Accident Assistance and Recovery of Vehicles with High-Voltage or 48-Volt Systems

Frequently Asked Questions (FAQs)

VDA | Verband der Automobilindustrie

Accident Assistance and Recovery of Vehicles with High-Voltage or 48-Volt Systems

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Project group “Recovery of vehicles with high-voltage systems from accidents”

Revised version

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VDA | Verband der Automobilindustrie

Topic of this brochure

Recovery of accident-damaged vehicles with high-voltage batteries/propulsion systems, including vehicle components, whenever they have been installed by the vehicle manufacturers as standard, or have been approved by the vehicle manufacturers as retrofit solutions.

Target group

Danger prevention experts in the police force and other organizations (police of the German states, national police, authorities, fire services, the Federal Agency for Technical Relief (THW), rescue services, vehicle recovery and towing services, and emergency doctors)

Scope of application

The information/details given here are explicitly restricted to vehicles and components in the categories passenger cars and light commercial vehicles up to 3.5 t (M1 and N1 pursuant to Directive 2007/46/EC). This document covers only measures in the Federal Republic of Germany. If it is applied in other states, it must be adapted to the respective national legislation.

Important note

Retrofit solutions and conversions by providers not approved by the vehicle manufacturer are not covered by this brochure, as the widely differing ways in which such systems and components are designed and realized do not allow us to make any safe recommendations which would assist the target group.
In cases of doubt, refer to the manufacturer’s specifications and instructions. Useful information may be contained in the operating instructions and/or manuals, and rescue data sheets for individual vehicle models.

Preliminary remark and liability disclaimer

With the increasing diversity of new vehicles with electric drive trains, products and technologies, it becomes ever more complex to recommend procedures to members of the police and other organizations for danger prevention with vehicles involved in accidents. To support the personnel attending the scene, rescue data sheets for specific models are available to everyone free of charge from the websites of the German Association of the Automotive Industry (VDA) and the Association of Motor Vehicle Importers (VDIK) (www.vda.de and www.vdik.de) in close cooperation with emergency doctors, fire services and other experts.

This document was elaborated by the VDA project group “Recovery of vehicles with high-voltage systems from accidents” in collaboration with the VDIK, to provide additional procedural recommendations to staff deployed at accidents to recover vehicles with high-voltage systems.

It answers typical questions concerning the handling of accident-damaged vehicles with high-voltage traction battery and propulsion systems.

If recommendations contained in this document are used by third parties (e.g. commercial recovery/towing companies), deviations may apply depending on the legislation in force. This applies in particular to the commercial transport of hazardous substances and goods, pyrotechnic restraint systems, and emergency shutdown/emergency opening systems.

This document does not replace training courses/programs delivering specialist and/or technical knowledge or skills.

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1. Definitions and terms

Battery Electric Vehicle (BEV)

A BEV is a vehicle with electric propulsion powered by energy supplied solely from a high-voltage traction battery.

Recovery

In this document recovery refers to the removal of vehicles/parts from a danger zone.

High-Voltage traction battery damaged/separated by an accident

In the case of a very serious accident or a direct mechanical impact to the traction battery, the traction battery may become damaged, or in extreme cases it may disintegrate or become detached from the vehicle. Damage to the high-voltage traction battery (which is extremely dangerous) can be recognized from the following criteria:

- the traction battery becomes warm;
- the presence of smoke, noises or sparks;
- deformation of the traction battery housing.

Electrical insulation

Non-conductive materials provide electrical insulation. They prevent an electric current from flowing if a person touches live cables or parts.

Galvanic isolation

In galvanic isolation there is no electrical connection between two electric circuits.

The high-voltage system is completely electrically insulated from the vehicle chassis and vehicle body.

High-Voltage system

The high-voltage system in a vehicle consists of several high-voltage components including the high-voltage traction battery and high-voltage cables.

High Voltage (pursuant to UN Regulation No. 100)

High voltage is the electrical voltage for which an electric component or an electric circuit is designed, whose root mean square of its working voltage is > 60 V and ≤ 1500 V (direct current) or > 30 V and ≤ 1000 V (alternating current).

High-Voltage traction battery (ultracapacitor, etc.)

A high-voltage traction battery is a rechargeable energy storage system providing electrical energy for electric propulsion.

Hybrid Electric Vehicle (HEV)

An HEV is a vehicle with an electric powertrain and a combustion engine. The high-voltage traction battery is charged by the combustion engine.

Plug-in Hybrid Electric Vehicle (PHEV)

A PHEV is a vehicle with an electric powertrain and a combustion engine. The high-voltage traction battery can be charged by the combustion engine or alternatively via an appropriate charging connection using a charging cable (plug-in).

Rescue

Rescue means averting a life-threatening situation by taking life-saving measures and/or by freeing persons from a life-threatening or health-endangering situation (DIN 13050:2015-04).

Serious accident

A serious road traffic accident in the meaning of this guide is defined by the extent of the damage to the vehicle involved. An accident is classified as serious if there is clearly recognizable deformation of the vehicle structure, which goes beyond external damage to sheet metal, the bodywork or attached parts. Serious accidents are usually accompanied by airbag activation.
It should be noted that only those components are activated that can act in the direction of the impact (front airbags in frontal impacts, side airbags in side impacts) and only if they have been installed in the vehicle. In the case of a pure rear impact, the accident may be serious even if no airbags have been activated.

Separation point

A separation point is a cut-off device for the high-voltage system, which can be recognized by rescue personnel. These points are described in the rescue data sheet and may also be found in the manufacturer's rescue guidelines. There are several different types of separation points (pursuant to ISO 17840).

One type disconnects the 12 V/24 V control voltage of the high-voltage system, resulting in deactivation. Such devices include:

- **12 V/24 V – removal of low voltage fuse**
- **12 V/24 V – cable cut**
- **12 V/24 V – operate low voltage service disconnect**

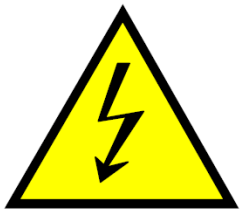
The other type interrupts the high-voltage system directly, as the separation point is connected in series with the high-voltage traction battery.

- **operate high voltage service disconnect**. This separation point is usually colored orange. Personal protection equipment is required.

2. Vehicle recognition/identification

2.1. What are the signs that a particular vehicle has a high-voltage system?

- In some European countries the rescue control centers or fire services can request information based on a vehicle's license plates in order to unequivocally identify the correct rescue data sheet for the vehicle.
- There may be a type designation on the rear of the vehicle, such as Hybrid, Electric Drive, or other markings, e.g. on the fenders.
- In the absence of vehicle markings, the following features may indicate a vehicle with a high-voltage system:
    - the absence of an exhaust pipe in battery-only electric vehicles
    - the letter "E" as last character on a German license plate[1]
    - an electrical charging connector (possibly with a second "fuel cap")
    - manufacturer's specific design elements
    - orange high-voltage cables (note: high-voltage cables inside high-voltage traction battery packs may have a different color)
    - warning stickers on high-voltage electrical components



    - presence in the vehicle of charging cables or similar equipment

[1] These special E-license plates have been issued in Germany only since September 2015. Marking a vehicle with an E-license plate is subject to the provisions of Section 3 of the German Electric Mobility Act (EmoG). In the meaning of the Act, only battery-only electric vehicles, hybrid electric vehicles that can be externally charged, or fuel cell vehicles, all of which mist have a range of at least 40 km on electric propulsion or emit no more than 50 grams of carbon dioxide per kilometer driven, are entitled to use these plates. **Important: The vehicle user is not obliged to apply for "E-plates" when registering the vehicle or to use them to identify it!**

- a charge indicator in the instrument cluster and/or indicator of the vehicle's operational status (e.g. "Ready")
- symbols and/or indicator light on the instrument panel

However, the absence of these features does not necessarily indicate that the vehicle has no high-voltage system.

3. Risk of electric shock

3.1. After an accident, is it possible to receive an electric shock by touching the vehicle or parts of it?

- Generally there is no risk that human beings will receive an electric shock.
- The vehicles are equipped with several different protection mechanisms:
    - The high-voltage system has touching protection.
    - The high-voltage system is fully electrically insulated from the chassis/body (galvanic/electrically separated).
    - In serious accidents where an airbag has been activated, in most vehicles the high-voltage system is then switched off.
- If, however, high-voltage components or high-voltage cables are damaged in very serious accidents (e.g. exposed components, detached cables), the damaged parts should not be touched. If work at the sites of damage cannot be avoided, the damaged parts should be covered to insulate them electrically.
- If there is any doubt, the vehicle's high-voltage system should be deactivated manually if possible (see the description in the rescue data sheet for the specific vehicle, and question 3.4 below).

3.2. Is it possible to tell whether the high-voltage system has been deactivated in an electric/hybrid vehicle involved in an accident?

- After an accident it is not possible to indicate directly that the system is voltage-free, owing to the wide variety of potential damage scenarios.
- If there is any doubt, the vehicle's high-voltage system should be deactivated manually if possible (see the description in the rescue data sheet for the specific vehicle, and question 3.4 below).

Note: The energy (charge status) of a high-voltage traction battery or individual cells inside the battery is not altered by deactivating the high-voltage system,

although deactivation does electrically isolate the high-voltage traction battery from the rest of the high-voltage system/on-board power supply.

3.3. Does a parked vehicle which has been involved in an accident (Stationary crash) pose an electrical hazard?

- Yes, under certain circumstances a vehicle's high-voltage system can be active while the vehicle is not in motion (e.g. air-conditioning during parking).
- When a stationary electric vehicle is involved in a crash, the airbags are generally not activated, which means it is not possible for their deployment to switch off the high-voltage system.
- Therefore, after a serious accident the vehicle's high-voltage system should be deactivated manually (see rescue data sheet and question 3.4 below).
- This applies both to vehicles at an electric charging point and to parked vehicles not connected to a charging point.
- Irrespective of the vehicle, the charging point's electricity supply could represent a danger if it was damaged during the accident (see questions in section 7 below).

3.4. Can the rescue services deactivate a high-voltage system manually?

- Yes, electric/hybrid vehicles have various options for manual deactivation of the high-voltage system.
- Most vehicles are equipped with an additional device for switching off the high-voltage system, which can be used by emergency personnel. These are separation points described in the rescue data sheets. They can be used to deactivate the high-voltage system.

Note: This does not discharge the high-voltage traction battery – however, it is electrically disconnected from the rest of the high-voltage system.

- The recommended procedure for manual deactivation is described in the rescue data sheet from the relevant vehicle manufacturer.

3.5. What is the danger from damaged high-voltage cables after an accident, if it can be seen that the airbags have not been activated?

- Damaged high-voltage cables or components can always cause an electrical hazard. Do not touch high-voltage cables/components.

Note: High-voltage cables located outside the housing of the high-voltage traction battery pack or other similar housings are always colored orange. High-voltage components are identified as such by warning stickers.

4. Hazards arising from high-voltage traction batteries

4.1. Can high-voltage traction batteries be discharged after an accident?

- No, it is not practicable to electrically discharge the high-voltage batteries or individual cells at the scene of an accident and is not recommended. Improper discharging of the high-voltage traction battery can leave it in a critical condition.

4.2. How do you proceed at the scene of an accident when the high-voltage traction battery in the vehicle is damaged but not on fire?

- The damaged high-voltage traction battery must not be touched directly.
- The state of the high-voltage traction battery needs to be observed (e.g. release of smoke, noises, sparks, increase in heat).
- Water needs to be made available to cool the high-voltage traction battery.
- If the temperature of the high-voltage traction battery is much higher than the outside temperature and is continually rising, the housing of the high-voltage traction battery needs to be cooled with water.

4.3. What is the procedure for dealing with high-voltage traction batteries or parts of one that have become detached from the vehicle in an accident?

- In this case, the high-voltage traction battery may present electrical, chemical, mechanical and thermal risks. Wear the appropriate protective clothing.
- Do not touch the high-voltage traction battery directly.

- When lifting separated components of high-voltage batteries off the ground, always use electrically isolating equipment. Further action must be decided depending on the situation and location.
- Take note of the condition of the high-voltage traction battery (e.g. release of smoke, noises, sparks, production of heat).
- Prepare to cool the high-voltage traction battery using water.

4.4. How do you proceed when a high-voltage traction battery or parts of it have separated or detached from the vehicle during an accident and someone is trapped in the vehicle?

- Approved personal protective equipment must be worn.
- The high-voltage traction battery must not be touched directly.
- If high-voltage components or high-voltage cables have been damaged (e.g. open components, torn-off cables), these damaged areas must not be touched.
- If work in these areas is unavoidable, the damaged parts or high-voltage traction battery should be covered with an electrically insulated material (see question 4.5 below).
- The state of the high-voltage traction battery needs to be observed (e.g. release of smoke, noises, sparks, increase in heat).
- Water needs to be made available to cool the high-voltage traction battery.

4.5. What is a suitable insulating material for covering live parts?

- A suitable, electrically insulating, supple material (e.g. in accordance with IEC 61112) is recommended.
- The fire service’s tarpaulin is generally a sheet of polyethylene. Due to frequent use of the tarpaulin and potential damage, using it to insulate live parts is not recommended.

5. Possible Hazards arising from 48-Volts Systems

Definition and vehicle identification

Vehicles with 48-volt systems are vehicles with a combustion engine and a starter generator / auxiliary electric motor. In these vehicles, the 48-volt system consists of a 48-volt battery (generally a lithium-ion battery), several 48-volt components, and a voltage transformer (48 volts/12 volts).

The rated voltage in these vehicles is 48 volts DC (direct current), which is below the threshold voltage requiring touching protection (60 volts DC).

As a rule, vehicles with 48-volt systems look the same as the conventional variants. The position of the 48-volt battery is indicated in the rescue data sheet.

At present there is no obligatory standard for labeling or color-coding 48-volt cables.

Questions and answers on shutoff and hazards

5.1 Is the 48-volt system automatically deactivated in accidents in which airbags have deployed?

- As a rule, the vehicle’s 48-volt system is automatically deactivated following accidents in which airbags have deployed.

5.2 Is there a risk of arcing when a 48-volt system is active?

- Yes, if the 48-volt system is active, arcing may occur when cables are cut, when the 48-volt battery is disconnected, or if a short circuit occurs.

5.3 How can the on-board electrical system be deactivated in a 48-volt vehicle?

- To fully deactivate the on-board electrical system, disconnect both batteries (12-volt and 48-volt batteries).

  Reason: in these vehicles the 48-volt system and the 12-volt system (operating in parallel) are connected via a voltage transformer. The location of the batteries, and options for deactivation, can be found in the rescue data sheet.

- To minimize the risk of arcing when the 48-volt battery is disconnected, the following procedure is recommended:

  1. **Switch off the ignition.**
  2. Disconnect the negative terminal of the 12-volt battery.
  3. Disconnect the 48-volt battery as described in the rescue data sheet.

5.4 What possible electrical hazards exist with an active 48-volt system?

- In 48-volt vehicles the DC voltage is below the DC voltage threshold requiring touching protection (60 volts). A 48-volt system therefore generally does not present an increased electrical risk.

  In some 48-volt vehicles, AC voltages may occur that exceed the AC voltage threshold requiring touching protection (30 volts). These components are identified by warning signs showing a lightning symbol and the relevant cables are colored orange.

5.5 What steps must be taken if a 48-volt battery is damaged or on fire?

- As a rule, 48-volt batteries are installed at sites in the vehicle with crash protection and/or are themselves provided with crash protection.

- If the 48-volt battery is nonetheless damaged, observe the state of the battery (e.g. generating smoke, sparks, heat).
- Given the risk of a fire developing at a later time, large quantities of water should be made available for extinguishing and cooling.
- The personal protective equipment (PPE) should be adapted accordingly.
- Avoid direct contact with the damaged battery.

6. Chemical hazards

6.1. What do you need to be aware of when dealing with a high-voltage traction battery leaking electrolyte following an accident?

- Electrolytes tend to be irritating, flammable and potentially corrosive.
- Conventional binding agents need to be used.

Note: Any fluids leaking from high-voltage traction battery packs tend to be refrigerant and not electrolyte. There are only small amounts (milliliters) of electrolyte throughout the individual cells.

- Skin exposure to electrolyte and the inhalation of released gases resulting from chemical reactions with leaking electrolyte should be avoided at all costs. (Note: Personal protective equipment should be used based on the situation).
- If your skin becomes exposed to the contents of the high-voltage traction batteries or their gases, the affected areas need to be flushed with lots of water. Soiled clothing needs to be taken off and cleaned. Medical attention should then be sought.

6.2. What are the risks when a high-voltage traction battery releases gases?

- The gases are irritating, flammable, and potentially corrosive and must therefore not be inhaled.
- The recovery process should be aborted and the next steps discussed with the fire service head of operations.
- The danger zone surrounding the vehicle should also be expanded.
- If possible, a high-voltage traction battery releasing gases should be cooled with water.

Note: As a rule, gases can also be perceived by an acrid, pungent odour.

7. Thermal hazards from fire

7.1. Is a high-voltage traction battery likely to explode in the event of a fire?

- An explosion of the entire high-voltage traction battery can be ruled out due to the corresponding safety technology.
- The high-voltage traction battery and its individual cells are equipped with mechanical safety devices that open, for example, in response to rising temperature and pressure due to a fire; this results in controlled "degassing" and releases the pressure.

Note: A bursting of open, defective cells accompanied by an exothermic reaction cannot be ruled out.

7.2. Is it likely that a high-voltage traction battery will degas if the vehicle catches fire?

- Yes. Both the high-voltage traction battery and its individual cells are fitted with mechanical safety devices, which, for instance, open in response to an increase in temperature and pressure resulting from a fire, thus releasing gases and pressure as a preventive measure.

Note: Self-contained breathing apparatuses are required when working in an exposed environment. A spray of water should be applied to contain vapours and gases.

7.3. Do fires in electric/hybrid vehicles generate toxic smoke?

- Yes, just as with conventional vehicles, fires in electric/hybrid vehicles generate harmful smoke from burning materials such as plastics.

Note: Self-contained breathing apparatus must be worn while working in exposed conditions. Use a water spray jet to remove vapors and gases from the air.

7.4. Could the high-voltage traction battery catch fire at a later time following an accident?

- Yes. As is the case with conventional vehicles involved in an accident, the risk of a delayed fire cannot be ruled out, which applies to damaged high-voltage traction battery in particular (see also question 10.5 below).

7.5. Can a burning vehicle with a high-voltage traction battery be extinguished and which extinguishing agent should be used?

- Generally, yes, it can be extinguished.

Water is the preferred extinguishing agent, because it also cools the high-voltage traction battery down. Large quantities of water are needed (approx. 200 l/min) for extinguishing and cooling.

7.6. Can a burning high-voltage traction battery in the vehicle be extinguished and which extinguishing agent should be used?

- Generally, yes, it can be extinguished.

Water is the preferred extinguishing agent, because it also cools the high-voltage traction battery down. Large quantities of water are needed (approx. 200 l/min) for extinguishing and cooling.

8. Electrical charging infrastructure

8.1. What action must be taken if an electric/hybrid vehicle connected to a 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 be switched off.
- Before disconnecting, check the cable and the connector for any visible signs of damage. Do not touch any sites of damage.
- After a **serious accident** deactivate the vehicle's high-voltage system (see rescue data sheet).

Note: A stationary vehicle's high-voltage system may be active independent of the charging station (e.g. air-conditioning).

8.2. What happens when a charging cable at a charging station is severed by vandals while the vehicle is charging?

- In such cases the technical infrastructure at the charging station ensures safety and generally the power at the charging station is turned off.
- Inform the operator of the charging station.

8.3. What action must be taken if the charging cable or the connector is damaged?

- Do not use the charging cable/connector, and secure them to prevent unauthorized use.
- Inform the operator of the charging station.

9. Vehicles in water

9.1. Are certain risks likely if an electric/hybrid vehicle is underwater?

- A high-voltage system submersed in water does not increase the risk of electric shock.
- The information in sections 3 and 4 above applies.
- The recovery procedure is identical to that for conventional vehicles.

This also applies to vehicle bodies made of carbon-fiber composite materials.

9.2. In drinking water protection areas (e.g. reservoirs), is there a water safety hazard if an electric/hybrid vehicle enters a body of water?

- Compared with conventional vehicles, there are usually no additional hazards for drinking water.

10. Towing, recovery, transportation, breakdown assistance and storage

10.1. What factors are important if an electric/hybrid vehicle has to be towed out of a danger zone (e.g. freeway construction site) using a tow-bar/rope?

- It is always permissible to tow the vehicle out of the immediate danger zone **at walking pace**.
- Further information about towing may be found in the owner's manual provided by the vehicle manufacturer.

10.2. What do you need to be aware of when loading an electric/hybrid vehicle following a serious accident?

- **Important**: Instructions can be found in the owner's manual for the vehicle or the rescue data sheet.
- The high-voltage system should be deactivated before loading (e.g. switch off ignition, use existing disconnect if applicable, disconnect 12 V battery).
- In the event of handover to the authorities/ recovery company, these need to be informed of the vehicle's type of drive and the measures taken by the fire service (e.g. high voltage deactivation). Specifically, they must be informed of the potential danger from damaged high-voltage components or high-voltage components which have come into contact with water (e.g. electric shock or risk of fire, including delayed fire, from the high-voltage traction battery).
- The national regulations/standards for loading and transportation must be observed (in Germany: DGUV Information 214-010 and DGUV Information 205-022, DGUV Information 200-005 and DGUV Information 214-081 and the provisions of the ADR – European Agreement concerning the International Carriage of Dangerous Goods by Road /

Accord européen relatif au transport international des marchandises Dangereuses par Route).

- If the vehicle is handed over to a third party (e.g. a workshop or disposal company), we recommend informing them of the measures taken (e.g. use of separation points, disconnection of 12 V battery, high-voltage components having had contact with water, etc.).
- When lifting the vehicle with a crane/jack, working with a winch or loading the vehicle, it's important to ensure that no high-voltage components are/become damaged.

10.3. What do you need to be aware of when transporting/towing electric/hybrid vehicles that have been involved in an accident?

- Damaged vehicles should only be transported by a platform vehicle and in accordance with the manufacturer's instructions.
- If a vehicle is being towed away in a lifting cradle, the electric/hybrid system may be damaged if the drive axle(s) remain(s) in contact with the road surface. Note: Be aware of four-wheel drive!
- If possible, vehicles with a damaged high-voltage traction battery should be transported to the nearest suitable workshop or to a safe place of storage (see also question 10.5 below).

10.4. Are there any regulations restricting passage through tunnels of a recovery vehicle loaded with a damaged electric/hybrid vehicle?

- No, the removal of battery-powered and hybrid vehicles is not governed by the provisions of the ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road / *Accord européen relatif au transport international des marchandises Dangereuses par Route*).
- Taking the measures described above (in section 10.2) and considering the severity of the damage, the vehicle recovery personnel should

ensure that the transport is safe to go on the road. Be aware of potential risks from damaged high-voltage components (e.g. electric shock or risk of fire from batteries).

- The transport must comply with national regulations applicable to tunnels and those of the operator.

10.5. How should damaged electric/hybrid vehicles be parked and stored?

- Just like conventional vehicles, for fire safety reasons electric/hybrid vehicles that have been involved in accidents should be parked in a restricted-access section of an **open-air parking area** a sufficient distance away from other vehicles, buildings, flammable objects and flammable surfaces.
- It is never recommended to park an electric/hybrid vehicle with a damaged high-voltage system in an **enclosed hall**.
- Follow the instructions/information from the manufacturer (e.g. rescue data sheets).
- Alternatively, electric/hybrid vehicles involved in accidents may be parked in dedicated fire protection systems.
- Parked electric/hybrid vehicles involved in accidents, which have high-voltage components directly exposed to the weather, should be covered with a weatherproof tarpaulin.
- The vehicle should be marked accordingly, especially if it is to be delivered outside business hours.

11. Further information

The German mnemonic "AUTO” has also proven useful for recognizing alternative propulsion technologies:

A **A**ssess fuel leaks
U Check the **U**nderbody
T Open the fuel **T**ank cap
O **O**bserve the whole surface

Additional information about electrical hazards at the scene of an accident may also be found in:

- DGUV Information 203-052 (“Elektrische Gefahren an der Einsatzstelle” [“Electrical hazards at the scene of an accident”], available in German)
- DGUV FAQ List of the working group “Handlungsrahmen Elektromobilität” (available in German)

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