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Radiation protection study: analysed electric cars comply with recommended maximum values for health protection

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Comprehensive magnetic field [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/M/magnetic-field.html?view=renderHelp>] measurements in and on electric cars and motorbikes

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In a radiation protection

[<https://www.bfs.de/SharedDocs/Glossareintraege/EN/R/radiation-protection.html?view=renderHelp>] study, all of the analysed electric cars complied with the recommendations for protection against the health effects of magnetic fields.

Moreover, people in all-electric cars are not generally exposed to stronger magnetic fields than in vehicles with conventional or hybrid drive systems. That is according to extensive measurements and computer simulations commissioned by the Federal Office for Radiation Protection (BfS) and the Federal Environment Ministry (BMUV).

Regardless of the type of drive system, all of the tested vehicles had field [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/F/field.html?view=renderHelp>] strengths below the maximum values recommended for health protection. These maximum values limit the electric currents and fields that can be caused by magnetic fields in the human body to a harmless level. The study measured and evaluated the magnetic fields present at the seats in 14 different car models manufactured in the years 2019 to 2021 in different operating states.



Source: Halfpoint/stock.adobe.com

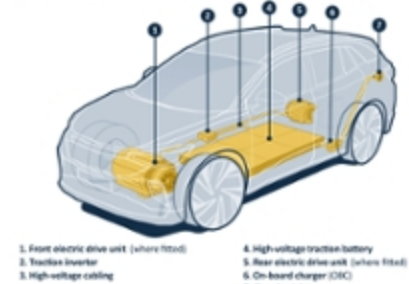
"Comparatively strong magnetic fields were detected in some cases – albeit in localised areas and for a limited time. However, the fields complied with the recommended maximum values for fields induced in the body in the test scenarios. According to current scientific knowledge, no health-relevant effects are therefore to be expected," says BfS President Inge Paulini. "The study's results are good news for consumers who already drive an electric car or are thinking about making the switch." The study was carried out by a project team made up of employees from Seibersdorf Labor GmbH, the Research Center for Bioelectromagnetic Interaction (femu) at RWTH Aachen University, and the Technology Centre of ADAC e.V. Vehicle manufacturers were not involved in the study.

Magnetic fields occur in all motor vehicles

Given that electric currents generate magnetic fields, there are many sources of such fields in modern motor vehicles – including, for example, air conditioning systems, fans, electric windows and heated seats. In the case of electric vehicles, these sources also include a larger and more powerful battery, the high-voltage [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/E/electric-current.html?view=renderHelp>] cabling and the inverter for the drive current, as well as the electric drive itself. The study took account of all magnetic fields occurring in the cars and – where possible – assigned them to the respective cause.

Highest values typically in foot area

Magnetic-field sources unique to battery-electric and hybrid vehicles (in addition to those found in internal combustion vehicles)



Magnetic field sources only in electric cars and hybrids

The evaluation of the measurements and simulations revealed that the recommended maximum values for fields generated in the body were complied with in all recorded scenarios. At the detailed level, however, the picture is more complex: the measured magnetic field



Dummy with measuring probes in the back of an electric car

[<https://www.bfs.de/SharedDocs/Glossareintraege/EN/M/magnetic-field.html?view=renderHelp>]

values varied significantly between the analysed vehicles, as well as spatially within the individual vehicles and depending on the operating state. The strongest magnetic fields occurred primarily in the foot area in front of the seats, while the magnetic fields in the head and torso area were generally low.

Motor power is not an indicator of magnetic field strength

[<https://www.bfs.de/SharedDocs/Glossareintraege/EN/M/magnetic-field-strength.html?view=renderHelp>]

There was no clear correlation between the power of the motor and the magnetic fields in the interior of the electric vehicles. Driving style had a greater influence [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/I/influence.html?view=renderHelp>] than the performance of the motor. Significantly stronger magnetic fields were briefly recorded with a sporty driving style, with strong acceleration and braking, as opposed to a moderate driving style.

Short-term peak values lasting less than a second occurred in situations such as when the brake pedal was pressed, when engine components were switched on automatically, and – regardless of the type of drive system – when the vehicles were switched on. The highest single local value was detected during the switching on of a hybrid vehicle.

Reduce peak values



President of the Federal Office for Radiation Protection, D. Inge Paulini
Source: Holger Kohl/ Bildkraftwerk

"The big differences between vehicle models show that magnetic fields in electric cars aren't necessarily excessively strong or even more pronounced than in conventional cars," says Paulini. "It's up to manufacturers to reduce local peak values and keep average values low through intelligent vehicle design. For example, the better they succeed in installing strong magnetic field sources at a distance from the vehicle occupants, the weaker the fields to which the occupants are exposed in the various driving conditions. These technical possibilities should be considered from the outset when developing vehicles."

About the study

To the BfS's knowledge, the study is the most comprehensive and detailed investigation into the occurrence of magnetic fields in electric vehicles so far. The collected data is based on systematic measurements of field [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/F/field.html?view=renderHelp>]

strength in current vehicle models approved for German road traffic, and these measurements were carried out in three situations: on roller dynamometers, on a closed-off test track and in real road traffic. A total of 11 all-electric cars, two hybrid vehicles and one vehicle with an internal combustion engine were analysed.

The study also included electric two-wheelers for the first time, in the form of a moped, two light motorbikes and a motorbike. These vehicles were similar to the cars in that the strongest magnetic fields occurred in the area of the feet and lower legs. In all of the analysed scenarios, the measurements complied with the maximum values recommended for fields generated in the body with a view to protecting health. On the whole, the occurrence of proven health-relevant field

[<https://www.bfs.de/SharedDocs/Glossareintraege/EN/F/field.html?view=renderHelp>] effects can therefore be assessed as very unlikely in the analysed vehicles.

Measurement procedure

By using sophisticated measurement technology, it was possible to reliably record and evaluate even short-term magnetic field [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/M/magnetic-field.html?view=renderHelp>] peaks lasting less than 0.2 seconds in the study. The current measurement regulations do not take into account such short-term fluctuations, which can occur when electrical vehicle components are activated. However, given the study showed that these fluctuations occur to a relevant extent, the BfS believes it is necessary to extend the measurement standards accordingly.

The study report "Determination of **exposure** [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/E/exposure.html?view=renderHelp>] to electromagnetic fields in electromobility. Results report – Part 1" is available in the digital online **repository** [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/R/repository.html?view=renderHelp>] and information system (DORIS) under the URN <https://nbn-resolving.org/urn:nbn:de:0221-2025031250843> [<https://nbn-resolving.org/urn:nbn:de:0221-2025031250843>]. Further information on **radiation protection** [<https://www.bfs.de/SharedDocs/Glossareintraege/EN/R/radiation-protection.html?view=renderHelp>] in electromobility can be found at <https://www.bfs.de/e-mobilitaet> [https://www.bfs.de/EN/topics/emf/electromobility/electromobility_node.html].

To the topic

- [Radiation protection in electromobility \[https://www.bfs.de/EN/topics/emf/electromobility/electromobility.html\]](https://www.bfs.de/EN/topics/emf/electromobility/electromobility.html)

To the study (in German)

- [Bestimmung von Expositionen gegenüber elektromagnetischen Feldern der Elektromobilität. Ergebnisbericht – Teil 1 \[https://nbn-resolving.org/urn:nbn:de:0221-2025031250843\]](https://nbn-resolving.org/urn:nbn:de:0221-2025031250843)

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