Exhaust system of a Volkswagen Golf

Volkswagen has used two basic types of technology to reduce emissions of nitrogen oxides from diesel engines, by either trapping the pollutants or treating them with urea. The first type is shown here.

**Main computer**
Engine control module

- Diesel oxidation catalytic converter
- Oxygen sensor
- Diesel particulate filter
- Temperature sensors
- Exhaust valve
- H2S catalytic converter
- Muffler

**Nitrogen oxide trap**

This system traps nitrogen oxides, reducing toxic emissions. But the engine must regularly use more fuel to allow the trap to work. The car's computer could save fuel by allowing more pollutants to pass through the exhaust system. Saving fuel is one potential reason that Volkswagen's software could have been altered to make 11 million cars pollute more, according to researchers at The International Council on Clean Transportation.
The on-road testing in May 2014 that led the California Air Resources Board to investigate Volkswagen was conducted by researchers at West Virginia University. They tested emissions from two VW models equipped with the 2-liter turbocharged 4-cylinder diesel engine. The researchers found that when tested on the road some cars emitted almost 40 times the permitted levels of nitrogen oxides.

### Average emissions of nitrogen oxides in on-road testing

**2011 Volkswagen Jetta**

- **HIGHWAY** 15 times limit
- **URBAN (LOS ANGELES)** 25 times
- **URBAN (SAN DIEGO)** 37 times
- **RURAL (UP AND DOWNHILL)** 38 times

**2012 Volkswagen Passat**

- **HIGHWAY** 9 times limit
- **URBAN (LOS ANGELES)** 20 times
- **URBAN (SAN DIEGO)** 17 times
- **RURAL (UP AND DOWNHILL)** 17 times

U.S. limit: .04 grams/kilometer

Source: Arvind Thiruvengadam, Center for Alternative Fuels, Engines and Emissions at West Virginia University