Guidelines for Car Rescue Crews

Mercedes-Benz

Contents

Introduction

Preface 4

Vehicle identification with QR code 5

Further information 6

Pyrotechnical systems 7

Combustion engines 12

Overview

Body 13

48 volt on-board electrical system 14

Rescue on vehicles with combustion engine

Switching off the engine 16

Note the easy entry and exit feature 17

Pay attention to roll bar 19

Rescue involving vehicles with natural gas drive

Overview 20

Vehicle identification 21

Automatic shutoff 23

Fire in the vehicle 24

High-voltage systems 25

High-voltage systems in vehicles with electric drives

Overview 26

Differentiation according to type of accident 27

Procedure for accidents involving electric-hybrid vehicles 28

Safety precautions 29

Rescue from vehicles with hybrid and electric drives

Overview 30
Vehicle identification 32
System components: High-voltage battery 35
System components: High-voltage drive 39
Other high-voltage components 40
Fire fighting involving high-voltage batteries 46
Vehicle fire in high-voltage system 49

Rescue involving vehicles with a fuel cell system

Overview 53
Vehicle identification 54
System components 56
High-voltage system shutoff 57
Hydrogen system shutoff 58
Vehicle fire involving fuel cell system 59

Appendix 61

Information and copyright 62

Introduction

Preface

Dear Reader,

One of Daimler's main priorities has traditionally been to guarantee the highest possible standards of safety. For this reason our vehicles always represent the state of the art. This also applies, in particular, to vehicle safety.

Our safety concept is as comprehensive as possible and also extends to providing rescue crews with information about our vehicles and their safety systems. Rescue crews must be able to gain access to the accident victims as quickly as possible without exposing them or themselves to avoidable additional danger. Along with well-founded training, knowledge of the vehicle-specific accessibility options and the safety systems' operational and functional principles is absolutely essential. Mercedes-Benz has been providing this information in its "Guidelines for Rescue Crews" since March 1994. The guidelines have been revised and updated regularly ever since. The guidelines describe standard methods used for extracting accident victims from the vehicle.

However, we would like to emphasize here that these guidelines cannot claim to be exhaustive and on no account should they, nor are they intended to, act as a substitute for proper specialist training and the relevant specialized literature. With this edition, these guidelines now appear in a new form and with a new content structure. The constant further development of our vehicles, in particular, in the area of vehicle safety, along with the extensions to our product range have required a revision of both the content and formal structure of the guidelines.

Daimler AG
Retail Operation (GSP/OR)

Note

Overviews of the vehicle models with the location of the supplemental restraint systems, gas generators, batteries, fuel tanks etc. are available in the rescue cards. Further information is available at http://rk.mb-qr.com.

Vehicle identification with QR code

The QR code provides rescue crews with quick and direct access through Internet-capable mobile devices to the digital rescue data sheets (rescue cards) of all Mercedes-Benz cars and smart vehicles. This requires only a free-of-charge, freely downloadable app for scanning QR codes. By scanning the QR code, the current rescue card for the vehicle in question is displayed in the language configured in the mobile device.

The QR code adhesive labels (rescue stickers) have been attached since 2014 as standard to all new Mercedes-Benz passenger cars and smart vehicles. Customers whose vehicles do not yet have rescue stickers have been able to have them retrofitted at any Mercedes-Benz service operation since 2014.

The rescue stickers are available for vehicles as of the 1990 year of manufacture. The QR code adhesive labels are affixed to the tank cap and to the B-pillar on the opposite side of the vehicle. If a serious accident is detected and the doors are automatically unlocked, the QR code can thus be quickly found and read with a smartphone or a tablet PC.

Further information

Online rescue cards

As a supplement to these guidelines, comprehensive information on rescue services and crews is available at http://rk.mb-qr.com.
The website enables, e.g. rescue cards for all Mercedes-Benz cars to be retrieved.

Note

Your link to the digital rescue assistants for Mercedes-Benz: http://rk.mb-qr.com.

“Rescue Assist” app

Additional access is provided through the “Rescue Assist” app from Daimler AG. This is currently available for smartphones and tablets running Android or Apple operating systems. The app provides not only a QR code scanner for the rescue stickers (cf.p.5) it also enables you to locate and download the matching rescue data sheet for your particular vehicle.

Laden im App Store

JETZT BEI Google Play

Pyrotechnical systems

Airbags and seat belt tensioners

Fires inside the vehicle can cause undeployed gas generators to be activated. These are a part of the following airbag or seat belt tensioner units:

· Front airbags
· Side airbags
· Knee airbags
· Head / thorax side airbags
· Window airbags or head airbags (cabriolet / roadster)
· Pyrotechnical seat belt tensioners

Note

When an airbag or seat belt tensioner is triggered, controlled combustion takes place. The components do not explode.

Hood lifter for pedestrian protection

The pyrotechnical hood lifter for the pedestrian protection is a restraint system for pedestrians with pyrotechnics that can be triggered the event of a fire.

A gas generator is designed to ignite as soon a temperature of 160-180 °C is reached in the gas generator. The combustion of the squib and the solid fuel produces a defined quantity of gas, which is directed into the airbag or seat belt tensioner at a certain pressure.

Seat cushion airbag

This airbag helps to reduce the risk of submarining in the Executive bunk/ reclining seat, and activates the seat backrest through a crash signal when in the fully reclined position.

Window airbag

The gas generators of the window airbags are filled not with solid fuel, but mainly with compressed gas. When a window airbag is triggered, the squib opens the cap of the gas generator.

Note

Before cutting the corresponding body panels the inner paneling of the A, B and C-pillars and the roof lining must be removed in order to determine exactly where the gas generator is installed.

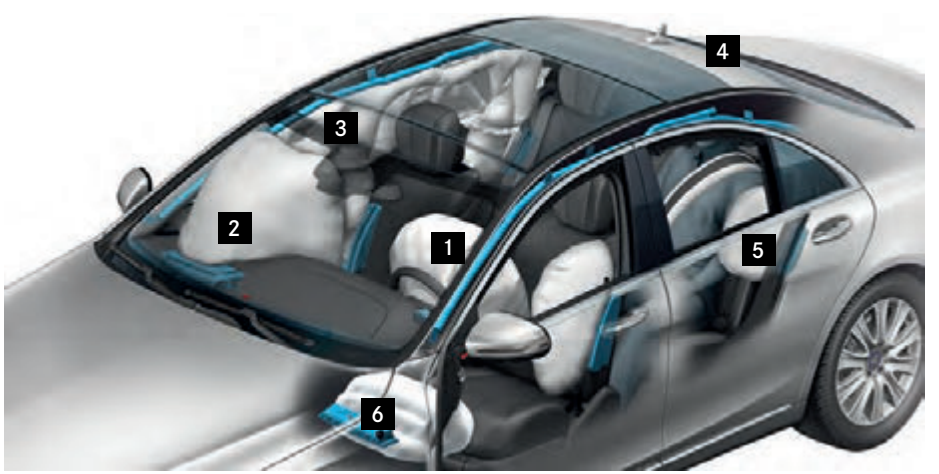
Note

The compressed gas generators of the window airbags must not be cut, as otherwise the compressed gas may suddenly escape.

Occupant restraint systems

All Mercedes-Benz and smart vehicles are equipped with occupant protection systems. Depending on model and equipment, these include:

· Airbags
· Seat belts with seat belt tensioners and seat belt force limiters
· Child restraint systems



Overview of airbags using S-Class (model 222) as an example.

1 Driver's airbag
2 Front passenger airbag
3 Window airbag
4 Gas generator for window airbag
5 Side airbag
6 Knee airbag

The approximate position of an airbag in the vehicle can be determined from the "SRS AIRBAG" or "AIRBAG" badge at the installation location or in its immediate vicinity, depending on the model series. The following airbags may be available in the vehicle, depending on the model and the equipment installed:

- Driver's airbag in steering wheel housing
- Front passenger airbag above or instead of the glove compartment
- Side airbags in the outer sides of the front seat backrests and, on several older model series, in the center door trim
- Rear side airbags in the doors, side trim or wheel arch
- Head/thorax side airbags in the doors or the outer sides of the front seat backrests
- Window airbags in the roof frame between A and C or D-pillar
- Window airbags for cabriolets/roadsters deploying upwards from the door trim of the front doors
- Knee airbag in the instrument panel level with the driver and front passenger knee
- Seat cushion airbag in center under the sitting surface of the rear passenger compartment occupant
- Belt airbag – inflatable seat belt on outer rear seats in several model series

Attention

When disconnecting batteries or when cutting through electric lines, always disconnect or cut through the ground lines first, as otherwise there is a risk of short circuit

If this is not possible, electrically insulated tools must be used when disconnecting or cutting through the lines.

Note

In vehicles with a two-battery on-board electrical system*, both batteries must be disconnected. If only one battery is disconnected, the other battery provides power for the airbag system, so that it remains active.

*See Rescue cards

Attention

There is a risk of injury from airbags that have not deployed or not deployed fully in the deployment area.

If, during rescue work where the battery has not been disconnected, parts of the vehicle undergo significant movement or if electric lines are cut through, the possibility of deployment of an airbag (front airbag, side airbag or window airbag) cannot be ruled out. If this happens, both the airbag and any loose objects and glass splinters which could be projected towards the accident victim or the rescuers, may cause injuries.

Cover up vehicle occupants before starting any work preferably with transparent film!
Wear protective clothing/safety glasses.

Disconnect all batteries. If this is not possible, or only partially possible, keep away from airbags that have not been deployed or have only been partially deployed.

Do not perform any cutting work in an area where an airbag has not deployed or not deployed fully. Avoid heating any areas in which an airbag has not deployed or not deployed fully.

Do not place objects into an area in which an airbag has not deployed or not deployed fully.

Combustion engines

Overview

Body

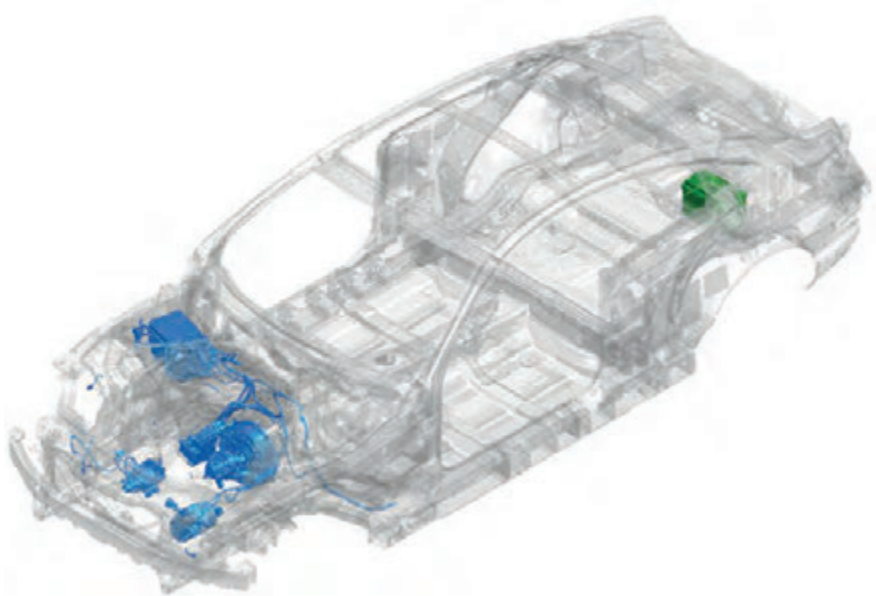
Mercedes-Benz bodyshell

The type and percentage content of the respective materials in a particular vehicle depends on the model series. Structural reinforcements in the A-pillars and B-pillars are predominantly installed in coupes, convertibles and roadsters, because these areas must be particularly strong in these types of vehicles.

Overview of materials using E-Class Sedan (W213) as an example.

- **A** Aluminum
- **B** High-strength steel grades
- **C** High-strength, hot-formed steel grades

48 volt on-board electrical system



Note

The 48 volt on-board electrical system is installed in model series 222 as from the facelift and 238 as from modification year 17/2, depending on the given engine version.

Note

The voltage range used in the 48 volt on-board electrical system is always lower than the contact voltage limit of 60 volts DC. As higher voltages may be present inside 48 volt components, they are identified by corresponding danger symbols and they are designed to be protected against any contact.

Potential risks

In the event of an internal short circuit in the Li-ion cells, the stored chemical energy may be dissipated in an uncontrolled manner as thermal energy. There is a risk of fire. Leaking battery electrolyte can cause severe burning if touched or inhaled.

12 volt power disconnect

Power to the 12 volt on-board electrical system power is removed by disconnecting the 12 volt battery from the on-board electrical system (e.g. by disconnecting the ground line from the 12 volt battery) and by detaching the signal connector or cutting the line.

48 volt power disconnect

Power to the 48 volt on-board electrical system is removed by shutting down the 12 volt on-board electrical system for at least 10 seconds.

Shutoff

The 48 volt on-board electrical system is deactivated as soon as the airbag control unit detects a crash and sends this information over the CAN bus. After severe accidents the power supply (circuit 30c) is interrupted by a pyrofuse.

Note

The rescue card is to be inspected to see if a 48 volt battery is installed.

Rescue on vehicles with combustion engine

Switching off the engine

Switch off engine on vehicles with START/STOP starter

KEYLESS-GO is an access and drive authorization system that does not require a key. In some accident situations the engine may continue to operate after a crash. If the vehicle key is not in the ignition lock in vehicles with a START/STOP starter, the engine can be switched off as follows:

· Move selector lever to position “P” or “N”.
· Press START/STOP starter once.

Note

The START/STOP starter is located either on the top of the selector lever or at the ignition lock in place of the ignition key, depending on the vehicle model involved.

Note

For KEYLESS-GO systems the “key” should be kept at least 5 m away from the vehicle to ensure that the engine is not inadvertently started.

Ignition key

START/STOP starter

Switch off engine on vehicles with ignition key

Switch off engine by turning the ignition key counterclockwise to the “0” position and then remove the ignition key.

Note

On vehicles with automatic transmission, the ignition key can only be removed when the selector lever is in position “P”.

Note the easy entry and exit feature

For Mercedes-Benz vehicles, an electronic easy entry and exit feature is available as special equipment. The electronic easy entry and exit feature is installed in the Maybach as standard. When the driver's door is opened (ignition off) or when the electronic key is removed, the steering column is moved all the way up. The driver's seat may be moved to the rear at the same time. When closing the driver's door, the steering column and driver's seat are automatically reset to the last adopted position. The rotary switch for the easy entry and exit feature is located on the adjustment lever for the electronic steering column adjustment below the combination switch (lights and windshield wipers) on the steering wheel. On the latest-generation Mercedes-Benz vehicles the easy entry and exit feature can be switched on or off in the "COMFORT" sub-menu of the control system using the buttons on the multifunction steering wheel.

Note

When the battery is disconnected, the easy entry and exit feature can no longer be used.

1 Rotary switch

2 Multifunction steering wheel buttons

Note

If the easy entry and exit feature is switched on, then when the driver's door is opened, the ignition is switched off or the electronic transmitter key is removed, the steering column is moved upwards and the driver's seat is moved to the rear. It is absolutely essential that care is taken to ensure that nobody is jammed by moving parts. Where possible, disconnect all batteries. If the easy entry and exit feature is activated, stop the adjustment procedure immediately.

Deactivate easy entry and exit feature

The adjustment procedure must be stopped immediately if there is any risk of someone being caught in between moving parts. This occurs either

1. by operating the steering column adjustment switch on the steering wheel
   or
2. by pressing the steering column adjustment switch in the control panel on the driver's door
   or
3. by operating the seat adjustment switch in the control panel on the driver's door
4. by pressing a memory function position key. The seat and steering column immediately stop.

1. Steering column adjustment switch
2. Steering column adjustment switch
3. Seat adjustment switch group
4. Memory function buttons

Pay attention to roll bar

In cases where the rescue or treatment of victims has to be carried out within the movement radius of an undeployed roll bar (e.g. where persons are trapped), the following points must be observed before commencing rescue operations:

- Switch off ignition
- Disconnect or cut through both battery lines (positive and negative cable) (on vehicles with two batteries at both batteries)
- Do not place tools, rescue equipment or any other objects on a roll bar that has not been extended.

Attention

Risk of injury in deployment area of a roll bar that has not been deployed.

If, in the course of rescue work where the battery has not been disconnected, parts of the vehicle undergo significant movement or electric lines are cut, a deployment of the roll bar cannot be ruled out. This can cause injury if there is anyone within the roll bar's deployment area.

Disconnect all batteries. If this is not possible, the vehicle occupants must be protected before the roll bar is raised.

Assistants should not stand without good reason in the deployment area of a roll bar that has not deployed.

Do not place any objects into the area of a roll bar that has not deployed.

Rescue involving vehicles with natural gas drive

Overview

Vehicles with natural gas drive

Various Mercedes-Benz production vehicles are equipped with engines powered by gasoline and natural gas. The drive motor can be driven using either natural gas, also known as compressed natural gas (CNG or c), or using spark-ignition engine fuels. The operating mode can be selected either manually by the driver or automatically depending on the vehicle model. The selection is made automatically when one of the two fuel types has been fully consumed.

Note

The installation positions of the rescue-relevant components of the natural gas drive system are shown in the vehicle-specific rescue cards.

In addition to the conventional fuel tank, gas cylinders made of high-strength steel or plastic composite material are also installed. These may be located in the spare wheel well and behind the rear seats in the trunk. The natural gas is stored in these cylinders at a normal pressure of up to 200 bar. The gas cylinders are filled via a filler connection located beside the gasoline tank filler neck behind the lengthened fuel filler flap.

Vehicle identification

Vehicles with natural gas drive

The type designations “Natural Gas Drive”, “c” or “NGT” at the vehicle rear indicate a vehicle that is equipped with a natural gas drive. If there is no designation on the body of the vehicle, information on the drive type can be found by looking inside the fuel filler flap or at the B-pillars (QR code), in the owner’s manual, at inscriptions on the instrument panel or the fill level displays in the instrument cluster.

Note

The vehicle-specific identifying features are available in the respective rescue cards.

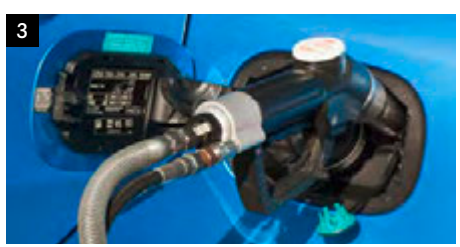
Type designation using B-Class Natural Gas Drive as an example.

The following distinguishing features indicate that the Mercedes-Benz vehicle encountered at the scene is a vehicle with a natural gas drive system:

1. Lettering CNG/NGT/NGD in the instrument cluster and the separate distance to empty display for gasoline and natural gas operation
2. QR code for rescue crews
3. Filler neck for natural gas refueling along with conventional tank filler neck
4. “NGT”, “c” or “Natural Gas Drive” lettering on the trunk lid at the right
5. Gas bottles in the underfloor area and/or in the spare wheel well

1

2

3


4

5

Automatic shutoff

Natural gas system

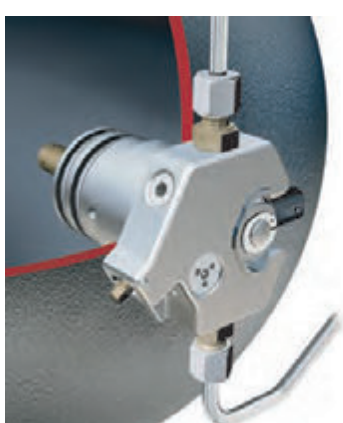
The natural gas system operates with pressures of up to 260 bar. If an accident triggers a restraint system, all the gas valves are closed immediately in order to halt the gas supply to the engine. In terms of its properties, the natural gas itself is much less dangerous than, for example, gasoline. A natural gas/air mixture has only a very narrow ignition range, an ignition temperature three times higher than gasoline, and it is lighter than air. Therefore, when all appropriate safety measures are complied with there is no expectation of any heightened safety risk compared with conventional vehicles.

Every gas cylinder is equipped with a safety valve. When the vehicle is parked, running on gasoline or involved in an accident, the cylinders are automatically locked by the electromagnetic shutoff valve. The thermally activated safety valves with fuses (range 110 ±10 °C), rupture disks and flow rate limiters prevent the gas cylinders from bursting. In the event of overtemperature, the fuses are tripped to eject the gas in a controlled manner.

Safety shutoff of gas cylinders

If the airbag control unit detects a vehicle collision, the gas cylinder safety shutoff is activated. This crash signal switches off the natural gas and the gasoline injection system.

The gas cylinders are mounted in stable holders. Each individual gas cylinder is tested at a test pressure of 300 bar, and each one has a burst pressure rating of more than 600 bar.



Fire in the vehicle

Natural gas

In terms of its properties, natural gas is generally less dangerous than gasoline, for example it exhibits an extremely limited ignition range (approx. 4-16.5 percent by volume), an ignition temperature that is three times higher (approx. 640 °C) and it is lighter than air (density ratio for natural gas/air approx. 0.6).

Natural gas is generally colorless and odorless. To enable leaked natural gas to be detected, an odorant is added which is responsible for the typical gas odor. Observe the following in the event of a gas leak:

- Avoid any ignition sources
- Switch off engine
- Measure gas concentration
- Allow gas to escape and provide cross ventilation, if required (“blow away” the natural gas)

Warning

There is a risk of explosion from natural gas escaping in an uncontrolled manner!

Natural gas system

The thermofuses of the gas cylinders are activated at a temperature of approx. 110 °C ± 10 °C. Note the discharge directions of the gas cylinders in vehicles which are lying on their side or on their roof as controlled jets of flame can occur when the thermofuses are triggered. Conventional firefighting methods should not be used until all the natural gas has escaped. Where possible, the natural gas should be allowed to escape with the aid of cross ventilation.

Blowing off the gas may result in temporarily large flash fires. These may occur several times in succession. Listen for any loud hissing noises caused by the gas venting under high pressure.

Extinguishing agent

Natural gas is a Class C gas according to European standard EN2 for “Flammable materials of various kinds”. All C-Class extinguishing agents such as, e.g. ABC powder extinguisher can be used as extinguishing agents. Generally, firefighting should not be commenced until the gas supply has been suppressed in order to avoid creating an explosive gas/air mixture.

High-voltage systems

High-voltage systems in vehicles with electric drives

Overview

Components in motor vehicles which are supplied with an AC voltage in excess of 30 volts or a direct voltage in excess of 60 volts are referred to as high-voltage components or high-voltage systems. High-voltage systems are operated in the most varied of model series from Mercedes-Benz and smart with a voltage of 120-450 V DC, and split up into the following categories: Battery driven, plug-in hybrid and fuel cell vehicles. Plug-in hybrid vehicles and fuel cell vehicles.

The basic design of the high-voltage system and the resulting rescue instructions are similar for all vehicle models. The QR code give below can be used to retrieve an overview of vehicles with alternative drives.
It can also be retrieved at: http://rk.mb-qr.com/de/alternative_engines

The conventional 12 volt on-board electrical system for powering the 12 volt components (vehicle illumination, control units, comfort systems etc.) remains unchanged. The high-voltage system is galvanically isolated from the vehicle ground and the 12 volt on-board electrical system.

If any technical questions arise following a severe accident involving vehicles equipped with high-voltage systems, that are not dealt with in the Guidelines for Rescue Services, further information can be requested from the manufacturer through the rescue headquarters.

Note

The vehicle-specific installation positions of the high-voltage components are available in the respective rescue cards.

Differentiation according to type of accident

Variant 1
Vehicle slightly damaged in accident

- No deployment of restraint systems
- High-voltage battery looks undamaged

Variant 2
Vehicle badly damaged in accident

- Deployment of one of the restraint systems (airbag or seat belt tensioner)
- High-voltage system switched off automatically (high-voltage contactor open)
- High-voltage battery may be damaged

Variant 3
Vehicle accident during standstill (also while charging)

- No deployment of one of the restraint systems (airbag or seat belt tensioner)
- High-voltage system may still be active
- High-voltage battery may be damaged

Procedure for accidents involving electric-hybrid vehicles

Variant 1
Vehicle slightly damaged in accident
(where a restraint system has not deployed)

1. Turn ignition key to position “0” and remove.

2. For KEYLESS-GO vehicles: Place key at a distance of at least 5 m away from vehicle.

Variant 2
Vehicle badly damaged in accident

1. Turn ignition key to position “0” and remove. For KEYLESS-GO vehicles: Remove key to a distance of at least 5 m from vehicle.

2. Operate/open high-voltage disconnect device (see rescue card).

2.1 Alternatively: Cut through cable of high-voltage disconnect device.

Variant 3
Vehicle damaged during accident at standstill
(also while charging)

1. If the vehicle was connected to a charging station, contact hotline for charging station, then disconnect charging cable. To disconnect the charging cable (on-board) the central locking switch in the interior must be operated beforehand.

2. Operate (open) high-voltage disconnect device (see rescue card).

2.1 Alternatively: Cut through cable of high-voltage disconnect device.

2.2 If high-voltage disconnect device is not accessible, cut through rescue separation point (cutting solution).

High-voltage disconnect device

Safety precautions

High-voltage system

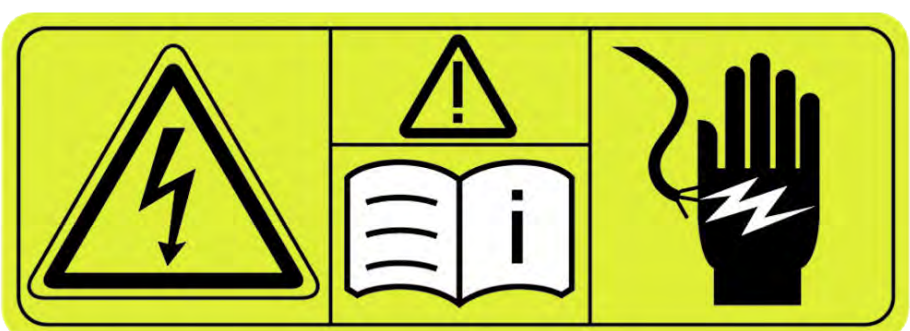
All high-voltage components are marked with an appropriate warning label. The high-voltage lines that supply the components are orange colored.

Personal safety measures

All contact with damaged high-voltage components in a vehicle should be avoided. This applies especially in the case of vehicles which have been involved in an accident or which have broken down due to a technical problem. The following safety precautions should be observed:

- Do not touch any high-voltage lines (orange colored) at the damaged point.
- Do not cut through any high-voltage lines (orange colored).
- Do not touch any high-voltage components with a damaged or broken housing, as this always involves the risk of an electrical shock.

Avoid cutting or deforming the body with rescue equipment in the vicinity of lines and components carrying high-voltage. The location of the high-voltage lines and the corresponding high-voltage components is available in the rescue cards for the vehicles in question.



Rescue from vehicles with hybrid and electric drives

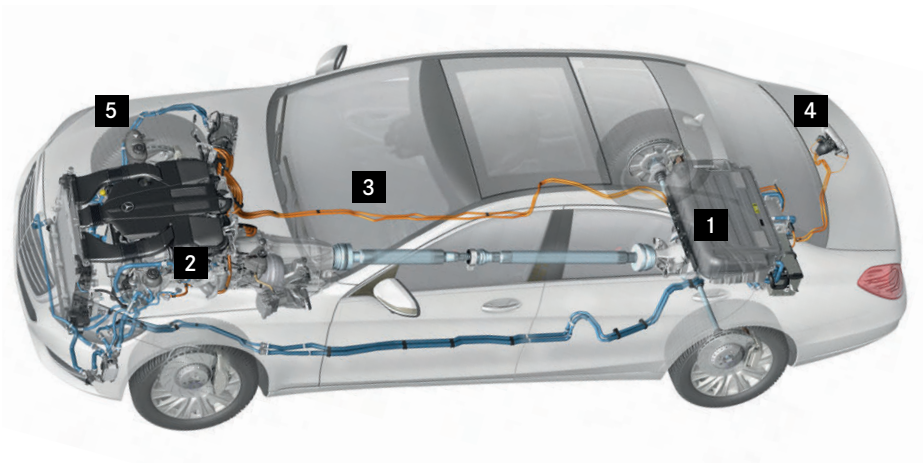
Overview

Plug-in hybrid electric vehicle (PHEV)

Various Mercedes-Benz vehicles are equipped with combustion engines in combination with an electric motor. HYBRID and PHEV vehicles are differentiated according to the share of electrical drive power and their range. The basic design of the drive train resembles that of a conventional vehicle. The electric drive is coupled to the combustion engine and is supplied from the high-voltage battery. The battery is charged by the electric drive's generator function through a regenerative brake system or, in the case of the plug-in hybrid, through a charging socket too. The electric refrigerant compressor (high-voltage components) ensures that the high-voltage battery has an optimum operating temperature.

Note

The installation positions of the high-voltage components in a hybrid vehicle are available in the vehicle-specific rescue cards.



Using an S500 plug-in hybrid as an example

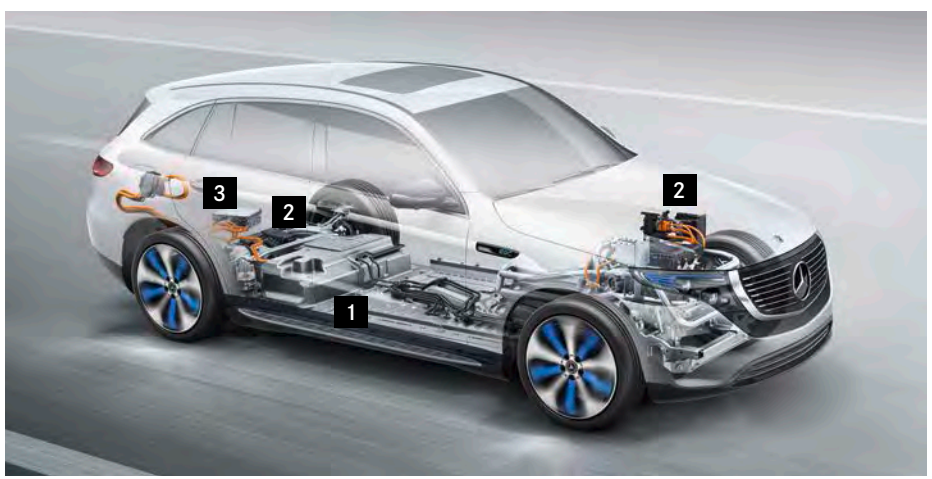
1 High-voltage battery
2 Combustion engine and electric machine
3 High-voltage line (orange colored)
4 Charging socket (plug-in hybrid)
5 Refrigerant compressor

Battery electric vehicles (BEV)

Several Mercedes-Benz and smart vehicles are propelled purely by electrical power from a battery. The entire drive force is generated by one or more electric motors. The high-voltage battery delivers the energy necessary for the drive system. This is charged through the charging socket and a regenerative brake system. As well as the electric drive motor, it also supplies or charges other assemblies, such as the electric refrigerant compressor (high-voltage component), the high-voltage heating element and the 12 volt on-board electrical system battery. The 12 volt on-board electrical system battery supplies, as with a conventionally-driven vehicle, comfort systems (radio, interior lighting etc.), lighting elements, control units and 12 volt major assemblies (such as, e.g. power steering system).

Note

The installation positions of the high-voltage components in an electric vehicle are available in the vehicle-specific rescue cards.



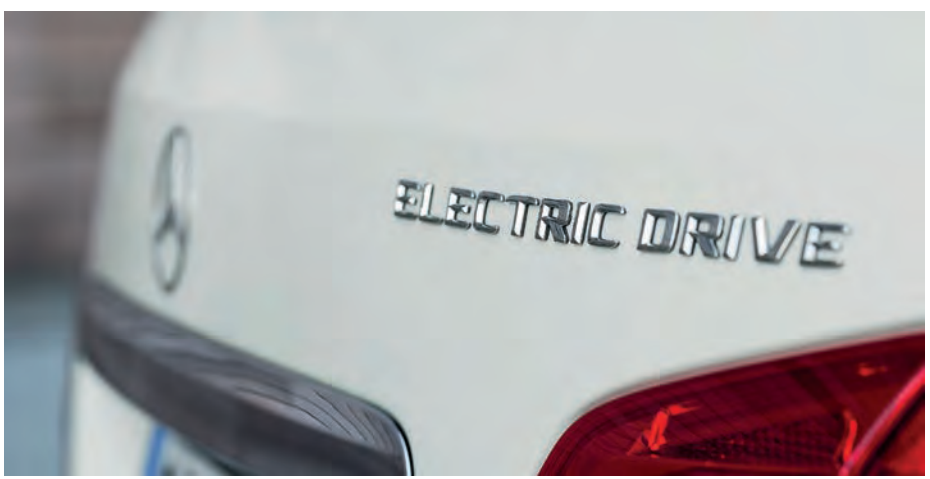
Installation positions of components using Mercedes-Benz EQC as an example.

1 High-voltage battery
2 Electric drive system
3 Charger

Vehicle identification

Hybrid and electric vehicles

The model designations on the rear of the vehicle, such as “HYBRID”, “ED”, “h” (hybrid), “e” (electric vehicle, plug-in hybrid) or “E-CELL” indicate a vehicle with an alternative drive system. There are often additional inscriptions, e.g. on the fender. Alternatively, the “E” on the sign indicates that the vehicle is driven solely by electrical power, this is however not a binding requirement in Germany. Further indicators may be charging socket connections or the discontinued use of an exhaust system on vehicles driven solely by electrical power. A look behind the fuel filler flap or at the B-pillar (QR code), into the operator’s manual, on the signs on the instrument panel or on the charging/fill level displays in the instrument cluster can provide information about the given drive type. All the high-voltage components in the vehicle are identified by a warning label. The high-voltage lines are orange.



Note

The vehicle-specific identifying features are available in the respective rescue cards.

Typical identifying features for hybrid and electric vehicles are:

1. High-voltage lines (orange colored) as well as warning labels on high-voltage components
2. Charge indicator in instrument cluster
3. QR code for rescue crews on B-pillar on driver's side as well as on inside of fuel filler flap
4. High-voltage charging socket behind fuel filler flap (electric vehicle) or in rear bumper (plug-in hybrid)
5. Type plates on trunk lid at right
6. "Blue HYBRID", "Electric Drive" lettering on fender/A-pillar at right/left

- "Electric Drive" symbol on B-pillar at right and left (only on smart)
- No exhaust system (only for electric vehicle)
- Operator's manual
- Alternatively, the "E" on the sign may be an indication of a vehicle that is driven purely by electrical power, this however, is not a binding requirement in Germany.

FAQ Vehicle determination/identification

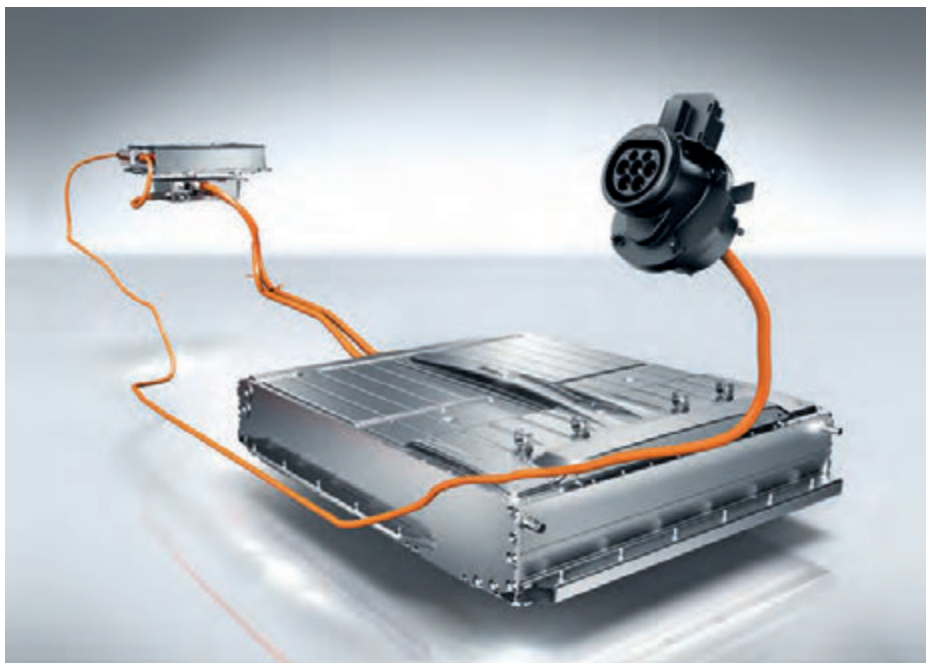
How can a vehicle be determined to be one equipped with a high-voltage system?

- A vehicle license plate number inquiry by the rescue headquarters or by the fire department means that in some European countries a clear assignment of the relevant rescue card is made possible.
- The type designations at the vehicle rear such as, e.g. hybrid, electric drive or additional inscriptions, e.g. on the fender may provide an indication here.
- If the vehicle does not bear such a type designation, the following features may indicate that the vehicle in question is equipped with a high-voltage system:
  - No exhaust system on vehicle driven solely by electrical power.
  - Presence of an “E” at the end of the letter-number combination on a German license plate number [1].
  - Electrical charging socket (possibly designed as second outside flap)
  - Manufacturer-specific design elements
- Orange colored high-voltage lines (Note: High-voltage lines inside high-voltage energy storage units can have colors other than orange).
- Warning stickers on electric high-voltage components
- Possibly charging cable or comparable equipment objects present in the vehicle
- Charge indicator in instrument cluster and/or status display on operating status of vehicle (e.g. “Ready”)
- Signs on the instrument panel using the QR code

Source VDA Guidelines

[1] This special “e” mark has been issued in Germany since September 2015. The identification of a vehicle using an “e” mark is subject to the conditions as per § 3 Act Governing Priority Status for Use of Electrically Powered Vehicles (Electric Mobility Act – EmoG). As understood by the Act, only solely battery-powered electric vehicles, hybrid electric vehicles that can be externally charged or fuel cell vehicles, that all have a range of at least 40 km with electric drive or maximum carbon-dioxide emissions of 50 grams per driven kilometer, are entitled to bear this mark. Important: The vehicle owner is not obliged as part of the vehicle registration procedure to apply for an “e” mark for his vehicle and to then affix this mark to his vehicle!

System components: High-voltage battery



The high-voltage battery is the central energy storage unit which delivers the energy for the electric drive motor. The battery is charged by the alternator of the combustion engine (HYBRID), the fuel cells (F-CELL), through a regenerative brake system or through a charging socket (plug-in hybrid or BEV).

In current Mercedes-Benz and smart vehicles equipped with a high-voltage system, only lithium-ion (Li-ion) battery cells are used as high-voltage batteries. According to the type and size of the Li-ion battery, the individual cells are combined into modules. A cell voltage of approx. 3.6 volts can be reached depending on the type and chemical composition of the individual cells. These are connected in series in order to produce the required operating voltage of the high-voltage system (up to 450 volts). Because the high-voltage battery is a safety-relevant component, it is installed in areas of the vehicle which are specially protected from the effects of a crash. In addition to this, the high-voltage batteries are protected by design measures (protective battery housing, battery housing with crash profile sections, protective frame) against deformation and the penetration of any surrounding component parts.

Every high-voltage battery has mechanical protective devices, that trigger when the inside of the battery exhibits exceptional increases in temperature and pressure, which can lead to a controlled pressure release. Other safety measures protect the high-voltage battery against mechanical damage. Each high-voltage battery is monitored and controlled by a battery management system (BMS). The BMS checks the status of the high-voltage battery in all operating conditions. In case of a serious accident or a system error, the BMS disconnects power to the battery terminals and the high-voltage on-board electrical system, by opening the battery contactor. The high-voltage battery itself remains charged even after the high-voltage system has been shut off and discharged.

If the high-voltage battery is damaged

Battery acid is generally combustible, irritating and corrosive. Skin contact and inhalation of the vapors must therefore be avoided at all costs. The condition of the high-voltage battery must be monitored (e.g. for smoke development) because subsequent spontaneous ignition cannot be ruled out in the case of Li-ion batteries.

FAQ Danger through high-voltage energy storage unit

What is to be done at an accident location with a damaged high-voltage energy storage unit in the vehicle that is not on fire?

- There must be no direct contact with the damaged high-voltage energy storage unit in the vehicle.
- The condition of the high-voltage energy storage unit must be observed (e.g. smoke development, noise, sparks, heat development).
- An extinguisher application using water should be prepared to cool down the high-voltage energy storage unit.
- If a temperature is measured on the high-voltage energy storage unit that is significantly higher than the outside temperature and the temperature continues to rise, then the housing of the high-voltage energy storage unit is to be cooled with water.

What is to be done with a high-voltage energy storage unit or parts of it that have been separated or detached from the vehicle in an accident?

- In this instance, electrical, chemical, mechanical and thermal hazards from the high-voltage energy storage unit can be expected. Protective clothing is to be adapted accordingly.
- Direct contact must not be made with the high-voltage energy storage unit.
- Separated component parts of the high-voltage energy storage unit are to be picked up off the ground using electrically insulated equipment only. A decision on how to proceed further is to be made dependent on the given situation and position.
- The condition of the high-voltage energy storage unit is to be observed (e.g. smoke development, noise, sparks, heat development).
- An extinguisher application should be prepared to cool down the high-voltage energy storage unit.

FAQ Danger through high-voltage energy storage unit

Which type of covering is best suited for insulating live parts?

- It is advisable to use a suitable electrically insulated flexible cover (e.g. as per IEC 61112).
- The deployment guide sheet used by the fire department is generally a film made of polyethylene. As a consequence of regular use of the deployment guide sheet and possible preliminary damage it is not advisable to use this for insulation from live parts.

Can high-voltage energy storage units be discharged after an accident?

- No, an electrical discharge of the high-voltage energy storage unit or of individual cells at the accident site is not practicable and not advisable. An improper discharge of the high-voltage energy storage unit may place it into a critical condition.

What is to be done with a high-voltage energy storage unit or parts of it that have been separated or detached from the vehicle in an accident, if at the same time a person is trapped in the vehicle?

- There must be no direct contact with the damaged high-voltage energy storage unit in the vehicle.
- The condition of the high-voltage energy storage unit must be observed (e.g. smoke development, noise, sparks, heat development).
- An extinguisher application using water should be prepared to cool down the high-voltage energy storage unit.
- If a temperature is measured on the high-voltage energy storage unit that is significantly higher than the outside temperature and the temperature continues to rise, then the housing of the high-voltage energy storage unit is to be cooled with water.

System components: High-voltage drive

The tasks of an electric motor in a hybrid vehicle are various. The high-voltage drive replaces the conventional function of a 12 volt starter and recharges the high-voltage battery in braking phases (regenerative braking). While driving, the electric drive can assist the combustion engine (boost mode) or replace it entirely for short distances.

High-voltage lines

All the high-voltage components are connected to each other by a special line system. High-voltage lines are immediately identifiable by their larger cross section and their orange sheathing, and are clearly distinguishable from the wiring of the 12 volt on-board electrical system. In accordance with the given use, high-voltage lines are designed as individual lines (direct voltage +/- separate, alternating voltage U, V, W separate). In isolated cases, lines may be of 2-core design. The combination of high resistance to mechanical tensile loads with a high degree of flexibility means that high-voltage lines are protected against damage even in the event of a crash. The connections and plugs on the high-voltage components are contact-safe and are also monitored by a separate signal line (interlock). Another safety feature is the insulation monitoring of the high-voltage system. If a serious insulation fault is detected, the high-voltage system is shut off and discharged. The high-voltage system is fully electrically insulated from the vehicle body. There is a danger of electric shock only if both live conductors are touched. The high-voltage on-board electrical system is galvanically isolated from the 12 volt on-board electrical system.

FAQ Danger from electric shock

Which danger is presented by damaged high-voltage lines after an accident, if it is clearly recognizable that the airbags have not been deployed?

- Electrical hazards from damaged high-voltage lines or components are present at all times. Damaged high-voltage lines/components must not be touched. The high-voltage system is switched off in the event of airbag deployment.

Note

High-voltage lines that are outside the high-voltage energy storage unit housings or comparable housings are always orange colored. High-voltage components have warning labels attached to them.

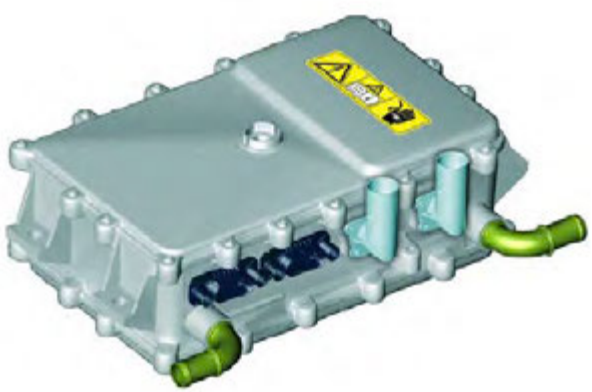
Other high-voltage components

Power electronics

The main task of the power electronics is to convert the direct voltage from the battery into three-phase alternating voltage at a corresponding frequency, so that the electric drive motor can be operated at its optimum operating point to meet the given requirements. In some hybrid vehicles, the conventional 12 volt alternator is no longer required. The alternator function is performed by a DC-DC converter which converts the direct voltage of the high-voltage battery to the direct voltage required by the 12 volt on-board electrical system.

On-board charger

To charge the high-voltage battery from the electricity grid, an on-board charger is required. It converts the alternating voltage into the direct voltage required by the battery with defined charging capacity. In addition, the on-board charger establishes the safety-relevant potential separation between the power network of a charging station and the high-voltage battery.



FAQ Danger from electric shock

Can a parked vehicle that was involved in an accident (stationary crash) present an electrical hazard?

- Yes, under certain circumstances the vehicle high-voltage system may also be active when at a standstill (e.g. auxiliary climate control).
- An airbag deployment does not generally occur in parked high-voltage vehicles that are involved in a “stationary crash”, so there is no automatic shutoff of the high-voltage system.
- Therefore, in severe accidents, the vehicle’s high-voltagee system has to be manually de-activated (see rescue card).
- This applies both for vehicles at an electric charging station as well as for parked vehicles that are not connected to a charging station.
- Irrespective of the vehicle involved, the power supply of the charging station could present an electrical hazard, where this is damaged during the course of an accident.

Electrical refrigerant compressor

The drive motor must be isolated so that sufficient cooling output for the air conditioning can be provided when the vehicle is stationary and the com-bustion engine switched off, so that the high-voltage battery can be cooled independently and the climate control for the vehicle interior can operate independently. This is achieved by means of an electrically driven refrigerant compressor. In vehicles operated with electrical power only, cooling is always provided by an electric refrigerant compressor.

High-voltage PTC heating element

When driving under electrical power, the waste heat of the combustion engine is not available for heating the passenger compartment. The high-voltage PTC heating element therefore delivers the necessary heat in vehicles which can be driven without combustion engine.

FAQ Danger from electric shock

Is there a risk of electrical shock if the vehicle or vehicle parts are touched after an accident?

- There is no risk of electrical shock to persons.
- The vehicles are equipped with several different types of protection mechanisms.
- The high-voltage system is designed to be contact-safe.
- The high-voltage system is fully electrically insulated from the vehicle body (galvanic/electrical isolation).
- In the event of severe accidents involving airbag deployment, the high-voltage system is switched off in the majority of vehicles.
- However, if – in the event of extremely severe accidents – high-voltage components or high-voltage lines are damaged (e.g. exposed component parts, ripped off lines), all contact with these damaged areas should be avoided. If it is essential that work is to be conducted in such areas, the damaged parts are to be covered up so they are electrically isolated.

In case of doubt, the vehicle's high-voltage system is to be manually deactivated, if possible.

FAQ Danger from electric shock

Is it possible for rescue crews to manually deactivate a high-voltage system?

- Yes, electric/hybrid vehicles are equipped with various options for manual deactivation of the high-voltage system.
- Most vehicles are equipped with an additional shutoff device for the high-voltage system that can be used by rescue crews. This refers to disconnection points that are described in the rescue card. These can be operated to deactivate the high-voltage system.
- The recommended procedure for manual deactivation is described in the rescue card for the relevant vehicle model.

Note

Here, the high-voltage energy storage unit is not discharged – it is however, electrically isolated from the remaining high-voltage system.

Is it possible to see if the high-voltage system has been deactivated in an electric/hybrid vehicle?

- A direct absence of voltage display after an accident is not possible because of the various types of damage scenarios involved.
- In case of doubt, the high-voltage system of the vehicle, where possible, is to be manually deactivated (see description at left as well as the vehicle-specific rescue card).

Note

The energy content (charge level) of a high-voltage energy storage unit or individual cells inside the energy storage unit remains unchanged after deactivation of the high-voltage system, however, the high-voltage energy storage unit is electrically isolated from the remaining high-voltage system or the on-board electrical system.

FAQ Electric charging infrastructure

What happens if a charging cable is cut through by vandalism at a charging station during an electric vehicle's charging process?

- This case is safeguarded by the technical infrastructure of the charging station and, generally, the charging station is shut down.
- The operator of the charging station must then be notified.

Note

The vehicle high-voltage system can also be active independently of the charging station, even when stationary (e.g. auxiliary climate control).

What has to be done if the charging cable or plug connector is damaged?

- The charging cable or the plug connector may not be used and it must be secured against any unauthorized use.
- The operator of the charging station must then be notified.

What should be observed when an electric/hybrid vehicle connected to the charging station is involved in an accident (stationary crash)?

- If possible, disconnect the charging cable from the charging station/socket or from the vehicle. Alternatively, the charging station/socket can also be switched off.
- Before disconnecting, the cable and plug connector must be visually inspected for any damage. Damaged areas must not be touched.
- In the event of severe accidents, the vehicle's high-voltage system must be deactivated (see rescue card).

FAQ Chemical hazard

What has to be observed when handling leaking electrolyte from high-voltage energy storage units after an accident?

- Electrolytes are generally irritating, combustible and potentially caustic.
- Conventional binding agents must be used.
- Skin contact with the electrolyte and inhalation of any gases released as a consequence of chemical reactions of the leaking electrolyte must be avoided at all times (Note: The personal protective equipment is to be adapted to suit the given situation).
- In the event of any contact with the ingredients of the high-voltage energy storage unit or its gases the affected areas of skin must be thoroughly rinsed with water. Soiled clothing must be removed and cleaned. A physician should be consulted afterwards.

Note

Fluids leaking out of high-voltage energy storage units are usually coolant and not electrolyte. Electrolytes are only distributed in small quantities (milliliters) in the individual cells.

Which hazards are present from outgassing of a high-voltage energy storage unit?

- The gases are irritating, combustible, potentially caustic, toxic and therefore they should never be inhaled.
- A recovery process must be terminated and the further procedure clarified with the fire department on-scene command.
- The danger zone around the vehicle must also be extended.
- Where possible, an outgassing high-voltage energy storage unit must be cooled with water.

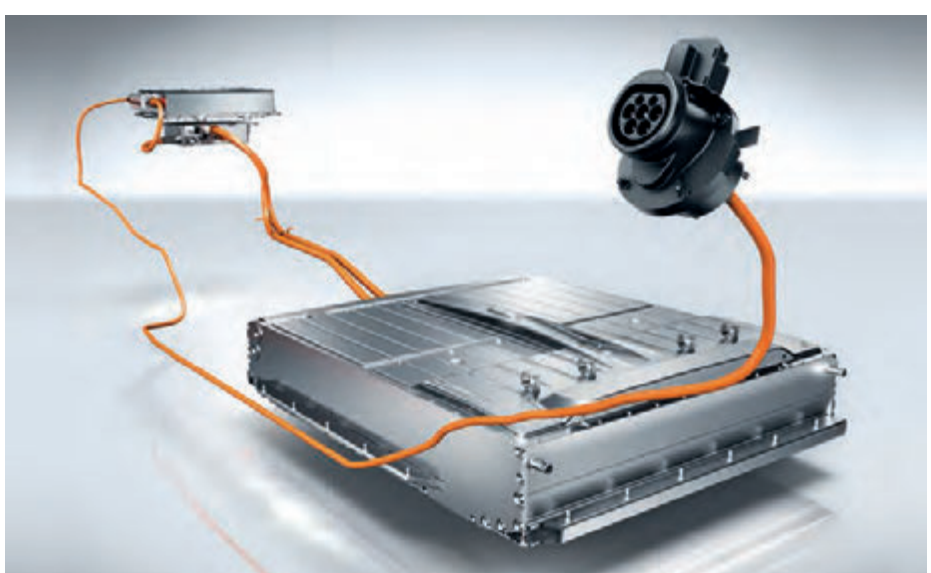
Note

Gases are generally perceivable on account of their pungent and caustic odor.

Fire fighting involving high-voltage batteries

Fire fighting recommendation

If metal housing of high-voltage battery is enclosed
· Object temperature up to 300 °C – No measure required
· Object temperature > 300 °C – Extinguish (cool) with lots of water from safe distance.



Info

Generally, burning Li-ion high-voltage batteries can be extinguished (cooled) with lots of water! If extinguishing with lots of water is not possible, stop the extinguishing attempts, because a lack of a sufficient amount of water may result in a hydrogen-gas reaction.

If the metal housing of the high-voltage batteries is open, but not on fire:
· Extinguish (cool) with lots of water from a safe distance.

Caution

The resulting smoke gas contains toxic and caustic components such as, e.g. hydrofluoric acids!

Post-processing damaged high-voltage batteries

- Damaged high-voltage batteries in the vehicle must be left where they are and transported safely to a specialist workshop.
- Temperature measurement on surface of high-voltage battery must be < 60 °C. The temperature measurement is to be conducted using a thermometer (not a thermal imaging camera)!
- The vehicle is to be transported as directly as possible to a specialist workshop and parked in a secure outside area, at a remote point from the building.
- Individual high-voltage battery parts are to be placed into a special transport container for “high-voltage batteries not safe for transportation” and transported to a specialist workshop.

FAQ Thermal hazard through fire

Is outgassing of a high-voltage energy storage unit to be expected in a fire instance?

- Yes, both the high-voltage energy storage unit and its individual cells are equipped with mechanical safety devices that, e.g. are opened in a fire-related increase in temperature and pressure, thereby leading to controlled “outgassing” and pressure relief.

If an electric/hybrid vehicle is on fire will the smoke from the fire be toxic?

- Yes, when electric/hybrid vehicles are on fire, as with conventional vehicles too, burning materials such as, e.g. plastics, cause a health hazard through the smoke from the fire.

Note

The use of recirculated air independent respiratory protection is required when working in an exposed location. Suppression of the vapors and gases with sprayed water is advised.

FAQ Thermal hazard through fire

Is an explosion of a high-voltage energy storage unit to be expected in a fire instance?

- An explosion of the complete high-voltage energy storage unit is not possible because of the corresponding safety engineering involved.
- Both the high-voltage energy storage unit and its individual cells are equipped with mechanical safety devices that, e.g. are opened in a fire-related increase in temperature and pressure, thereby leading to controlled “outgassing” and pressure relief.

Note

A bursting of openly exposed defective cells with the accompanying exothermic reaction cannot be ruled out.

Can a fire in the high-voltage energy storage unit also occur at a later stage after an accident?

- Yes, as with conventional vehicles involved in an accident, the residual risk of a delayed outbreak of fire cannot be ruled out, this applies, in particular, for damaged high-voltage energy storage units.

Can a burning vehicle with a high-voltage energy storage unit be extinguished and which extinguishing agent must be used?

- Basically, yes. Water is the preferred extinguishing agent as this also has a cooling effect on the high-voltage energy storage unit. Lots of water (approx. 200 l/min) are to be used for extinguishing or cooling.

Vehicle fire in high-voltage system

As in the case of conventionally-driven vehicles, fire in hybrid and electric vehicles can produce harmful fumes due to the burning materials, e.g. plastics. Rescue crews must wear the usual personal protective equipment.

Li-ion battery

Li-ion batteries are generally combustible due to their constituent materials. The same applies for other energy storage units, such as fuel tanks. The safety of the high-voltage batteries is further improved by additional design measures on the battery housing and by the installation location of the batteries. Thanks to these safety measures, no greater risk of fire should be expected than for conventional vehicles. The Li-ion battery as a whole and the individual battery cells feature mechanical safety devices which are triggered in the event of an (e.g. fire-related) increase in temperature and pressure inside the battery, and which help to deliberately degas the battery to release the pressure. Any bursting of the Li-ion battery can therefore be almost entirely ruled out.

Use of extinguishing agents

Generally, any available extinguishing agent may be used. If possible, fires should be extinguished with large quantities of water. Permanent extinguishing with water can cool down the Li-ion battery far enough to ensure that the fire does not spread any further, and to enable a controlled burn off of the Li-ion-battery.

All contact with leaking battery acid should be avoided, as – depending on the battery type involved – they may be irritating or caustic. Inhaling electrolyte vapors is to be avoided at all costs. Any conventional binding agent can be used to absorb the electrolyte.
It cannot be ruled out that the Li-ion battery could catch fire again on another occasion if it has been physically damaged due to an accident. Therefore, the condition of the Li-ion battery should be assessed by trained specialists and then be properly stored and kept under observation. This applies both for the damaged or burnt-out vehicle as a whole as well as for a Li-ion battery removed from the vehicle.

When recovering from water

Submerged or partially submerged vehicles with high-voltage system are recovered by the same procedures as for conventional vehicles. Basically, there is no risk of electrical shock from the high-voltage system flushed by water. Once the vehicle has been retrieved from the water, the high-voltage system should be deactivated according to the specified shutdown procedure. There is therefore generally no higher risk of electric shock when recovering from water compared with recovery on land.

FAQ Vehicles in water

Is there a risk for the water in a drinking water protection area (e.g. dam) if an electric/hybrid vehicle lands in the area's water?

- Compared with conventional vehicles there is generally no risk to the drinking water.

Are there any special risks to be expected with the electric/hybrid vehicle that has ended up in the water?

- There is no increased of electrical shock for the high-voltage system in the water.
- The recovery procedure here is identical to the one deployed for conventional vehicles. This also applies for bodies made of carbon fiber composite materials (carbon).

Note

When deactivating the high-voltage system on vehicles recovered from water, personal protective equipment (face protector and insulated gloves, protection class 0) should be worn. Further details about the towing and recovery of vehicles with electric drive systems are available in the "Guidelines for Car Breakdown Services".

FAQ Towing, recovering, transporting, roadside assistance and safekeeping

What has to be observed when loading an electric/hybrid vehicle after an accident?

- The high-voltage system should be deactivated before the loading procedure (e.g. switch off ignition, use any available disconnection points, disconnect 12 volt battery).
- When handing over to the authorities/recovery service companies, notification of the vehicle's drive type and fire-fighting measures performed (e.g. high-voltage deactivation) must also be provided. Notification is to be made, in particular, of the possible risk presented by damaged high-voltage components or high-voltage components that have been in contact with water (e.g. electrical shock or risk of fire, even delayed, from the high-voltage energy storage unit).
- National regulations/standards must be observed for loading and transporting (in Germany: DGUV Information 214-010 and DGUV Information 205-022, DGUV Information 200-005 and DGUV Information 214-081 as well as the regulations governed by the Accord européen relatif au transport international des marchandises Dangereuses par Route (ADR) - European Agreement Concerning the International Carriage of Dangerous Goods by Road).
- If the vehicle is handed over to a third party (e.g. workshop or waste disposal company), it is recommended to provide notification of any conducted measures (e.g. disconnection point actuated, 12 volt battery disconnected, high-voltage components that were in contact with water, etc.).
- When lifting with a crane/jack or performing work involving a winch or when loading, care must be taken to ensure that high-voltage components were/are not damaged.

What has to be observed if an electric/hybrid vehicle has to be removed from a danger zone (e.g. freeway construction sites) using a tow rope/bar?

- The removal of a vehicle from the immediate danger zone at walking pace is always permissible.
- Further details on towing are available in the operator's manual from the vehicle manufacturer.

What has to be observed when transporting/towing electric/hybrid vehicles involved in an accident?

- A vehicle should always be transported using a platform vehicle or as per the manufacturer's specifications.
- When towing in the lifting cradle the electric/hybrid system may be damaged if the drive axle(s) is/are left on the road. Note: Observe vehicles with all-wheel drive!
- Vehicles with damaged high-voltage energy storage units should be transported, where possible, to the nearest specialist workshop or to a secure location for safekeeping.

FAQ

Towing, recovering, transporting, roadside assistance and safekeeping

How are electric/hybrid vehicles to be parked and stored?

- Electric/hybrid vehicles involved in an accident are to be parked, as with conventional vehicles, for fire protection reasons in a cordoned-off area on an outdoor parking space at sufficient distance to other vehicles, buildings, combustible objects and combustible flooring/ground coverings.
- On no account is it advisable to park an electric/hybrid vehicle with a damaged high-voltage system in an enclosed building.
- Vehicle-specific information (e.g. rescue data sheets) must be observed.
- Alternatively, electric/hybrid vehicles involved in an accident can be parked in designated fire protection systems.
- Parked electric/hybrid vehicles that were involved in an accident whose high-voltage components are directly exposed to the weather must be covered up with a weatherproof tarpaulin.
- The vehicle should identified accordingly. This is to be observed, in particular, when delivering vehicles outside of office hours.

Note

Information on this is available in the vehicle's operator's manual or on the rescue card.

Are there any regulations restricting journeys through tunnel passages when a towing vehicle has a damaged electric/hybrid vehicle loaded on it?

- No, battery-driven vehicles and hybrid vehicles being transported are not subject to the regulations governed by ADR (Accord européen relatif au transport international des marchandises Dangereuses par Route – European Agreement Concerning the International Carriage of Dangerous Goods by Road).
- The recovery company is responsible for road safety during transportation, taking the previous measures and the degree of damage involved into account. A potential hazard from the damaged high-voltage components (e.g. electrical shock or risk of fire through the energy storage unit) must be noted.
- Country-specific and operator-specific tunnel regulations must be observed.

Rescue involving vehicles with a fuel cell system

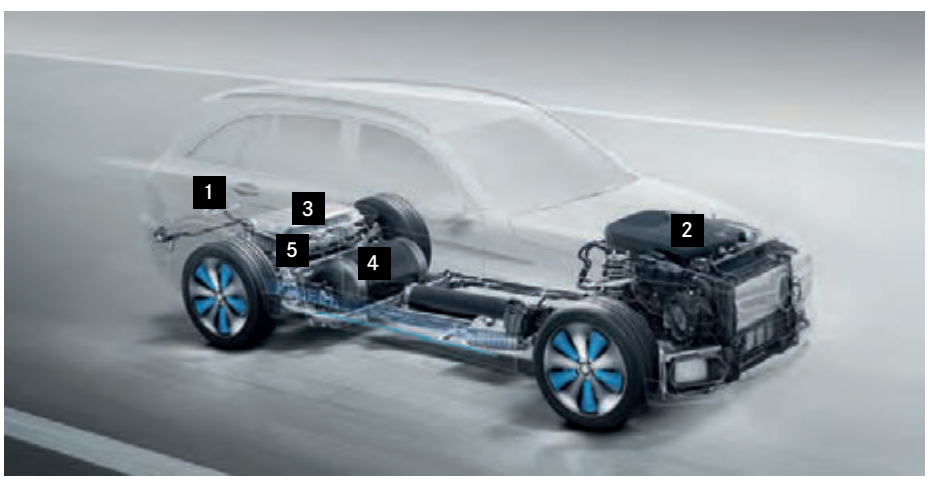
Overview

Various Mercedes-Benz production vehicles are equipped with fuel cell systems for generating the drive energy. The complete fuel cell system, for example, on the GLC F-CELL, is located in the major assembly compartment and the vehicle underbody. Instead of a conventional fuel tank, the cylinder-shaped hydrogen tanks are mounted on the vehicle floor between the front and rear axle.

The fuel cell stack is a highly-efficient energy converter, which generates the electrical energy required by the electric motor through an electrochemical process. The high-voltage battery is housed in the trunk floor. This stores the electrical energy generated in the fuel cell system and the energy produced through recuperation and thereby powers the high-voltage components and supports the fuel cell system during the startup phase.

Note

The installation positions of the high-voltage components in a fuel cell vehicle are available on the vehicle-specific rescue cards.



Location of fuel cell system using the GLC F-CELL as an example

1 High-voltage battery
2 Fuel cell drive system
3 On-board charger
4 Hydrogen tank
5 Electric motor

Vehicle identification

Fuel cell vehicle

The type designations “F-CELL” or “f” on the rear of the vehicle indicate a vehicle with a fuel cell system. If the vehicle does not bear a type designation on the body, a look inside the fuel filler flap or on the B-pillar (QR code), in the operator’s manual, at signs on the instrument panel, at the charge/fill level displays in the instrument cluster or the notice on the charging flap about H2 refueling, provide information about the given drive type. All the high-voltage components in the vehicle are identified by a warning label. The high-voltage lines are orange.

Note

The vehicle-specific identifying features are available in the respective rescue cards (Ref. p. 6).

The following distinguishing features indicate that the Mercedes-Benz vehicle encountered at the scene is a vehicle with fuel cell system:

1 Orange colored high-voltage lines
2 Power availability display in the instrument cluster instead of the engine rev counter
2 Charge indicator in instrument cluster
3 QR code for rescue crews
4 Filler neck for hydrogen behind fuel filler flap, identified by an “H2” label
5 Type designations on the trunk lid at the right
6 High-voltage components with warning signs

· Fuel tank in underbody area
· Operator’s manual

System components

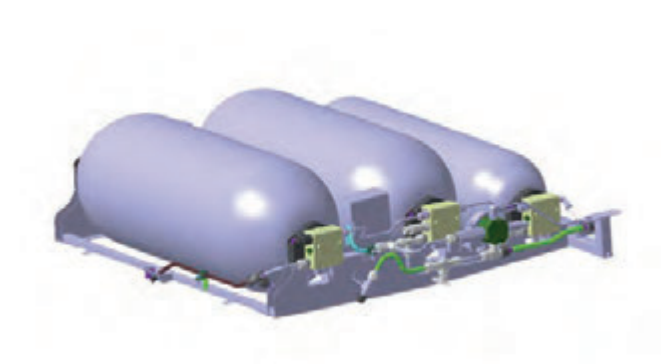
Fuel cell stack

The fuel cell stack is the heart of the fuel cell drive system. The stack describes the energy converter, which uses oxygen from the ambient air and the hydrogen stored in the tanks to generate electrical energy through ah electrochemical process. The generated electrical energy supplies power to the drive system as well as all high-voltage components and charges the high-voltage battery.

Fuel cell stack

Hydrogen tank

In the hydrogen tanks reinforced with carbon fibers, gaseous hydrogen is stored at a pressure of up to 700 bar. Refueling takes place at hydrogen refueling stations. The refueling process itself is not substantially different from the current refueling procedure with natural gas.



Hydrogen tank

High-voltage system shutoff

Before introducing rescue measures it is necessary to ensure that the high-voltage system and the H2 system are deactivated on vehicles equipped with a fuel cell system.

When actuated the high-voltage system operates with voltages of approx. 400 volts. In a severe accident, where a restraint system has deployed, this is automatically switched off and discharged in less than 5 seconds. Here, the valves are closed and the fuel cell stack is short circuited, thereby discharging it. The battery itself remains charged even after shutting off the high-voltage system.

The automatic shutoff means that there is never an increased risk of an electrical shock for the vehicle occupants and the rescue crews. The high-voltage system is isolated from the vehicle body and other electric circuits, i.e. it is not connected to the vehicle body, but galvanically isolated.

Along with the automatic deactivation of the high-voltage system, vehicles equipped with fuel cell systems have a manual and an alternative manual high-voltage shutoff, as with vehicles equipped with hybrid and battery-electric drive.

A direct display, that also shows the voltage in a high-voltage system even after an accident, is not available because of the various types of damage scenarios involved.

The position and operation of the manual high-voltage shutoff, as well as the alternative manual high-voltage shutoff are available in the respective rescue cards.

Note

The automatic shutoff of the high-voltage system is linked to deployment of the restraint systems. Therefore, if an airbag or a seat belt tensioner has been deployed, it can be assumed that the high-voltage system has been shut off and the H2 tanks have been sealed.

Hydrogen system shutoff

Fuel cell stack

The hydrogen is stored at normal pressure of up to 700 bar with a gas temperature of 15 °C. At higher temperatures the reservoir pressure may rise to 875 bar. This can also happen when refueling. If an accident triggers a restraint system, all the gas valves are closed mechanically in order to halt the gas supply.

Overpressure safeguard

In the event of a malfunction in the hydrogen pressure regulator in the fuel system, the overpressure valve is opened thereby enabling hydrogen to be released into the atmosphere in a controlled manner through a vent tube. The overpressure valve opens at pressures above approx. 16 bar.

Hydrogen tank vent lines

The vent lines are routed downwards intentionally. The outlet opening is closed off with a protective cap. The venting of the gases can produce large jets of flame for short periods. These may occur several times in succession. Hydrogen flames are colorless so it may not be possible to detect them under certain circumstances. A blown protective cap on the outlet opening can be an indication that hydrogen has been or is being vented into the atmosphere via the vent line. Listen for any loud escaping gas noise (“hissing”) caused by the gas venting under high pressure.

Note

Particular caution must be exercised when venting gas in vehicles lying on their roof.

Overheating protection

Each hydrogen tank is equipped with a shutoff valve with integrated overheating protection. The overheating protection prevents the hydrogen tanks from bursting under the effects of heat. At temperatures > 110 °C the overheating protection opens and enables the hydrogen to be released in a controlled manner through the vent tube.

Vehicle fire involving fuel cell system

As in the case of conventionally-driven vehicles, fire in vehicles equipped with a fuel cell system can produce hazardous smoke gas due to the burning materials (e.g. plastics). Rescue crews are advised to wear the customary personal protective equipment.

Li-ion battery

Li-ion batteries are generally combustible due to their constituent materials. The same applies for other energy storage units, such as fuel tanks. Li-ion batteries are protected by safety measures, e.g. a high-voltage system shutoff in the event of a serious accident, as well as by design measures on the battery housing and by the installation location of the batteries. Thanks to these safety measures, no greater risk of fire is expected than for conventional vehicles. Generally, any available extinguishing agent may be used.

Use of extinguishing agents

If possible, fires should be extinguished with large quantities of water. Continuous extinguishing with water can cool the Li-ion battery far enough to prevent the fire from spreading, and to allow the Li-ion battery to burn out in a controlled manner. All contact with leaking battery acid should be avoided, as depending on the type of battery involved, this may exhibit an irritating or caustic effect.

The inhalation of electrolyte vapor should be avoided under all circumstances. Any conventional binding agent can be used to absorb the electrolyte. It cannot be ruled out that the Li-ion battery could catch fire again on another occasion if it has been physically damaged due to an accident. For this reason the condition of the Li-ion batteries should be assessed by trained specialists and then be properly stored and kept under observation. This applies both for the overall vehicle involved in the accident or the burnt out vehicle as well as a Li-ion battery detached from the vehicle.

Under the European standard EN2 for “Flammable Materials of Various Kinds” for fire-resistance class C, hydrogen is classified under “Gases”. All C-Class extinguishing agents such as, e.g. ABC powder extinguisher can be used here as an extinguishing agent.
Generally, fire fighting should not start until the supply of gas has been stopped to avoid the generation of an explosive gas-air mixture.

Note

Further details about the towing and recovery of vehicles with electric drive systems are available in the “Guidelines for Car Breakdown Services”.

Recovering from water

Submerged or partially submerged vehicles with high-voltage system are recovered by the same procedures as for conventional vehicles. Basically, there is no risk of electrical shock from the high-voltage system flushed by water. After the vehicle has been recovered from the water, the high-voltage system should be deactivated after a specified shutdown procedure. There is therefore generally no higher risk of electric shock when recovering from water compared with recovery on land.

Hydrogen properties

Hydrogen gas has a density of approx. 0.09 kg/m³ under standard conditions and is therefore lighter than air. When mixed with air, hydrogen gas – in ranges of 4 percent by volume up to 77 percent by volume – produces an ignitable mixture. A mixture with a hydrogen content of up to 10.5 vol% is heavier than air and sinks to the ground. This mixture is ignitable until diluted to less than 4 vol% hydrogen. A hydrogen flame is virtually invisible in daylight. Escaping hydrogen gas is not odorized and is therefore entirely odorless and colorless.

Appendix

Information and copyright

Questions and suggestions

If you have any questions, suggestions or proposals concerning this product, please write to us.
Email: thomas.g.weber@daimler.com

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