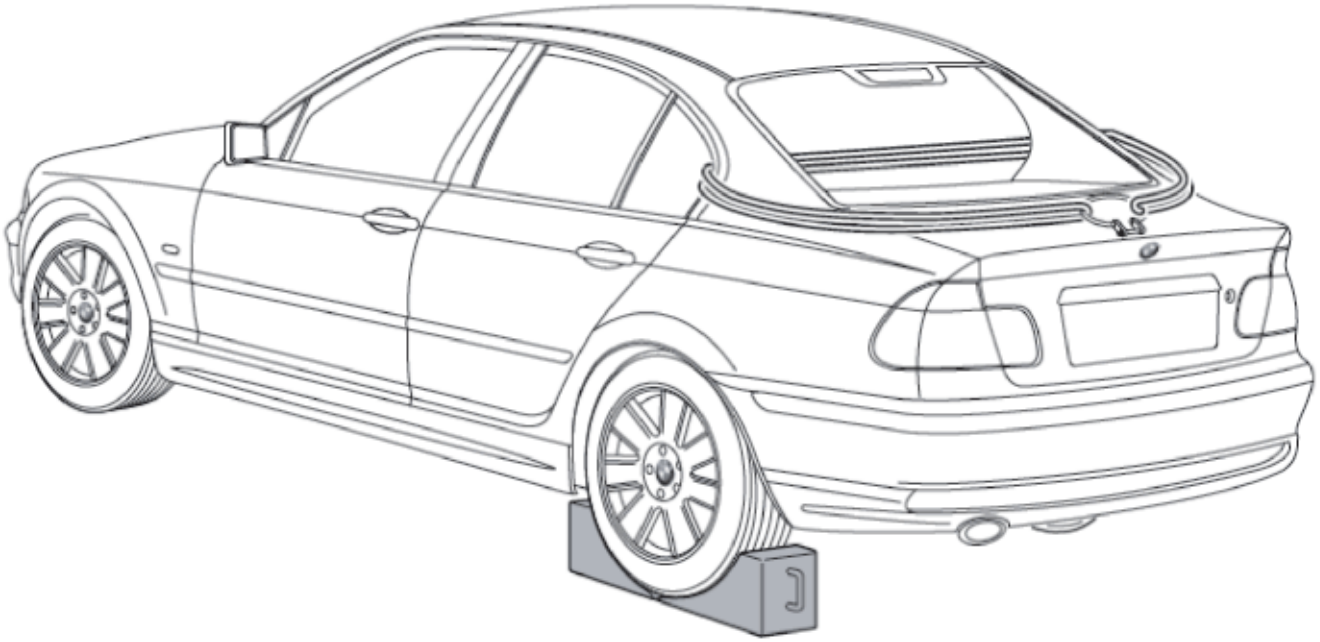
# Electric seat adjustment



Since the seats in vehicles with electric seat adjustment cannot be adjusted once the battery has been disconnected, under certain circumstances we would recommend disconnecting in the area marked.

# Securing vehicles



Example: Possible ways of securing vehicles

**Chock**

Place chock in front of and behind the rear axle wheel on the side opposite that on which the vehicle will be raised.

Ideally, the mounting points for the jack should be used.

**Continuous loop**

Secure the continuous loop to the rear or front by passing through the window openings and affix to a suitable counter support.

**Front and rear axles**

When securing the vehicle, always combine several axle components (axle support, wishbone, drive shaft).

**Towing eye**

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|  Important! | The towing eye must not be used to recover or secure the vehicle! |

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# Safety concepts and systems

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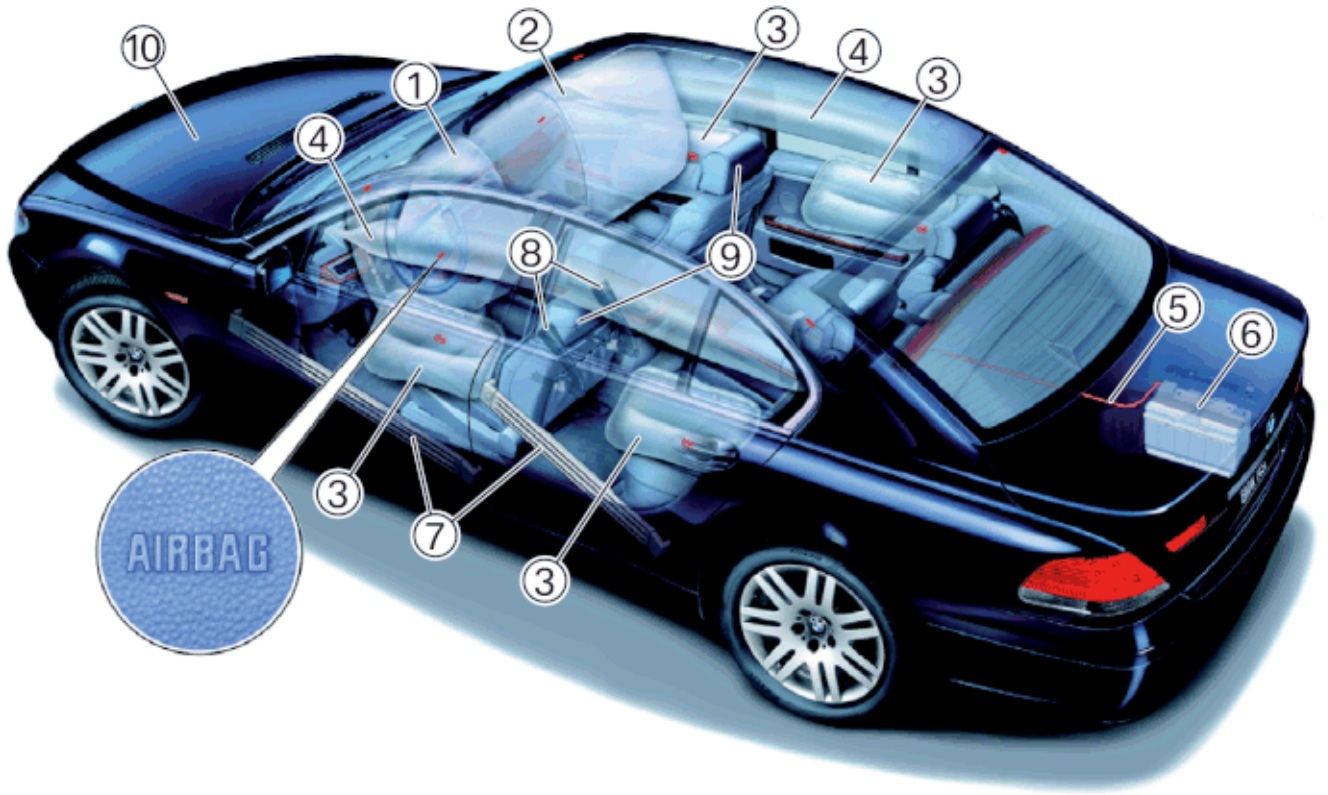
# Complete overview of restraint and safety systems




| | |
|---|---|
| **1** Driver's airbag | **6** Battery |
| **2** Front passenger airbag | **7** Side impact protection |
| **3** Side airbag | **8** Belt tensioner |
| **4** Head airbag | **9** Active head restraint |
| **5** Positive battery cable | **10** Active engine compartment lid |

# Identification of safety systems

**Airbag system**

**Driver's airbag**

SRS, SRS airbag or AIRBAG labelling on the steering wheel (steering wheel baffle plate)

**Front-passenger airbag**

SRS, SRS airbag or AIRBAG labelling on the dashboard (passenger's side)

**Side airbag**

- Side airbag in the interior door frame (virtually all BMW models):
  SRS, SRS airbag or AIRBAG labelling on the door trim panel (front and rear) in the area of the door lock
- Side airbag in the front seat (all MINI models and a few BMW models):
  AIRBAG labelling on the outer side of the backrest of the driver's and front passenger seats

**Head airbag**

SRS, SRS airbag or AIRBAG labelling on the trim panel of the A- and C-pillars

**Knee airbag**

AIRBAG labelling on the glove box lid (top right) or on the steering column shroud (top left)

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**Belt tensioners**

No identification

The vehicles contain four kinds of systems for reducing belt slack:

- Mechanical belt tensioners
- Pyrotechnic belt tensioners
- Pyrotechnic automatic tensioners / end fitting pretensioners
- Seat-integrated belt system (SGS)

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**Active head restraints**

No identification

The active head restraints are integrated into the driver's and front passenger seats.

Active head restraints that have not been triggered require no special attention.

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**Roll-over protection system**

- 3-Series (E36): no identification
- 3-Series (E46): "Rollover protection system" identification on the top side of the head restraint on the rear seat
- 1-Series(E88), 3-Series(E93), 6-Series(E64): "Rollover protection system" identification
  The rollover protection system is only installed in convertibles in the 1-Series (E88), 3-Series (E36, E46, E93) Convertible and 6-Series (E64).
  Rollover bars that have not been triggered require no special attention.

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**Active engine compartment lid**

No identification

Installation depending on series and national-market version.

Engine compartment lids that have not been activated require no special attention.

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**Child restraint systems**

Front passenger and side airbags can be switched off when using child restraint systems. Labels can be found near the airbag in question if this applies.

# Airbag - technical information

**Use**

In view of different legal requirements in Europe and the USA, different airbag variants are used in BMW vehicles.

**Front airbag for driver I**

Large air cushion fitted as part of the vehicle's standard equipment (the volumes used in the USA and European versions differ due to differing legislation)

**Front airbag for driver II**

Small air cushion (compact airbag; Eurobag) used in vehicles equipped with a sports steering wheel

**Front airbag for front passenger**

Air cushion, under the dashboard on the passenger's side

**Side airbag**

Small air cushion, on the interior door frame (front and rear doors) or in the outside of the front seats

**ITS head airbag**

Air pipes, from the bottom end of the A-pillar along the inside of the roof structure to just shortly before the C-pillar

**AITS head airbag**

Head airbag stretching from the A-pillar to the C-pillar; extension of the ITS head airbag with a canvas between the ITS airbag and roof frame

**Head airbag**

Head airbag stretching from the A-pillar to the C-pillar; extended covered area for the front and rear side windows

**Rear head airbag**

Small air cushion in the roof frame above the C-pillar

**Knee airbag**

Small air cushion, behind the glove box lid or behind the steering column shroud (only available in the US version)

**Driver's airbag**

Triggered driver's airbag

The driver's airbag is located in the steering wheel's impact absorber.

Acceleration is recorded and evaluated by a sensor. If the triggering threshold is exceeded, the airbag control unit and/or the satellite responsible (= intelligent sensor) transmits an ignition voltage to the ignition squib which then triggers the airbag.

The gas created by ignition escapes into the airbag which then unfolds in full.

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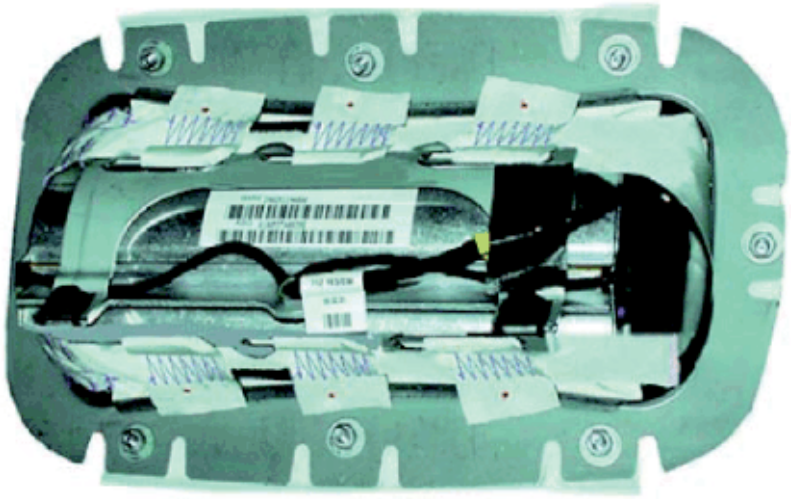
**Front-passenger airbag**



Front passenger airbag that has not been triggered

The front passenger airbag is located in the dashboard above the glove box on the passenger's side.

A seat occupancy detection feature has been integrated in the vehicle for many years to prevent the front passenger airbag from being unnecessarily triggered in the event of a crash when the front passenger seat is not occupied.

Using sensors in the front passenger seat and by evaluation of data in the airbag control unit and/or in the satellites ( = intelligent sensor), above a weight of 12 kg the front passenger seat is recognised as being occupied and the system is activated.

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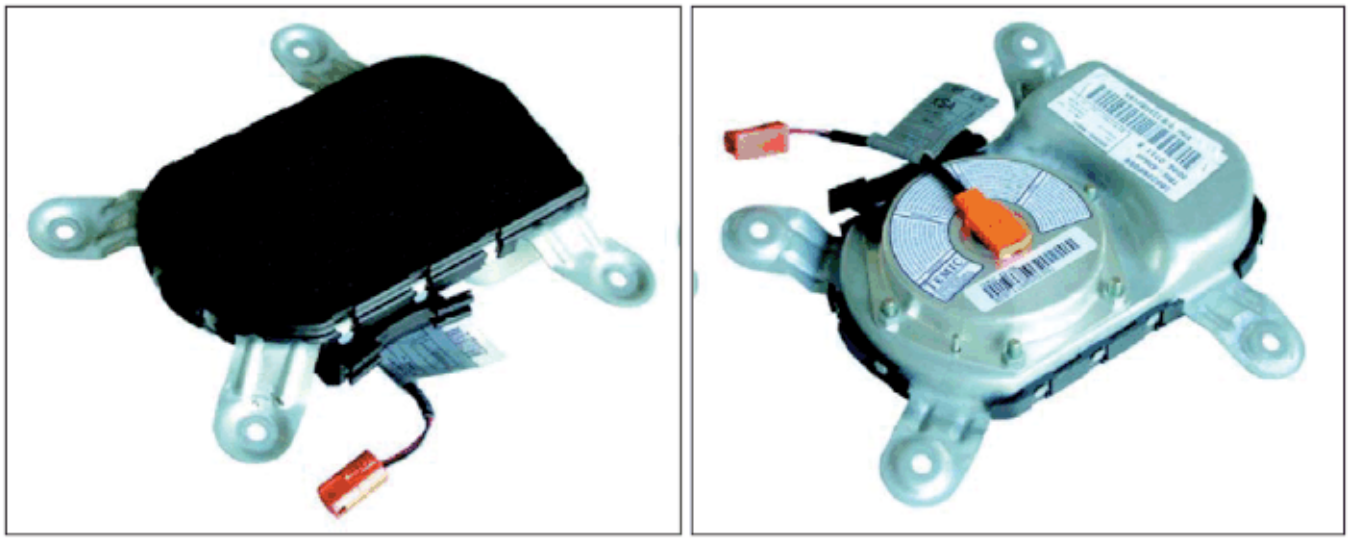
**Side airbag**



Side airbag not triggered

The side airbags are located behind the side trim panel in the door in most BMW models. On some BMW models, as well as on all MINI models, the side airbags are located to the side, in the backrest of the driver's and front passenger seats.

In the event of a side collision, the resulting lateral acceleration is recorded by sensors.

If the triggering threshold is exceeded, the airbag control unit and/or the satellite responsible (= intelligent sensors) activates the side airbags and, if fitted, also the head airbag.

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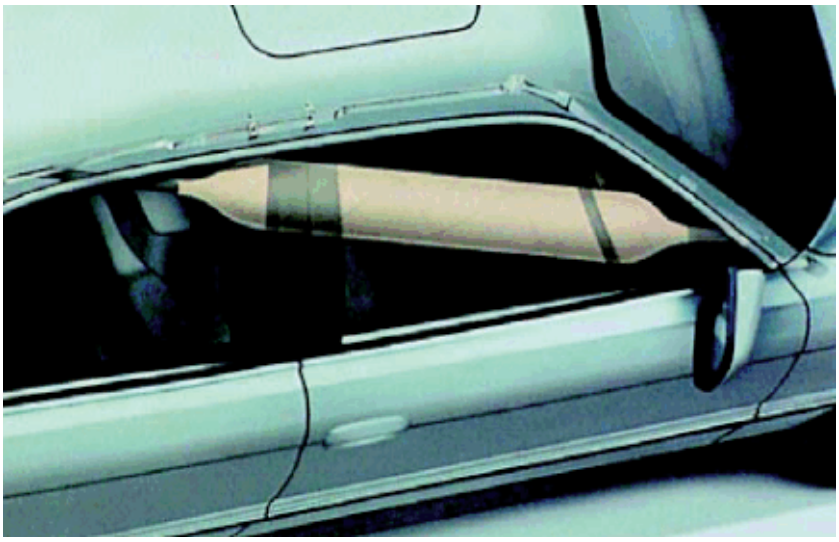
**ITS head airbag**



ITS not triggered (in the roof area) and triggered

The ITS head airbag, unlike other airbags, involves a tube system that is secured to the body with seat belt straps.

When the generator is ignited, the diameter of the head airbag increases and its overall length is reduced. This process stretches the head airbag between the lower end of the A-pillar and the rear mounting on the roof frame.

Unlike the front and side airbags that collapse relatively quickly after inflation, the head airbag retains its gas volume and therefore offers protection in the event of the vehicle rolling or secondary accidents.

The head airbag can be cut off or (safely) cut through at the seat belt straps.

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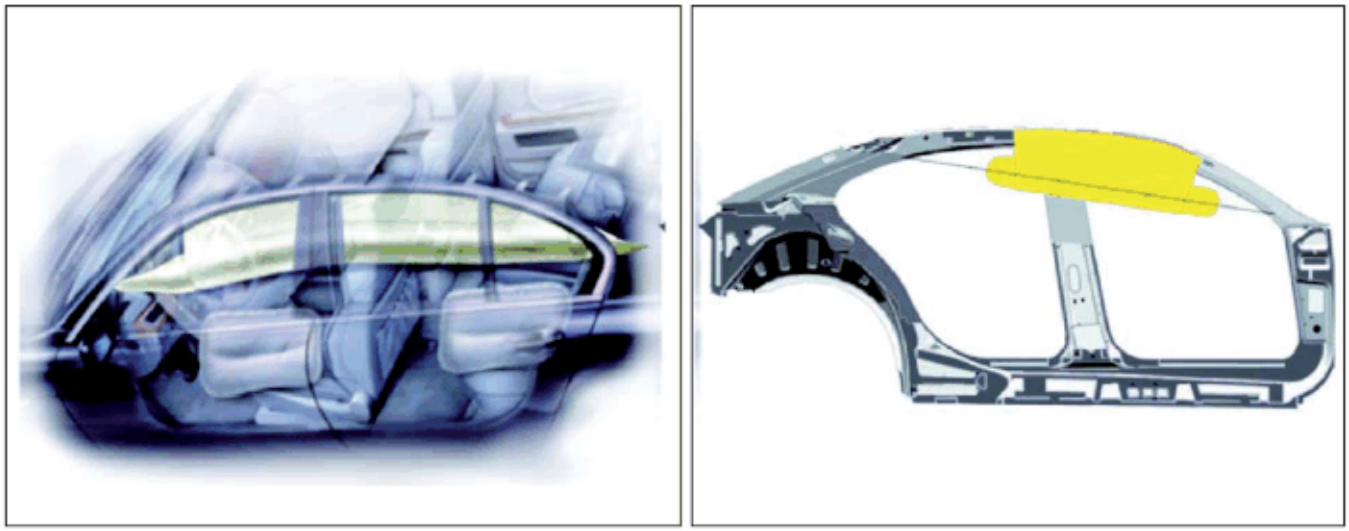
## AITS head airbag



AITS for front and rear seat passengers (triggered)

The AITS head airbag is a head protection system like the ITS. Its advantage, however, lies in its curtain-like area protection.

The AITS prevents the head and limbs from swinging back and forth. This means that the neck experiences lower shearing forces and there are fewer head injuries.

System features:

- Extended covered area for the front and rear side windows
- Protection from broken glass and penetrating objects
- Optimised covered area, even for very large occupants

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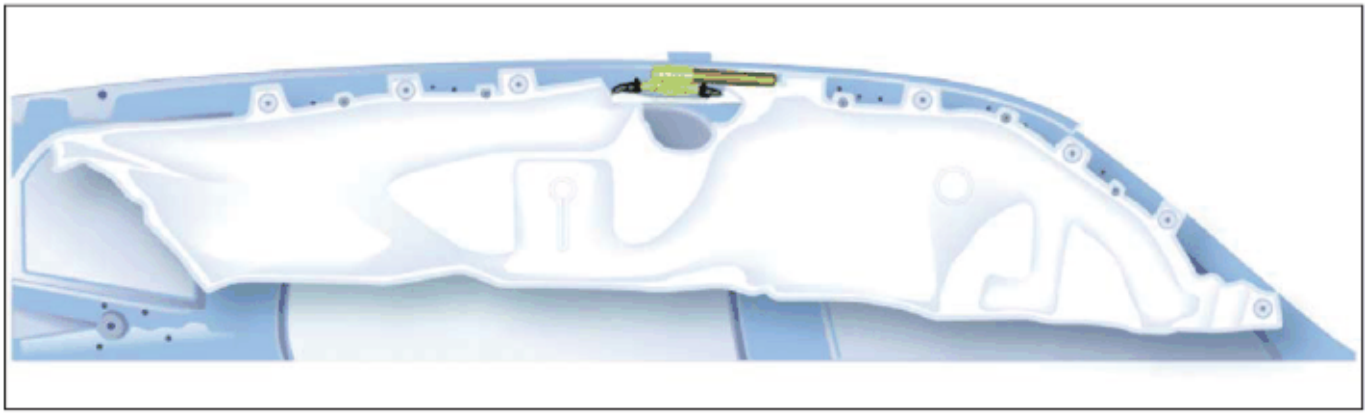
## Head airbag



Side airbag triggered

The side airbag stretches from the A-pillar to the C-pillar and covers the entire side area. It unfolds between the occupants, side window and pillar trim panels.

System features:

- Extended covered area for the front and rear side windows
- Protection from broken glass and penetrating objects
- Optimised covered area, even for very large occupants

The side airbag is stored folded-up in the roof frame area. It comprises the gas generator, two gas lances and curtain.

In the event of a side collision, the generator is activated. The resulting gas flows through the two gas lances into the curtain. The simultaneous filling of the curtain at the front and rear ensures a more even filling.

The side airbag's mounting at the A-pillar and C-pillar ensure that the head airbag is brought into position. As it unfolds, the side airbag stretches between the side window, pillar trim panel and occupant.

The closed system preserves the structural solidity and stability for several seconds.

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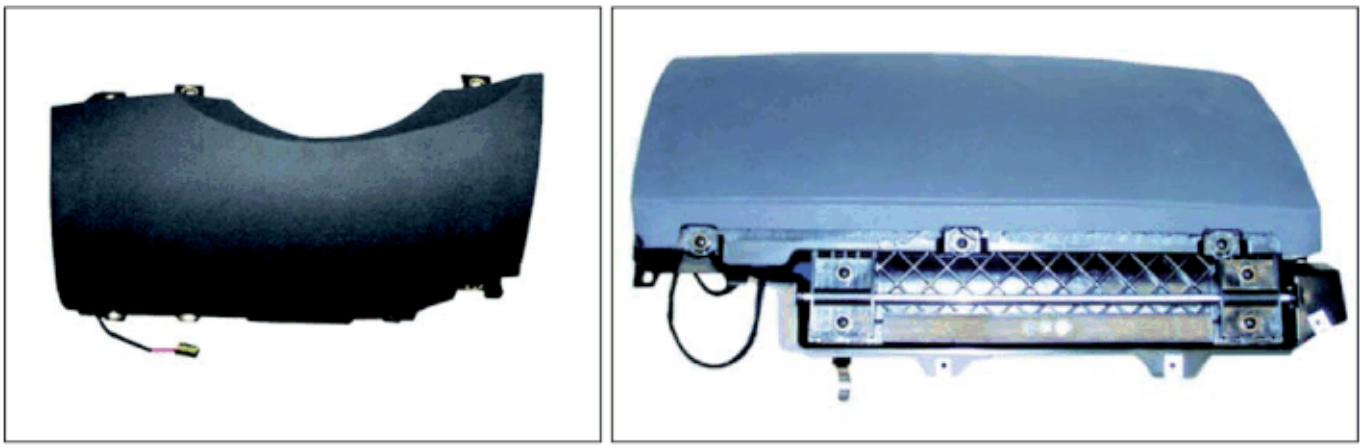
## Knee airbag



Knee airbag on driver's side (top) and passenger's side (bottom).

In the event of a crash, when the driver or front passenger is not wearing a seat belt, the knee airbag will support their knees.

This results in the upper body being shifted forwards in a controlled manner and being caught by the airbag.

The knee airbag on the passenger's side is located in the lid of the glove box behind a cover.

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## Ignition sequence

The airbag is triggered by the airbag control unit and/or the responsible satellite (= intelligent sensor).).

The integrated sensors activate the required systems when the triggering thresholds are exceeded. In the gas generator, the solid propellant sodium azide or nitro-cellulose mainly burn to nitrogen gas. Negligible volumes of carbon monoxide and nitrogen oxide are produced. This gas then flows into the airbag and unfolds it. As the air sack unfolds, the cover (impact absorber of driver's airbag, cover of the front passenger airbag, trim panel of the side/head airbags) tears of at the predetermined breaking points.

The deposits of talcum powder from the airbag in the passenger compartment are totally safe.

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### Safety mechanisms

The restraint and safety systems are triggered by electronic and mechanical acceleration sensors. Two sensors which function independently of one another are always needed to trigger the airbags.

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### Electronic acceleration sensors

Driver's and front passenger airbag, head and side airbags, belt tensioner and safety battery terminal.

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### Mechanical acceleration sensor (safety sensor)

The driver's and front passenger airbags are triggered in conjunction with the mechanical acceleration sensors.

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### Electronic side impact sensors

The side and head airbags are triggered in conjunction with the electronic acceleration sensors.

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### Airbag control unit

The airbag control unit is the central unit in the entire restraint and safety system and carries out the following tasks:

- Impact detection
- Calculation of triggering time for airbags, belt tensioner, safety battery terminal
- Ignition of airbags, belt tensioner and safety battery terminal
- Self-test
- Fault display and fault memory with diagnostic capability
- Seat occupancy and weight recognition for the front passenger seat

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### Satellites

Satellites consist of a control unit with an integrated sensor system for activating actuators (airbags, belt tensioner, etc.). Satellites are able to make intelligent decisions on selective and fast triggering of actuators. Any functions not needed are not activated.

In the 7-Series (E65/66) models the Intelligent Safety Integration System (ISIS) and, from the 5-Series (E60/E61), 6-Series (E63/E64), and Z4 (E85) models, the Advanced Safety Electronics (ASE) are installed with satellites.

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# Belt tensioner - technical information

Four different belt tensioner systems are used in the vehicles:

- Mechanical belt tensioners
- Pyrotechnic belt tensioners
- Pyrotechnic automatic tensioners / end fitting pretensioners
- Seat-integrated belt system (SGS)

All the systems have the same goal of reducing belt slack. This is the biomechanical load to which the human body is subjected after an accident.

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### Mechanical belt tensioner

On the mechanical belt tensioner, a mechanical sensor detects a crash and triggers the release of the tensioner energy via a switching mechanism. A force transfer element pulls the seat belt buckle obliquely downwards to tension the seat belt strap against the occupant's body. When the belt force is subsequently built up, a locking system blocks the seat belt buckle in any tensioned position. The occupant is therefore secured more effectively to the vehicle.

In the event of a head-on collision, the mechanical impact sensor activates the system. A preloaded spring pulls the seat belt buckle back. The shoulder and lap belts are tightened.

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### Pyrotechnic belt tensioner

The pyrotechnic belt tensioner is a further development of the mechanical belt tensioner for reducing belt slack even more quickly.

The pyrotechnic belt tensioners are activated by the airbag control unit and/or seat satellites, a pyrotechnic unit is responsible for tightening the seat belt.

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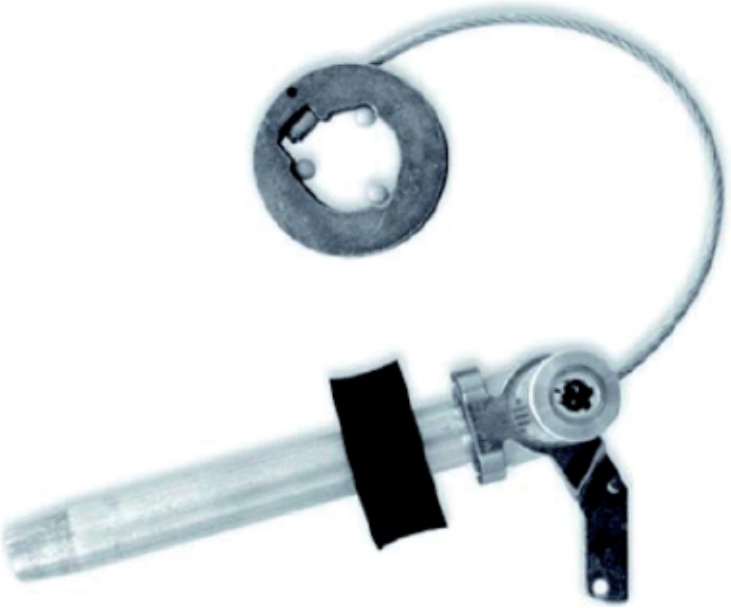
**Pyrotechnic automatic tensioner / end fitting pretensioner**



Pyrotechnic automatic tensioner

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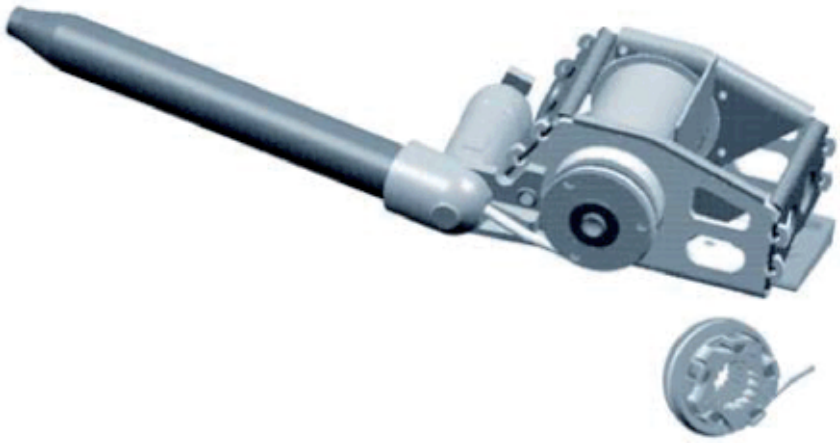

Pyrotechnic end fitting pretensioner

The pyrotechnic automatic tensioner reduces belt slack by creating friction in the seat belt guides, primarily in the shoulder region.

Sensors and control electronics activate a pyrotechnic unit which starts the automatic shaft rotating through a wound cable.

To eliminate the film spool effect, a clamping fixture holds the seat belt strap secure when the occupant moves forwards.

At present, pyrotechnic end fitting pretensioners can only be fitted on the outer seats in the rear passenger compartment.

Since there is little space under the rear seat, a solution similar to that of the front belt tensioner is not possible. Belt slack is therefore overcome by drawing in the seat belt strap at the end fitting. The automatic reel forms the top attachment point, the end fitting pretensioner the bottom one.

The end fitting pretensioners are activated by the seat satellites and/or the seat module, a pyrotechnic unit is responsible for tightening the seat belt.

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## Seat-integrated belt system (SGS)

In the seat-integrated belt system (SGS) all the belt elements, including the reversing points, are moved into the seats. In the event of a crash, all forces in vehicles without B-pillars are absorbed by the floor assembly.

The head restraint and top belt reversing point also automatically adjust depending on the seat length adjustment.

A top seat belt strap tensioner fitted on the top belt feed also restricts the amount by which the occupant moves forwards in the event of a crash. The overall arrangement reduces the free seat belt strap lengths to a minimum.

Since all three belt points move with the seat adjustment, the belt geometry automatically guarantees the body is restrained by the belt as best as possible.

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# Active head restraint

The active head restraints are integrated into the driver's and front passenger seats.

**Function**

In the event of a rear-end collision, the head is jolted to the rear because it becomes the most inactive part of the body due to the long distance to the head restraint. This jolt movement may result in cervical injuries (whiplash).

To reduce the distance between the head and head restraint, the active head restraint swings forward to the head in the event of a rear-end collision.

Two additional impact sensors and/or satellites in the rear end activate the gas generator in the backrest during a rear-end collision. The gas generator's piston rod moves a sliding piece. This sliding piece moves forward the support tube to which the head restraint is attached, and thereby reduces the distance between the head and head restraint.

Depending on the height adjustment of the head restraint, adjustment travel of 40 to 60 mm may be produced.

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# Roll-over protection system

The rollover protection system is an additional safety function in some BMW convertible models. In the event of rollover or other situations that encourage the vehicle to roll over, the rollover protection system extends, locks positively and thereby helps maintain a large enough survival space for occupants.

The first thing is to gain access (support opening) to the (locked in or trapped) people. As with all other measures, the patients should be treated with all due care.

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**Function of the BMW 1-Series E88, 3-Series E93, 6-Series E64 and MINI Convertible R57**

Rollover protection of the 6-Series E64 in normal position and triggered (right)

Two rollover protection bars are stored behind the two rear seats in a carrier structure.

The rollover protection system is a separate system and is not linked to the airbag control unit.

On models in the 3-Series (E93), the ROC control unit (rollover protection controller) is installed in the carrier structure in addition to the right-hand rollover protection bar.

On models in the 6-Series (E64), the rollover sensor is located in one of the satellites.

The rollover protection bars are retracted in the carrier structure during normal operation. The rollover protection bars are pre-tensioned in the direction of extension by a spring and held by the lock on the actuator.

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**BMW 3-Series E93 and MINI Convertible R57**

If the rollover protection controller control unit detects an imminent rollover, the two actuators are triggered directly. The rollover protection bars are extended by spring force and mechanically locked in their end position.

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**BMW 6-Series E64**

If the rollover sensor in the satellite detects an imminent rollover, the data are transmitted via a light-linked bus system to the SGM safety and gateway module. At the same time, the signal to release the rollover protection system is sent via a copper cable (arming cable) to the SGM. This triggers the two actuators via an output stage. The rollover protection bars are extended by spring force.

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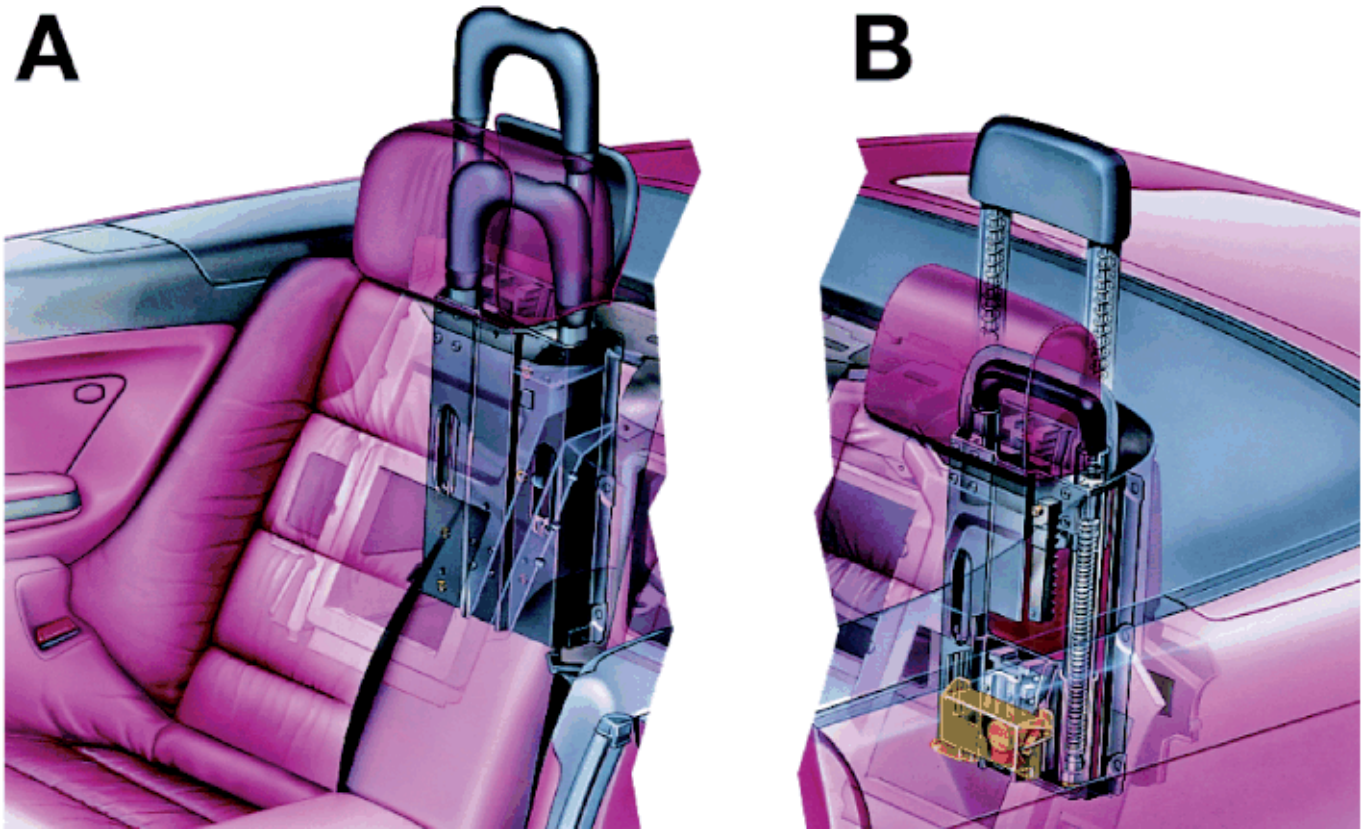
**Function of the 3-Series E36 and E46**




Triggered rollover protection system in the 3-Series E46 (A) and E36 (B) Convertible

On models in the 3-Series (E36), the rollover protection system comprises two rollover protection bars behind the head restraints of the rear seat (visible), and on models in the 3-Series(E46) of two rollover protection bars in the head restraints of the rear seat (installed concealed).

The rollover protection system is a separate system and is not linked to the airbag control unit.

The rollover sensor is screw-mounted directly to the protective cover behind the seat bench on the right.

The rollover sensor consists of:

- A level sensor for identification of vehicle inclination, latitudinal and longitudinal acceleration
- A g-sensor (g = gravity) for identification of loss of contact with the road surface
- Evaluation electronics with self-diagnosis
- Two capacitors to provide the reserve energy needed to trigger the rollover protection bars should the vehicle voltage fail

When the limit values are reached, the integrated rollover sensor issues a command to the actuator to enable the locks. A solenoid operates the lock and releases the spring-loaded rollover protection bar. The rollover protection bars are extended and mechanically locked in their end position.

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# Active engine compartment lid

In the event of a collision with a pedestrian, the engine compartment lid is raised. This creates a deformation zone that protects the pedestrian.

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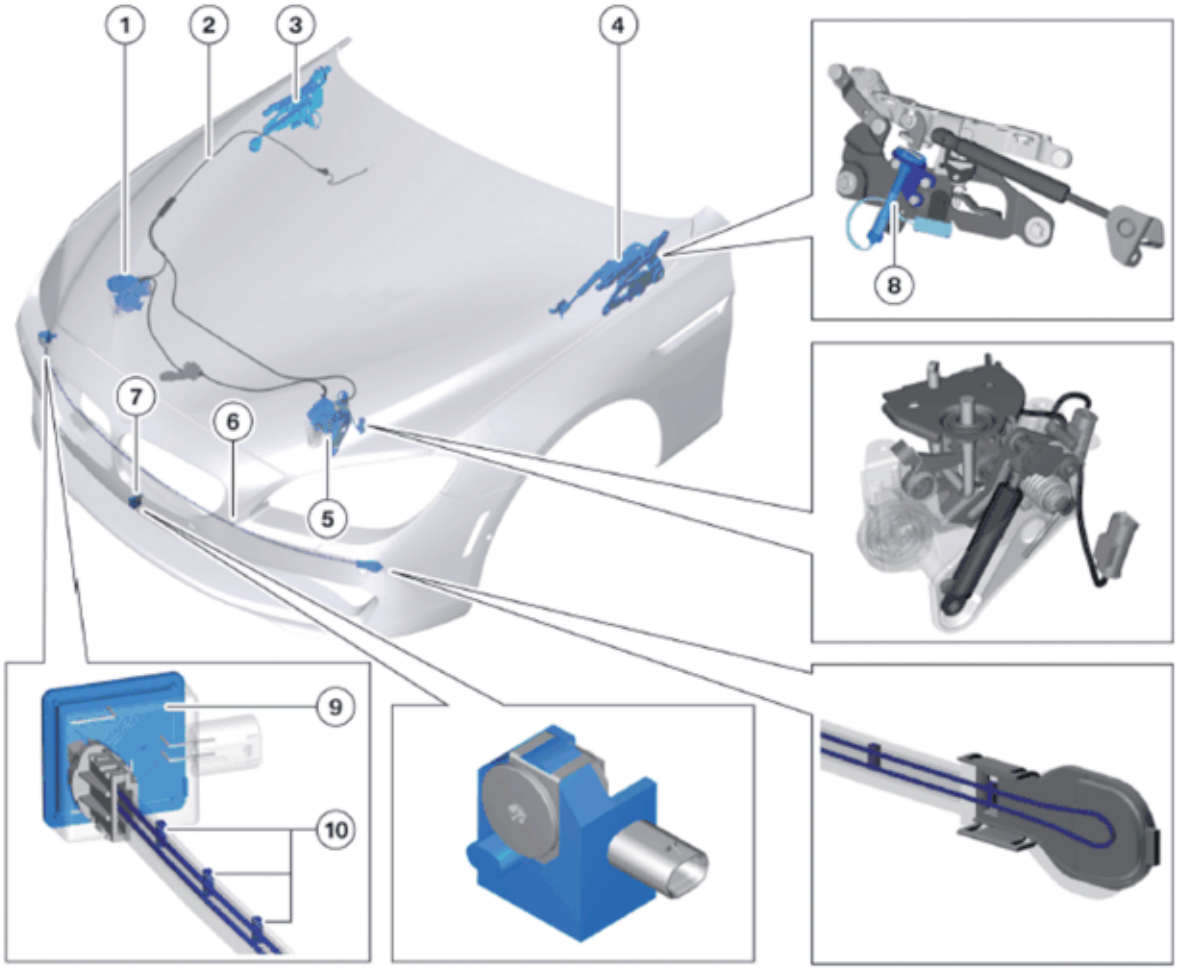
**Function**




| | |
|---|---|
| **1** Right engine compartment lid catch (with actuator) | **6** Optical fibres |
| **2** Bowden cable | **7** Central sensor (acceleration) |
| **3** Right engine compartment lid hinge (with actuator) | **8** Actuator (on engine compartment lid hinge) |
| **4** Left engine compartment lid hinge (with actuator) | **9** Sensor (optical fibre) |
| **5** Left engine compartment lid catch (with actuator) | **10** Deformation structure |

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An optical fibre is integrated between the bumper support and impact absorber. The optical fibre is connected to a sensor and passes in a loop around to the opposite side of the vehicle before heading back to the sensor again.

A force acting on the optical fibre deforms it between the deformation structures. This causes the light in the optical fibre to be attenuated. The acting force is proportional to the light attenuation. A characteristic signal is thus generated by the differing damping action on the light, the nature of which depends on the mass and rigidity of the colliding object.

This signal is measured by the sensor and sent along a data line to the Crash Safety Module (ACSM). The Crash Safety Module (ACSM) uses this data and the data from the central acceleration sensor in the bumper to determine whether the thresholds for detecting a pedestrian collision have been reached or exceeded. It decides whether to activate the engine compartment lid actuators based on the result.

The actuators are activated pyrotechnically and lift the engine compartment lid. Gas pressure springs also support the engine compartment lid when raised.

The active engine compartment lid is only triggered at speeds of approx. 20 –55 km/h. For safety reasons the system may activate on those rare occasions where a pedestrian collision cannot be unequivocally ruled out, e.g.:

- a crash against a dustbin or bollard
- a collision with an animal
- hitting a rock
- driving into a snowdrift.

After the active engine compartment lid is triggered, a Check Control message is shown in the instrument cluster and in the central information display.

The engine compartment lid cannot be returned to its initial position after activation. Active pedestrian protection is only re-established after a component change has been carried out. After the pedestrian protection has activated, it is only possible to continue driving carefully at a maximum speed of 80 km/h.

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# Body and materials

### Structure of the body

Thanks to high-strength steels, greater wall thicknesses and a multi-shell construction, the stability of the vehicles is optimised and therefore the safety of the occupants is increased.

Modern heavy duty cutting equipment is mandatory for cutting the body; older hydraulic cutting tools could be overloaded.

The heavy duty cutting equipment must be properly used by trained and qualified personnel.

The optimum cutting zone for each vehicle is drawn on the emergency services cards.

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### Materials

The type and percentage proportion of each material differ for individual model ranges.

Structural reinforcements in the A- and B-pillars are primarily installed in convertibles, roadsters and coupés. This is where there are particular stability requirements on these vehicles.

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### Magnesium moulding

Magnesium moulding may be found in the area of the engine compartment and on the dashboard.

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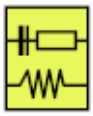
# Glazing

| | |
|---|---|
|  Important! | Danger of injury!<br>Before removing glass panes, the occupants should be fully protected against dust and glass splitters. |

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**Single-layer safety glass (ESG)**

Single-layer safety glass (ESG) is thermally pretreated glass that can withstand high loads. If the load is too high, however, it shatters into many fragments with not particularly sharp edges.

ESG is used for side windows, rear windows and the slide/tilt sunroof.

**Note:**

Intact ESG window glass can jump out of position suddenly when recovery work is being performed on the vehicle. Depending on the accident situation and the scope of the rescue work, the ESG window glass should be removed first. ESG window glass can be removed by applying a pointed load, e.g. using a spring centre punch or an emergency hammer. The ESG window glass should be secured before doing so.

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**Laminated safety glass (VSG)**

Laminated safety glass (VSG) consists of two layers of window glass and an interleaving plastic film. The window glass remains largely intact when damaged.

VSG is used for windscreens and possibly for side windows. The windscreens are bonded to the body.

**Note:**

Since VSG window glass cannot jump suddenly out of place, it only needs to be removed if the rescue work requires it.

VSG window glass can be removed with special glass saws or hooligan tools.

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**Special safety glass**

Some vehicles are equipped with special safety glass. It can be identified from outside by virtue of the thicker window glass.

Special safety glass cannot be cut using conventional emergency equipment.

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# Electrical system - battery management

## 12-Volt batteries

7-Series Hydrogen E68: Always comply with the detailed information, see 7-Series Saloon emergency services card.

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## Notes on usage

The procedure should be defined on the basis of the situation assessment at the scene.

The use of active electrical systems, such as power window regulators, seat adjustment or steering column adjustment, can significantly assist the rescue operation. The decision to disconnect the battery is therefore to be made by the crew leader on site.

In some cases following an accident, damaged wiring in vehicles can represent a source of ignition despite protection. Disconnection of the batteries can significantly reduce the risk of fire.

The extremely low risk of an unintentional triggering of the restraint system (airbags, belt tensioners) can be excluded by disconnecting the batteries.

The ignition must be switched off.

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## Position of the 12-Volt batteries

The vehicle may be equipped with one or two batteries.

The 12-Volt batteries are located in either the engine compartment or the luggage compartment depending on the vehicle.

Exception: On E34 and E32 models the 12-Volt battery is located in the engine compartment or under the seat bench.

The precise position of the 12-Volt battery for each vehicle is drawn on the emergency services cards.

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## Position of the positive battery cables

If the 12-Volt battery is not located in the engine compartment, the red positive battery cable runs mainly on the vehicle underbody to the engine.

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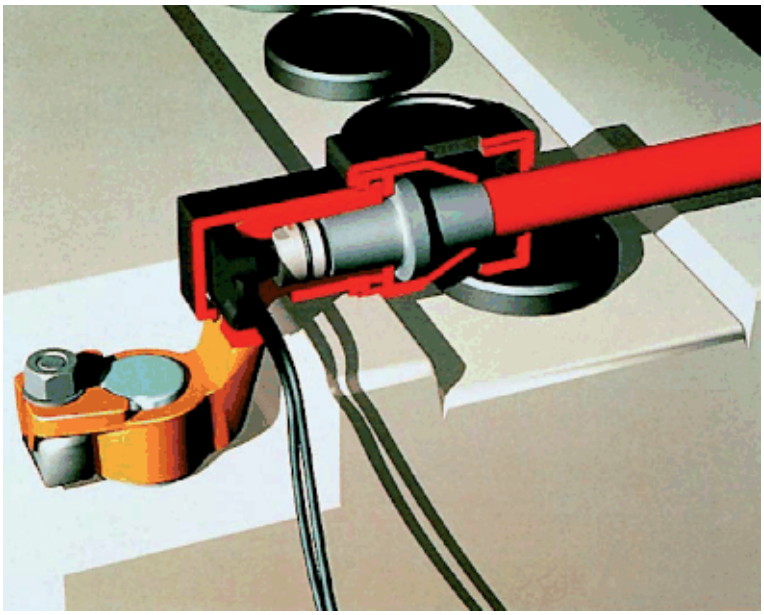
## Safety battery terminal



The safety battery terminal is fitted on the battery's positive terminal.

**The ignition squib of the safety battery terminal must not be crushed, cut through or heated!**

**The safety battery terminal disconnects only the positive battery cable between the battery and starter motor/ alternator.**

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## Identification

No identification

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## Function

The safety battery terminal is screwed directly onto the battery's positive terminal.

In order to minimise the risk of shorting following an accident, the vehicle electrical system in BMW vehicles is divided into two circuits: the vehicle electrical system power supply section and the starter circuit.

If the key criteria are satisfied during an accident, the airbag control unit and/or one of the satellites transmits the command to activate the propellant charge in the safety battery terminal. The gas volume this produces slides the cable pin out of the battery terminal bracket, thereby disconnecting the plug connection between the battery and starter motor/alternator.

The other consumers continue to be supplied with voltage by their own connection to the battery (vehicle electrical system power supply section).

The entire triggering process lasts approximately 3 ms.

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# Disconnecting batteries

When disconnecting batteries the following must be complied with:

- Switch off ignition.
- Firstly disconnect the negative terminal, then the positive terminal.
- If two batteries are installed, always disconnect **both** batteries.

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**Note:** Mechanical belt tensioners cannot be deactivated by disconnecting the battery.

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**Note: If the vehicle cannot be de-energised:**

- Do not remain in the area in which the triggered airbag may unfold and do not place material in this area if heavy emergency equipment is being used.
- Wherever possible, treat casualties from the side.

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# High-voltage battery

High-voltage batteries have a voltage of over 40 volts.
Detailed information for each of the vehicles is described on the emergency services cards.

- For Active Hybrid 7 F04, F01, see 7-Series Saloon emergency services card
- Active Hybrid 5 F10, 5-Series Saloon see emergency services card
- Active Hybrid 3 F30, 3-Series Saloon see emergency services card
- X6 Active Hybrid E72, SAV see emergency services card X6.
- BMW Active E, E82, see 1-Series emergency services card.
- MINI E, see MINI E emergency services card.

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# Alternative engines

### Electric vehicle

For detailed information on MINI E, see MINI E emergency services card.

For detailed information on BMW Active E, see 1-Series emergency services card.

### Hybrid cars

For detailed information on Active Hybrid 7 F04, F01, see 7-Series Saloon emergency services card.

For detailed information on Active Hybrid 5 F10, see 5-Series Saloon emergency services card.

For detailed information on Active Hybrid 3 F30, see 3-Series Saloon emergency services card.

For detailed information on X6 Active Hybrid E72, see SAV X6 emergency services card.

# Fuels and fuel tanks

**Fuels**

Diesel engine: Diesel fuel DIN EN 590

Petrol engine:

- Premium grade fuel, 98 RON
- Premium grade fuel unleaded, 95 RON
- Regular-grade fuel unleaded, 91 RON

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**Fuel tank**

The fuel tank is located in the area of the rear axle on the vehicle underbody.

Exception: On E32 and Saloon E34 models, the fuel tank is located in the area of the luggage compartment.

The precise position of the fuel tank for each vehicle is drawn on the emergency services cards.

.

**Fuel filler flap**

BMW: The fuel filler flap is located on the right-hand side.

MINI: The fuel filler flap is located on the left-hand side.

The precise position of the fuel filler flap for each vehicle is drawn on the emergency services cards,.

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# Frequently asked questions

**How does an airbag work?**

The acceleration recorded by the sensors is integrated and evaluated. Once the corresponding triggering thresholds are exceeded, the required airbags are triggered. The ignition squib in the gas generator obtains the ignition voltage from the airbag control unit and/or relevant satellite. The gas produced escapes into the airbag.

.

**How do I identify whether a vehicle is fitted with airbags?**

Labelling AIRBAG or SRS or SRS airbag on the steering wheel, dashboard, door trim panel and A-pillar trim panel, C-pillar, outer side of the backrest of the driver's and front passenger seats. If in any doubt, assume that newer vehicles are equipped with an airbag.

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**Is smoke ejected during ignition?**

Generally dust is produced from the talcum powder applied to the air sack in the factory.

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**Does the airbag get hot?**

The airbag doesn't get hot. Only the components inside the airbag module reach high temperatures after triggering. These components are near the airbag attachment and do not pose a risk to the emergency services. The parts need approximately 15 minutes to cool down.

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**Does the residue contain sodium azide?**

Sodium azide, the solid propellant in the gas generator, combusts totally when the gas generator is ignited and is totally chemically converted. The product of the reaction is mainly safe nitrogen gas which makes up approximately 80 % of the air we breathe.

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**What precautions need to be taken if an airbag module is mechanically damaged but has not triggered?**

In the extremely unlikely event that the airbag gas generator has been destroyed, the propellant (pressed into tablet form) could fall out. If this happens, avoid contact with the skin at all costs (wear gloves and safety goggles). The tablets must be treated and disposed of separately. They must be kept away from any source of ignition (electricity, fire etc.).

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**If the vehicle catches fire, is there a risk of the gas generator exploding?**

The gas generator has been designed so that it will normally be triggered when exposed to fire if the surface temperature of the generator exceeds 200 °C.

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**Can water be used as an extinguishant?**

Yes. Any effective fire-extinguishing agent can be used, even in vehicles equipped with airbags.

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**Is it safe to inhale the air in the passenger compartment after an airbag has triggered?**

Yes. Chemical and medical analyses confirm that it is totally safe. You may however experience a tickly throat for a short period.

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**If the airbag was not triggered during the crash, will it probably trigger after the crash?**

No. The impact sensor respond to unique physical properties of an accident.

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**Are first-aiders putting themselves at any risk?**

No. A first-aider (a helper without emergency equipment) will find the same situation as in normal driving. If the vehicle is stationary, the airbag systems are not triggered.

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**If the airbag has not been ignited during the crash, how can the system be deactivated?**

Switch off the ignition, disconnect both battery cables (first the negative terminal and then the positive terminal) from the battery.

This rules out the risk of the airbag triggering during the rescue. For exceptions, refer to the "Airbag" section.

.

### Should the emergency services wait for the airbag system to be deactivated before administering aid?

No. Switch off the ignition, disconnect both battery cables (first the negative terminal and then the positive terminal) from the battery.

If the points raised in “Response of the restraint and safety systems after an accident” are noted emergency aid can be given to the occupants straight away.

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### What should you do if people are trapped in the vehicle, individual airbag systems have not been triggered and the vehicle cannot be de-energised?

- Administer emergency medical aid immediately.
- Create support openings as a priority.
- Test: which untriggered airbag systems does the vehicle have and where are they in relation to where the emergency service and recovery helpers are working?
- If at all possible, do not pull the steering column with the spreader.
- Do not cut through any cables near the airbag systems (this will result in a small risk of the airbag deployment by a short circuit)
- Protect the casualty from the area in which an untriggered airbag would unfold
- Attend to casualties from the side.
- Wherever possible, do not move your head or upper body into the area in which the airbag operates when work is being carried out on the vehicle with heavy emergency equipment.
- Do not remain in the area in which the untriggered airbag may unfold and do not place material in this area if heavy emergency equipment is being used.

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### Can other emergency techniques be used?

Yes, the final decision on the procedure for the rescue always lies with the head of the technical emergency team and the emergency doctor or emergency services staff on site. They must reach agreement on how to proceed. They must reach agreement on how to proceed. The technical and tactical possibilities open to them, details of the accident and extent of vehicle destruction must also be taken into account.

# High-voltage / hybrid technology

# BMW i - the safety of the e-Drive is an essential element of all BMW i vehicles

The safety of the e-Drive is an essential element of product development. A variety of measures safeguard operating safety, including in the event of accidents.

- Fully insulated high-voltage system.
- Automatic safety cutout (disconnection) of the high-voltage battery in the event of an accident with airbag activation.
- Permanent monitoring of the high-voltage cables and other safety-relevant criteria, as well as automatic safety processes.

All systems have demonstrated their safety in crash tests and standard checks. The BMW system tests have demonstrated system safety at a level that exceeds the statutory requirements.

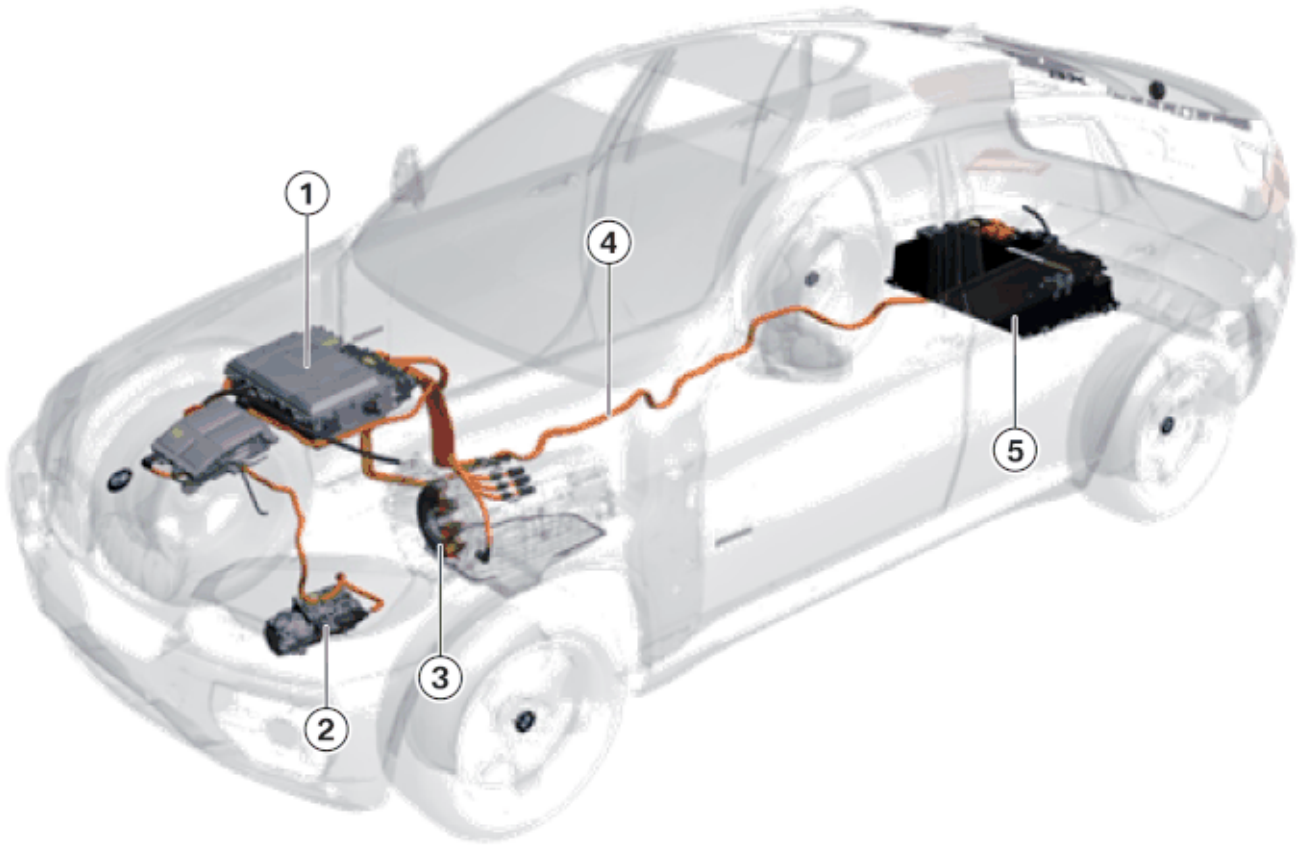
# What does "high-voltage system" mean in the vehicle?

In vehicles with a high-voltage system components are installed that are operated with voltages above 60 V direct current voltage or 25 V AC voltage. Some components in these vehicles need high electrical powers. The high-voltage electrical system in hybrid cars operates with direct current voltages up to 650 V and has to provide large amounts of electrical energy.

# Which components make up a hybrid car?

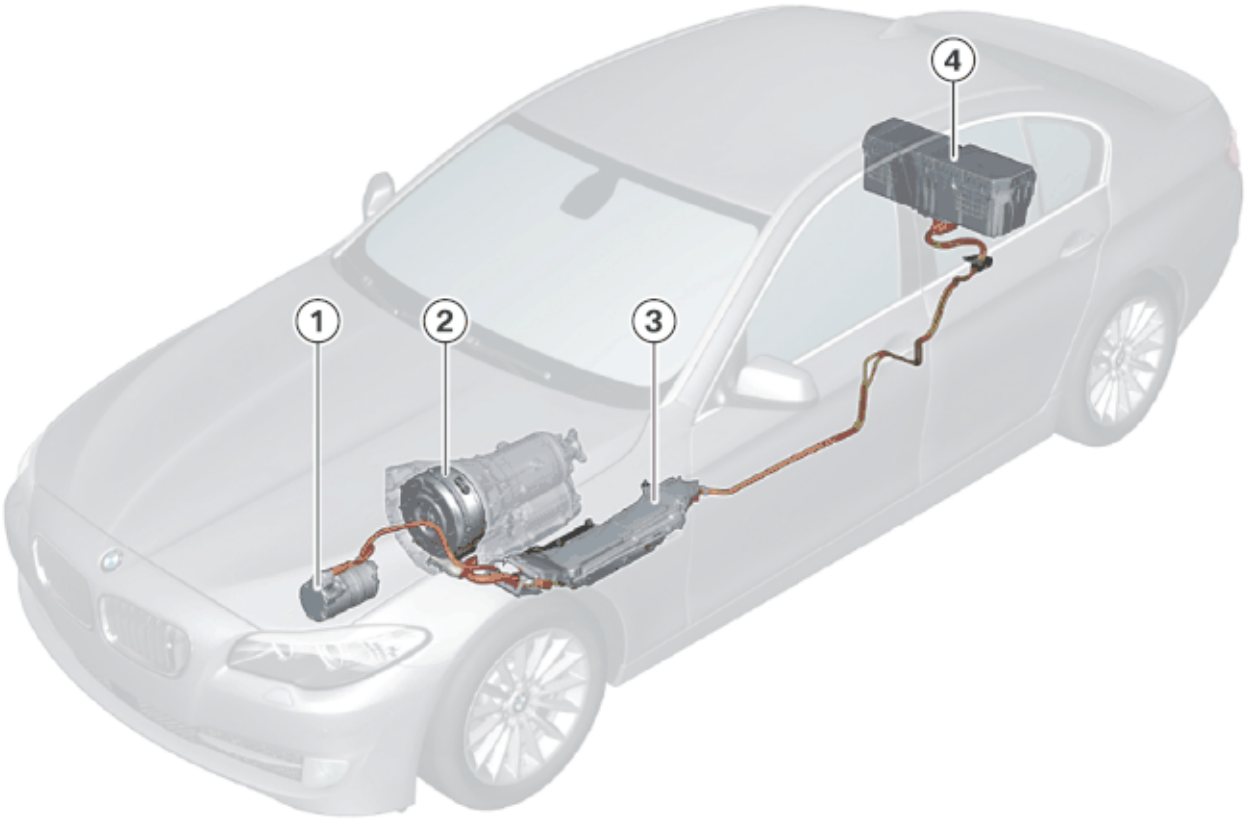
In addition to the drive unit, a hybrid car is made up from the following fundamental components:

- High-voltage battery pack
- High-voltage cables
- Power and control electronics
- Electric motor(s) and alternator(s)




High-voltage component overview based on the example of the X6 ActiveHybrid E72:

| Item | Explanation |
|---|---|
| 1 | Power and control electronics |
| 2 | Electrical refrigerant compressor |
| 3 | Active transmission with electric motors/alternators for full hybrid |
| 4 | High-voltage cables |
| 5 | High-voltage battery pack |




High-voltage component overview based on the example of the 3-Series ActiveHybrid F30:

| Item | Explanation |
|---|---|
| 1 | Electrical refrigerant compressor |
| 2 | Electric machine |
| 3 | Electrical machine electronics |
| 4 | High-voltage battery unit |

# High-voltage safety

With improper use, the high voltage in the high-voltage system may become a source of danger. The vehicle therefore has a comprehensive safety concept. Only technicians who have been appropriately trained are permitted to carry out the repair, maintenance and servicing of high-voltage components including the orange-coloured high-voltage cables. **Unauthorised repair work on the high-voltage system is forbidden.**

Further information on high-voltage safety

- The high-voltage battery is located in a battery box underneath the luggage compartment floor in the luggage compartment. It has been installed in such a way that it is protected against damage.
- An orange-coloured maintenance connector (high-voltage safety connector) is positioned close to the high-voltage battery. The high-voltage system is deactivated by disconnecting this plug connection. (Switched to de-energised)
- The high-voltage system is electrically isolated from the vehicle GND.
- All connections and connectors on the vehicle high-voltage components are designed to be safe to touch.

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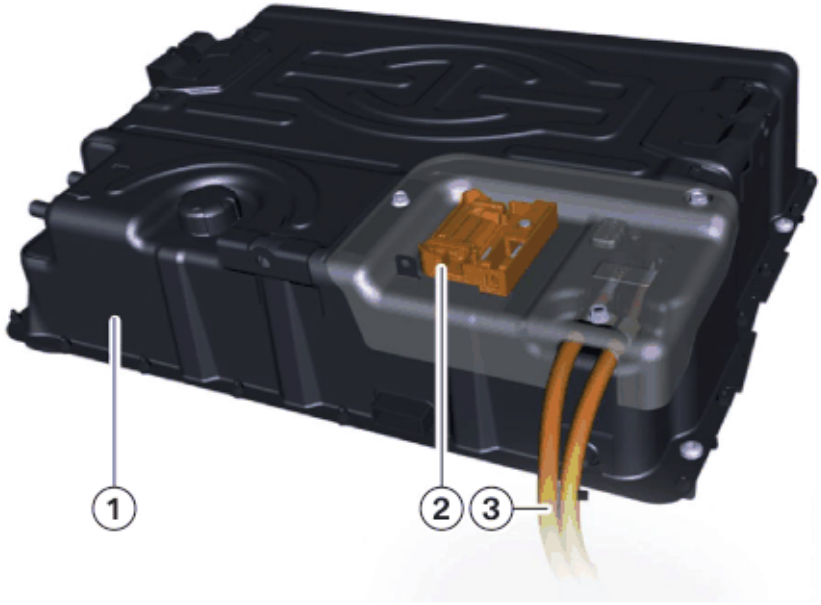
**The high-voltage system is switched-off when:**

- **the ignition is switched off, or**
- **a crash is identified that causes a triggering of airbags and/or belt tensioners, or**
- **the 12-Volt battery negative terminal connection on the negative battery terminal is disconnected**

# High-voltage battery pack including high-voltage safety connector (service disconnect)

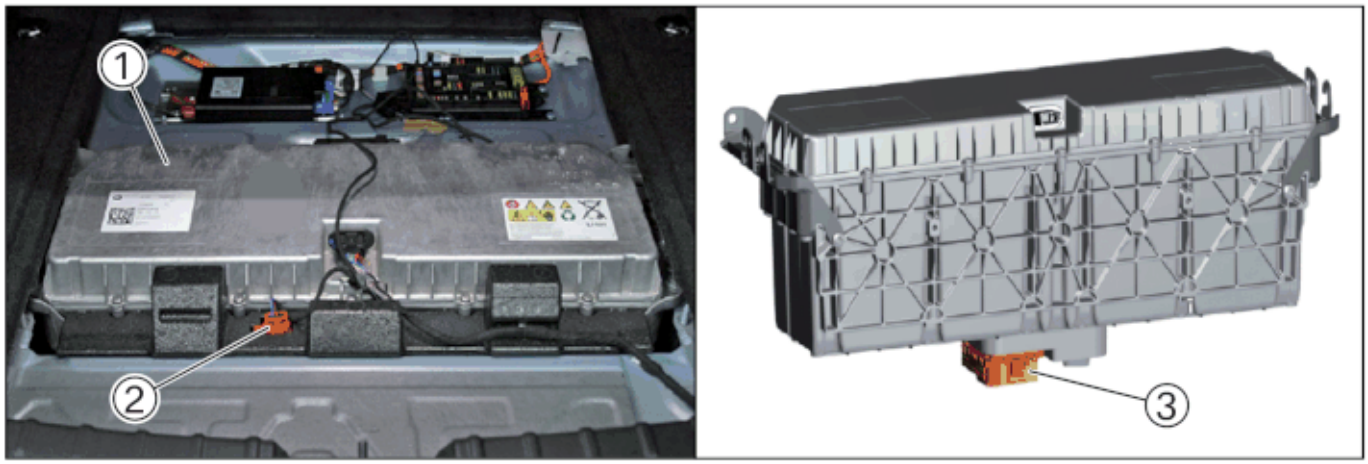
Example X6 Active Hybrid E72




| Item | Explanation |
|---|---|
| 1 | High-voltage battery pack |
| 2 | High-voltage safety connector |
| 3 | High-voltage cables |

.

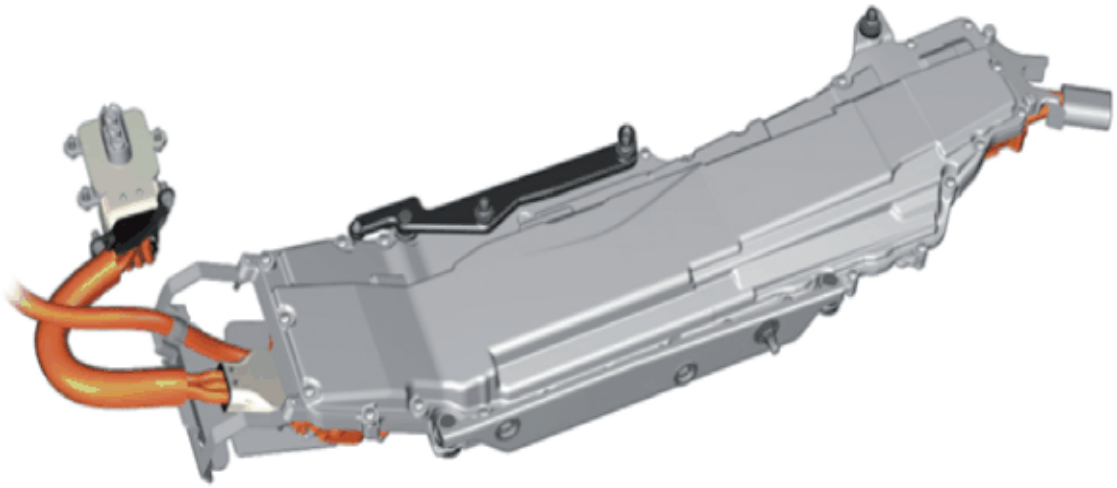
Example of 3-Series Active Hybrid F30:




| Item | Explanation |
|---|---|
| 1 | High-voltage battery pack |
| 2 | High-voltage safety connector |
| 3 | High-voltage cables |

The high-voltage safety connector (service disconnect) plays a crucial role in vehicle manufacturer safety concepts. It has the same function in all concepts, namely that of interrupting the circuit between the individual modules in the high-voltage battery pack. The circuit outside of the battery and therefore the entire high-voltage system is interrupted immediately when the high-voltage safety connector (service disconnect) is removed. Dangerous voltage is therefore no longer applied to the terminals of the high-voltage battery pack.

# Power electronics



In hybrid technology, power electronics are used to convert currents. The power electronics are called an inverter. It converts alternating current generated in the high-voltage alternator into direct current. As with all other high-voltage components, the inverter is not to be opened in any circumstances as high voltages are applied internally.

# Electric machine

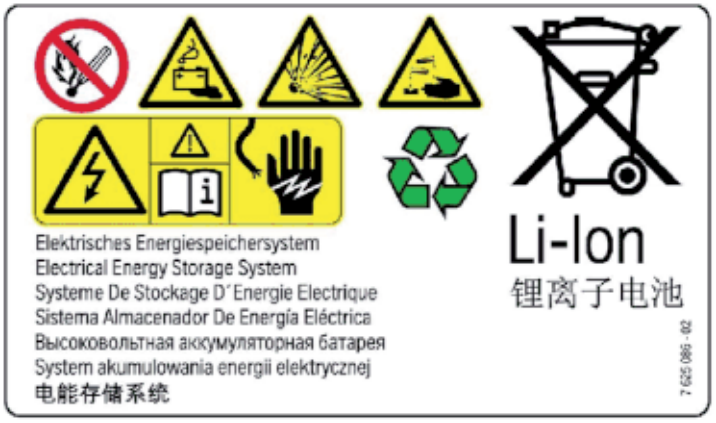
The electrical machine in the Active Hybrid 5 is a permanently excited synchronous machine. It can convert the electrical energy from the high-voltage battery unit into the kinetic energy that drives the vehicle. Driving with electrical power up to approximately 60 km/h as well as support to the combustion engine, e.g. when overtaking (boot function), or active torque support during gear change are possible.

Conversely, during braking and in coasting (overrun) mode the electrical machine converts kinetic energy into electrical energy and feeds it into the high-voltage battery (energy recovery).

# High-voltage cables


The high-voltage cables (1) connect the high-voltage components to each other, e.g. the high-voltage battery pack to the power electronics or the power electronics to the electric motors. High-voltage cables can be identified by the orange coloured insulation (coating).

# Identification of high-voltage batteries

# Identification of the remaining high-voltage components

**Further information:**

It is mandatory to consult the respective **emergency services card** for vehicle-specific information and the procedure for vehicles involved in accidents.

# Frequently asked questions

**Structure**

1. **Investigation / vehicle ID**
2. **Danger by electrical shock**
3. **Danger from HV battery pack**
4. **Chemical danger**
5. **Thermal danger (fire)**
6. **Electrical charging infrastructure**
7. **Vehicles in water**
8. **Transport and storage**
9. **Further information**

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**1. Investigation / vehicle identification**

**1.1 How can I identify if the vehicle concerned has a high-voltage system?**

- The type designation on the rear end such as e.g. hybrid, electric drive or other labelling, e.g. on the mudguard or the like provide indication.
- If the vehicle does not have any type designation, the following characteristics **may** indicate an HV vehicle:
  - Electrical charging socket
  - Orange-coloured high-voltage cables
  - Warning sticker on electrical HV components
  - Charge indicator in the instrument panel
  - Identification on the dashboard
  - No exhaust system
  - Conversely, if this identification is absent, it does not indicate that the vehicle does not have a HV system
- Since January 2013, vehicle number plate requests for vehicles registered in Germany have been possible for German emergency control centres to allow clear allocation with the emergency services data sheet.

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**2. Dangers of electric shock**

**2.1 Is there a danger of an electric shock after an accident if touching the vehicle or vehicle components?**

- Risk of personal injury from electric shock can be excluded with utmost probability. The vehicles are in principle realised intrinsically safe.
- The vehicles are equipped with several, differing protective mechanisms.
  - The HV system is designed to be touch-protected.
  - The HV system is fully electrically insulated from the vehicle body. (galvanic / electrical separation)
  - In the event of a serious accident with airbag activation, the HV system on most vehicles is switched off, or comparable protection mechanisms are fitted.
- In case of doubt, the HV system of the vehicle can be deactivated manually where possible (see 2.4).

.

**2.2 Is it possible to identify whether the HV system has been switched off on an electric or hybrid vehicle that has been involved in an accident?**

- Immediate display of the de-energisation of the system after an accident is not possible due to the variety of potential damage scenarios.

- During a serious accident, an automatic switch-off of the HV system takes place in most vehicles. Normally, it can be assumed that the HV system is switched off if there is an activated airbag / belt tensioner.
- In case of doubt, the HV system can be deactivated manually where possible (see 2.4).

.

**2.3 Is there any electrical hazard from a parked vehicle that has been involved in an accident (stationary crash)?**

The vehicle's HV system can be active when stationary (e.g. stationary cooling), independently of the charging station. In the event of a **serious** accident, the vehicle's HV system must be deactivated (see emergency services datasheet).

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**2.4 Is it possible for emergency service personnel to manually deactivate a HV system?**

- Yes, electric or hybrid cars offer various ways of manually deactivating the HV system.
- Most vehicles are equipped with an additional switch-off device for the HV system, which can be used by emergency service personnel. This takes the form of a 12V connector that can also be operated by those not skilled with use of the high-voltage system
- The recommended procedure for manual deactivation is described in the emergency services datasheet of the corresponding manufacturer.

.

**2.5 What are the dangers from damaged high-voltage cables following an accident if it is identified that the airbags have not been activated?**

There is always an electrical hazard from damaged HV cables or components. Never touch HV cables / components. HV cables are always orange.

Note for the fire service: Modify any service regulations / recommendations (vfdb) to address cases in which the HV cable must be touched.

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**3. Danger from HV battery pack**

**3.1 Can high-voltage battery packs discharge after an accident?**

No, electrical discharging of the HV battery pack is not practical at the scene of an accident.

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**3.2 How should I proceed with a damaged HV battery pack in the vehicle?**

Never touch a damaged HV battery pack.

Qualified electrical specialists must be requested via the central control centre, to assess the specific electrical danger and determine how to proceed.

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**3.3 How should I proceed with a HV battery pack or parts thereof that have become separated from the vehicle due to an accident?**

In the very unlikely event of this occurring, you should be aware of the possibility of electrical, chemical, mechanical and thermal risks from the HV battery pack. Never touch the HV battery pack. Qualified electrical specialists must be requested via the central control centre, to assess the specific electrical danger and determine how to proceed.

.

**4. Chemical damage**

**4.1 How should I deal with leaked electrolyte from HV battery packs after an accident?**

- Electrolytes are usually irritants, combustible and potentially corrosive. Contact with the skin and inhalation of the vapours must **always** be avoided.
- Conventional binders are to be used. Additional procedures for protecting and cleaning the site of the accident should be performed in a similar manner to those for losses of hydrocarbon compounds (e.g. oils / fuels).

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**4.2 What are the potential hazards from "degassing" a HV battery pack?**

- In the immediate vicinity, gases are irritants, combustible and potentially corrosive and should not be inhaled **under any circumstances**.
- The recovery process must be halted and further procedures coordinated with the head of the fire service.

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### 5. Thermal danger (fire)

#### 5.1 In the event of a fire, should I expect an explosion of the high-voltage battery pack?

- An explosion of the HV battery pack can be ruled out with virtual certainty.
- The HV battery pack and its individual battery cells have mechanical safety fittings which open during e.g. a fire-related temperature and pressure increase, thus leading to targeted degassing and pressure release.

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#### 5.2 In the event of an electric or hybrid car fire, should I expect the release of toxic smoke from the fire?

Yes, in the event of an electric or hybrid car fire, as well as a conventional vehicle fire, hazardous smoke should be expected from burning materials such as plastics.

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#### 5.3 Can a fire in the high-voltage battery pack still take place at a later time after an accident?

Yes, as with conventional vehicles which have been involved an accident, the residual risk of a delayed fire cannot be ruled out. This particularly applies for damaged HV battery packs.

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### 6. Electrical charging infrastructure

#### 6.1 What do I need to be aware of if an electric or hybrid HV vehicle connected to a charging station is involved in an accident? (Stationary crash).

If possible, pull off the charging cable from the charging station or switch off the charging station. The charging cable must always be disconnected from the vehicle. In the event of a **serious** accident, the vehicle's HV system must be deactivated (see emergency services datasheet).

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#### 6.2 What if a charging cable is cut at a public charging station during the charging procedure of an HV vehicle due to vandalism?

The technical infrastructure of the public charging station safeguards against this scenario by switching charging off.

The operator of the charging station should be informed.

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### 7. Vehicles in water

#### 7.1 Are there special risks to be aware of for an electric or hybrid car that enters water?

- In principle, in water there is no increased danger of an electric shock from the HV system.
- The notes as described in sections 2 and 3 apply.
- The procedure for recovery is identical to conventional vehicles.

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#### 7.2 If an electric or hybrid car enters the water, will the safety of water in a drinking water protection zone (e.g. reservoir) be endangered?

- Compared with conventional vehicles, there is normally no additional danger for the drinking water.

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### 8. Transport and parking

#### 8.1 What should be borne in mind if an electric or hybrid car is to be removed from a danger area (e.g. motorway construction site) by tow rope / tow bar?

- The removal of the vehicle from the immediate danger area **at walking speed** is in principle always permitted.
- Further information on towing away can be obtained from the Owner's Handbook of the vehicle manufacturer.

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### 8.2 What should be borne in mind when loading an electric or hybrid car after a serious accident?

- The HV system should be deactivated before loading. Notes on this can be found in the Owner's Handbook for the vehicle or in the emergency services datasheet.
- In the event of transfer to the authorities representative / recovery company, it is recommended that these are informed of the measures carried out by the fire service (HV deactivation). Specifically, they must be informed of the potential danger from damaged HV components (e.g. electric shock or risk of fire from the battery pack).
- National regulations / standards for loading and transport must be observed (in Germany: BGI 800 and BGI 8686).

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### 8.3 What should be borne in mind when it comes to transporting electric or hybrid cars that have been involved in an accident?

- The vehicle should always be transported on a flatbed trailer or in accordance with the manufacturer's stipulations.
- Where possible, vehicles with damaged batteries should be transported to the nearest suitable vehicle workshop / safe place of storage.

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### 8.4 Are regulations in place that restrict passage through a tunnel when a towing vehicle is loaded with a damaged electric or hybrid car?

- No, the regulations of the ADR apply to towing away.
  (ADR: **European Agreement on the carriage of dangerous goods by road** – acronym **ADR**, for "**A**ccord européen relatif au transport international des merchandises **D**angereuses par **R**oute")
- Country-specific tunnel regulations must be observed.

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### 8.5 How should damaged electric or hybrid cars be parked?

- As with conventional vehicles, electric or hybrid cars should be parked in a closed-off area of an **outdoor parking area** with sufficient clearance to other vehicles, buildings and combustible objects. The vehicle should be marked accordingly.
- This is particularly important if the vehicle is delivered to the site outside of working hours.

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## 9. Further information

The following rule has proved useful in helping the fire service identify alternative drive technology:

**Escaping operating fluids**

**Assess vehicle underbody**

**Open fuel filler cap**

**Check surface**

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Additional notes on electrical hazards at fires are described in BGI/GUV-I 8677 (governing electrical hazards at fires).