

# Study of the Impact of Malfunctions of and Interferences in the Exhaust Gas Recirculation System on Selected Vehicle Characteristics

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## Abstract

The impact of technical vehicle conditions on dynamical and emission vehicle characteristics has been of relatively little interest. Therefore, this study focuses on the impact of malfunctions of and unwarranted interferences in the exhaust gas recirculation system, known as EGR, on selected vehicle characteristics. Attention has been paid to the EGR blanking off and its permanent opening, carbon deposition in the engine's intake manifold, and other malfunctions and interferences commonly occurring during the lifespan of vehicles. The parameters observed have included the composition of the exhaust gases, smoke opacity, engine power and torque, and others. The measurements have been performed with vehicles of different ages, different numbers of kilometers driven, and different levels of engine management. Blanking off the EGR has led to a multiple increase in the concentration of nitrogen oxides ( $\text{NO}_x$ ) in the exhaust gases, and this unwarranted interference has not been recognized by the engine control unit, so a vehicle would have been assessed as roadworthy during the regular emission inspection. Clogging of the EGR system has caused a 257% increase in smoke opacity as well as a significant reduction in the engine power and torque, which can result in a reduction in the active safety of a vehicle. Since the EGR cooler has not been tight, the particulate matter (PM) and other harmful substances have been drawn into the vehicle cab. This study clearly demonstrates the importance of a properly functioning EGR system and the performing of regular technical and emission inspections for those vehicle parameters that are required by relevant legislation to lower the negative impact of road transport on the environment.

## Highlights

- The article is focused on the malfunctions of and unwarranted interferences in the EGR system.
- Blanking off the EGR multiplied the  $\text{NO}_x$  production, and it was not recognized by the engine control unit.
- EGR malfunction can lead to a reduction in the active safety of a vehicle.
- EGR leak leads to a serious health threat for passengers.

## History

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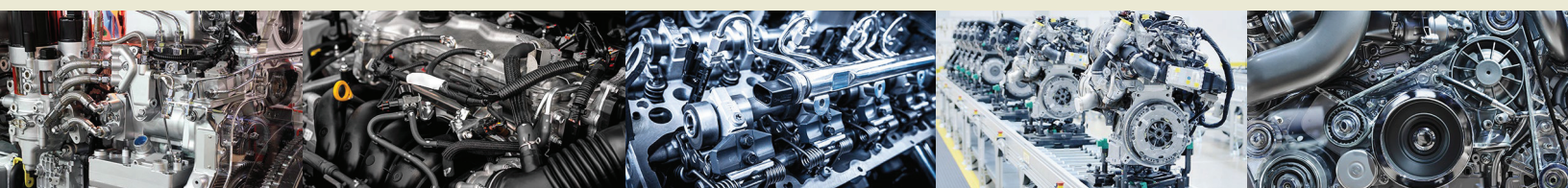
## Keywords

Emissions, Exhaust gas recirculation, Smoke opacity, Engine power, EGR, Engine failure, Technical condition, Engine maintenance, Road transport, Engine torque

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engine control unit via intake air sensor and lambda sensor, which further puts the vehicle into the emergency mode.

- If the EGR cooler is not tight, the exhaust gases penetrate the vehicle cab. The EGR cooler is located in front of the catalytic converter and DPF, so there are exhaust gases taken into the cab through the ventilation and they have not undergone the reduction of the most harmful substances that can negatively affect human health. There was also an excessive amount of PM measured in the vehicle cab. When measuring PMs in the exhaust gases emitting from the exhaust pipe, there were zero values measured.
- The engine control unit did not recognize the EGR blanking off, and it did not put the vehicle into the emergency mode, neither during measurements with the Škoda Fabia with PD system nor with EGR blanking off in relation to the Kia Sportage with a CRDI system.
- The EGR blanking off cannot be detected by police check during the vehicle running, neither during the regular emission inspection nor during the technical inspection of vehicles.
- NO<sub>x</sub> values in the exhaust gases significantly increase by blanking off the EGR.
- EGR blanking off evinces in values of NO<sub>x</sub> concentrations almost only at the engine load.

The insights gained on the basis of measurement analysis performed can be applied within the scope of operation, maintenance and repair of road vehicles, fleet management, and adjustment of vehicle maintenance intervals, and so on. These insights may also be used for law-making regarding vehicle operation and regular emission and technical inspection of road vehicles.

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