

22. ETH Conference on Combustion  
Generated Nanoparticles  
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**Loaded Tests for  
Petrol and Diesel Engines**

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# Agenda

1. Deficits of the current periodic emission test
2. Consequences
3. Examples of different researches
4. Recommendation

# 1. Deficits of the current periodic emission test

- Test procedures have been developed **25 years ago** (Euro 1)
- Simple **unloaded tail pipe test** procedures
  - Idle/high idle test for CO Vol. % (petrol)
  - Free acceleration test for smoke (diesel)
- **Simple OBD-reading** since 2006
- Other **dangerous pollutants** especially arising in high concentrations in modern engines (e. g. nano-PM, NO<sub>x</sub>) **are not measured**

## 2. Consequences

**Deterioration** because of age or milage **and illegal manipulation** of the emission system (Diesel and petrol) **cannot be detected:**



Blocking baffle (gas tube)



Zapping device

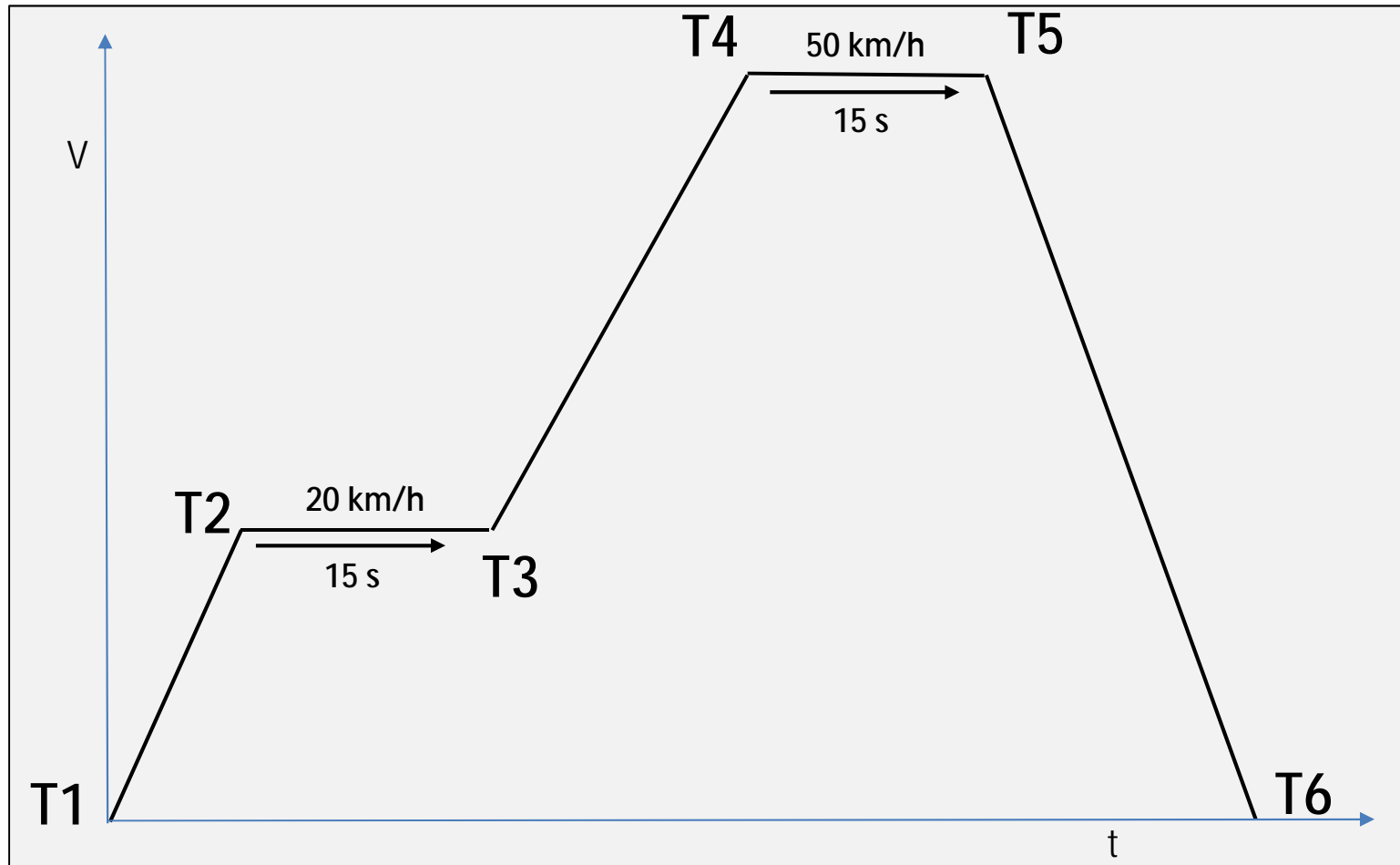


Refit 3-way catalyst

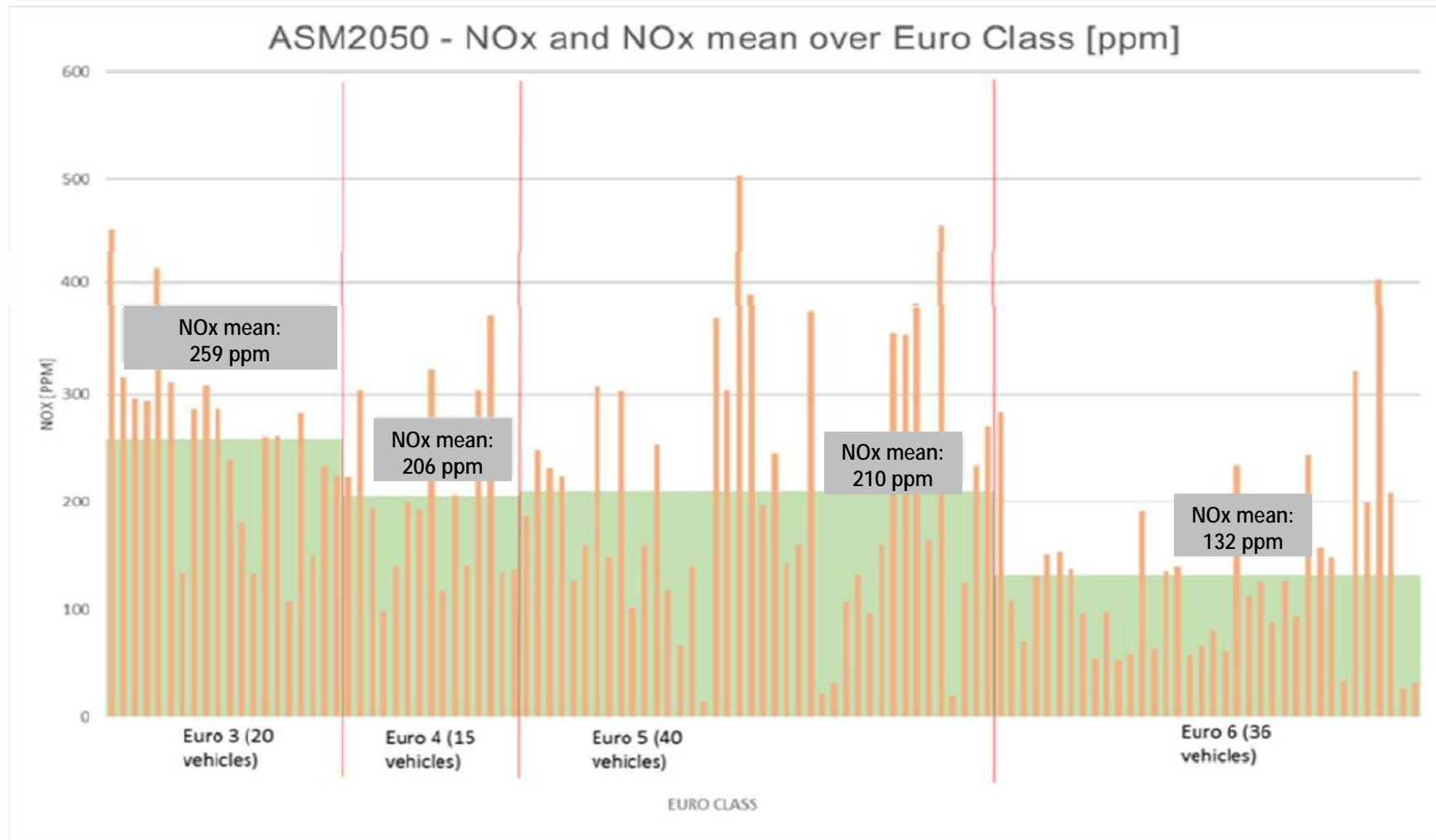
- ➔ High number of **vehicles are exeeding** the allowed **poluttant concentrations**
- ➔ High **negative impact on air quality especially** in urban areas

### 3. Examples of different researches

#### 3.1 Diesel NO<sub>x</sub> emissions: CITA SET II Study, ASM 2050 cycle



### 3.1.1 Field tests ASM 2050 (diesel vehicles)



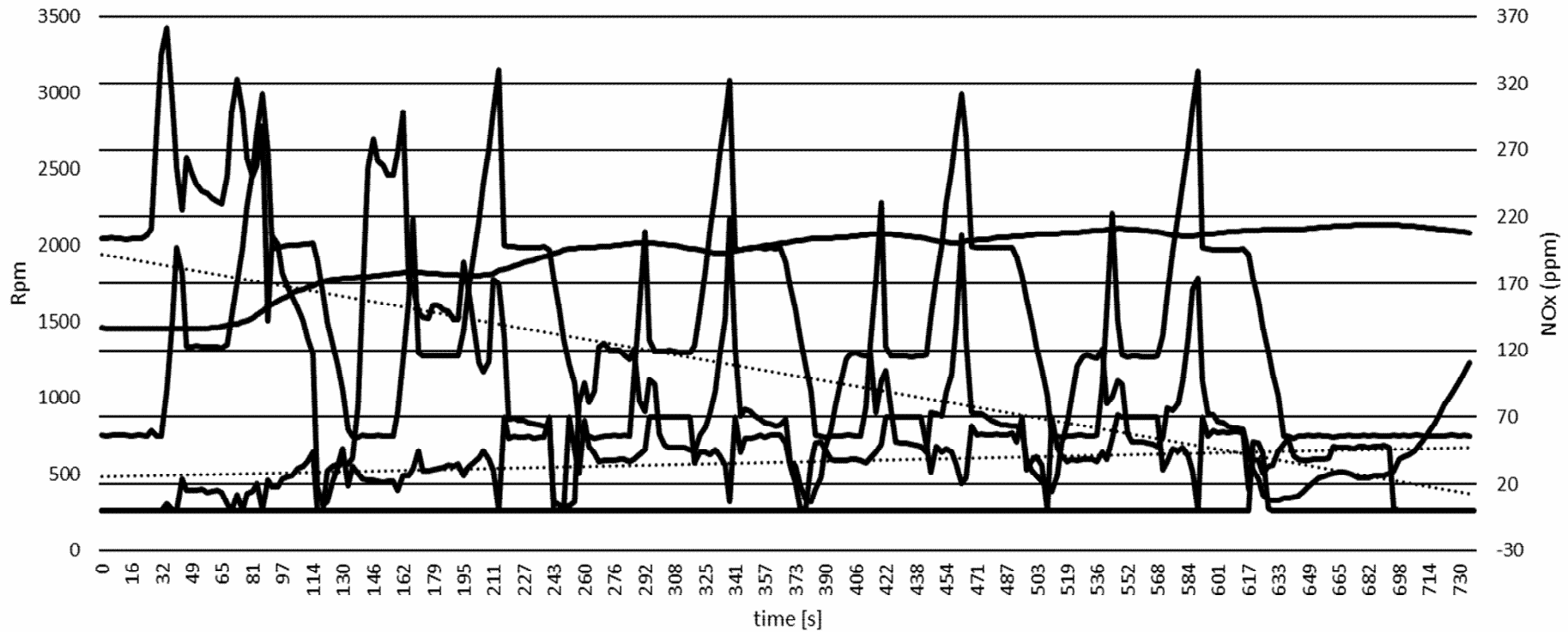
## Main findings:

- Concentrations of NO<sub>x</sub> between 50 ppm and 600 ppm
- Average NO<sub>x</sub> is decreasing from Euro 3 to Euro 6, but not in correlation with type approval
- Condition of vehicles was not known (e.g. software concept, SCR-temperature)
- Reasons for the wide spread of concentrations could be:
  - ∅ Failure condition of components or engine (deterioration or manipulation)
  - ∅ Legal reduction or switch off of the operation
  - ∅ Vehicle not sufficient conditioned (e. g. temperature)
  - ∅ Regeneration phase

The **ASM2050** shows promise for a **periodic emission test**. **Comprehensive information** regarding the after treatment systems and the software strategy (function) are necessary to evaluate the systems.

# 3.1.2 Laboratory tests ASM 2050 (diesel vehicle EURO 6)

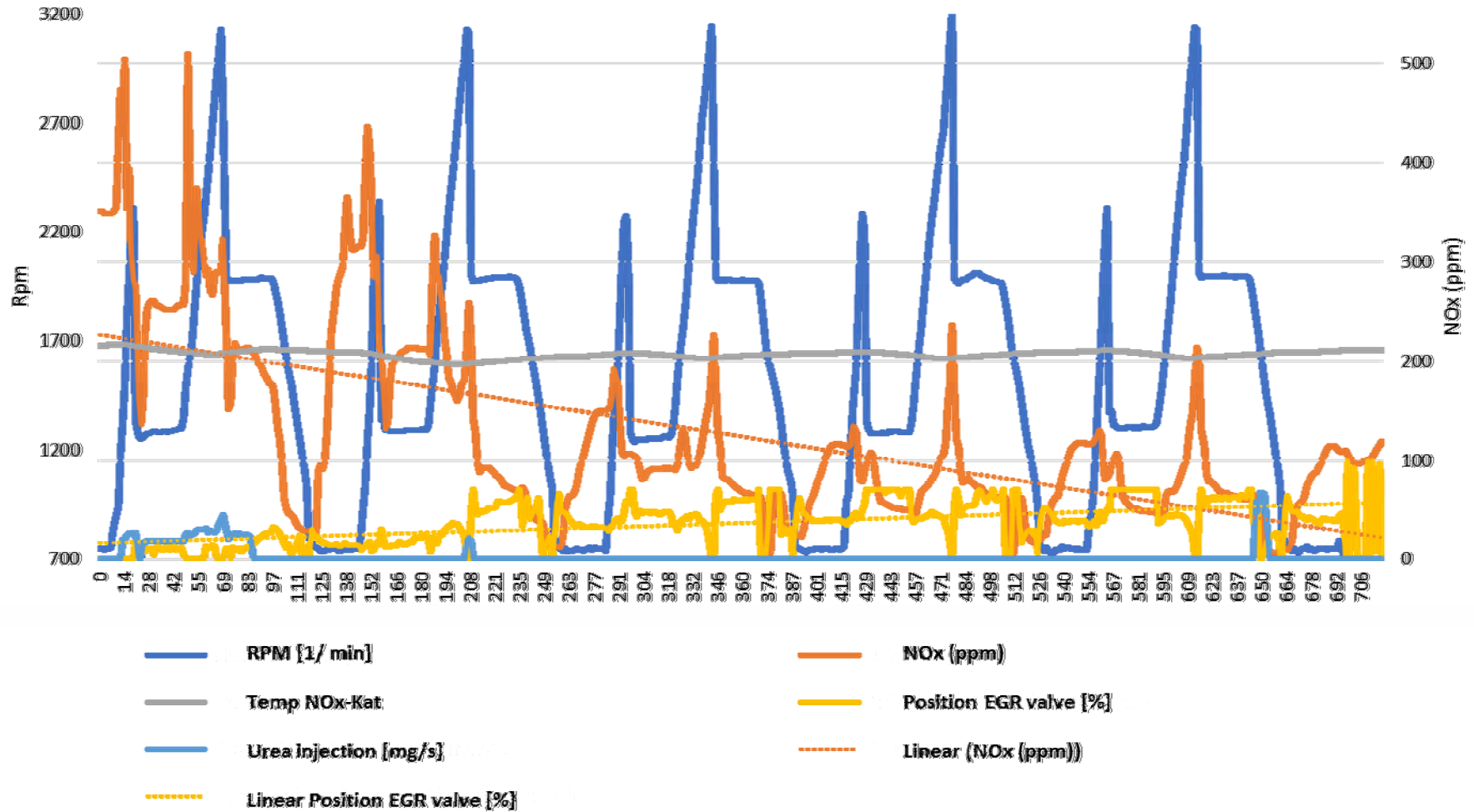
## EGR + SCR, without Failure, 200N



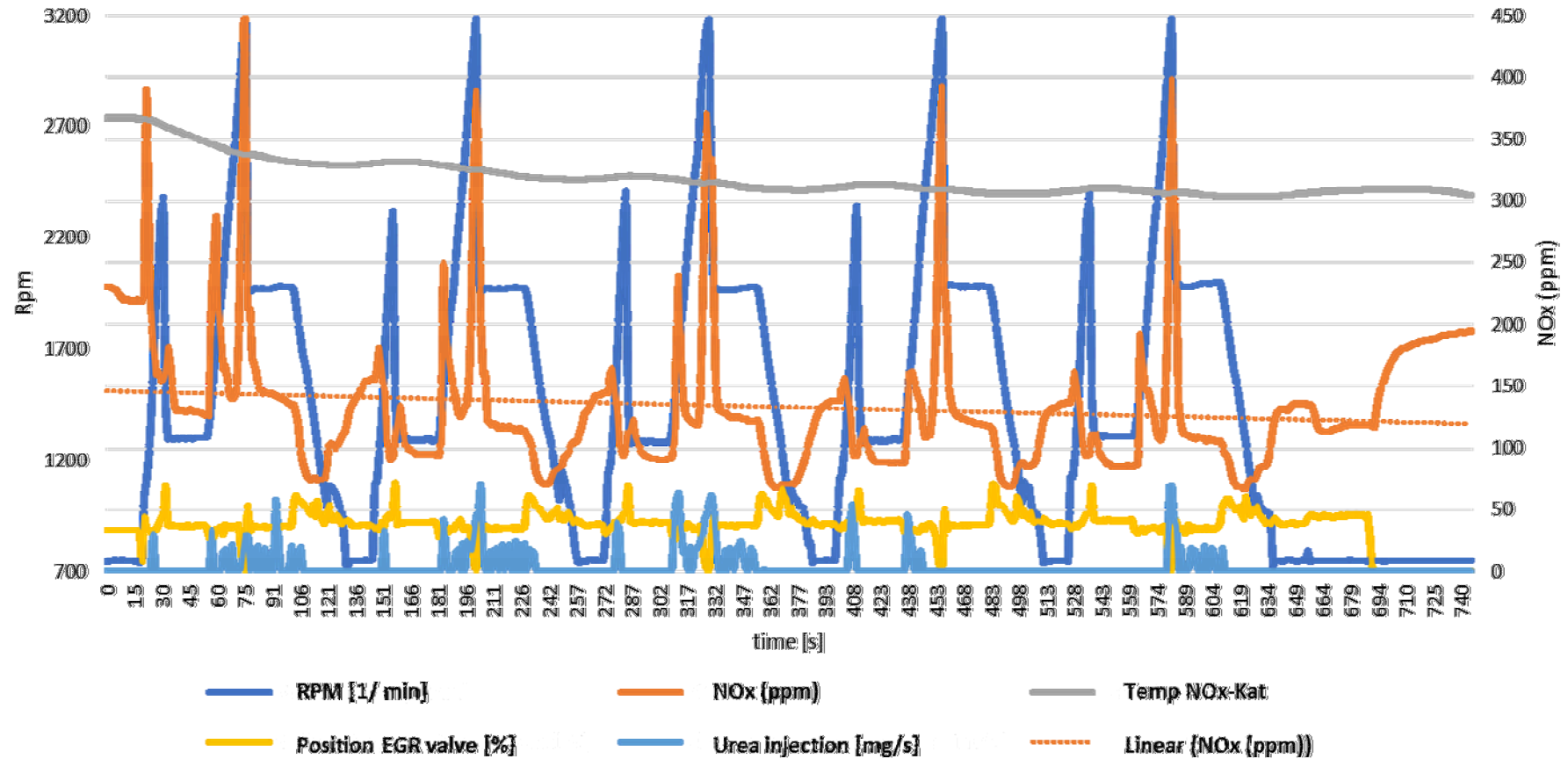
- n RPM [1/ min]
- NOx (ppm)
- Temp NOx Kat
- Position EGR Valve [%]
- EGR injection [mg/s]
- Linear (NOx (ppm))
- ..... Linear (Position EGR Valve [%])



## EGR + SCR, with failure SCR, 200N



## EGR + SCR, with failure SCR, 1000N

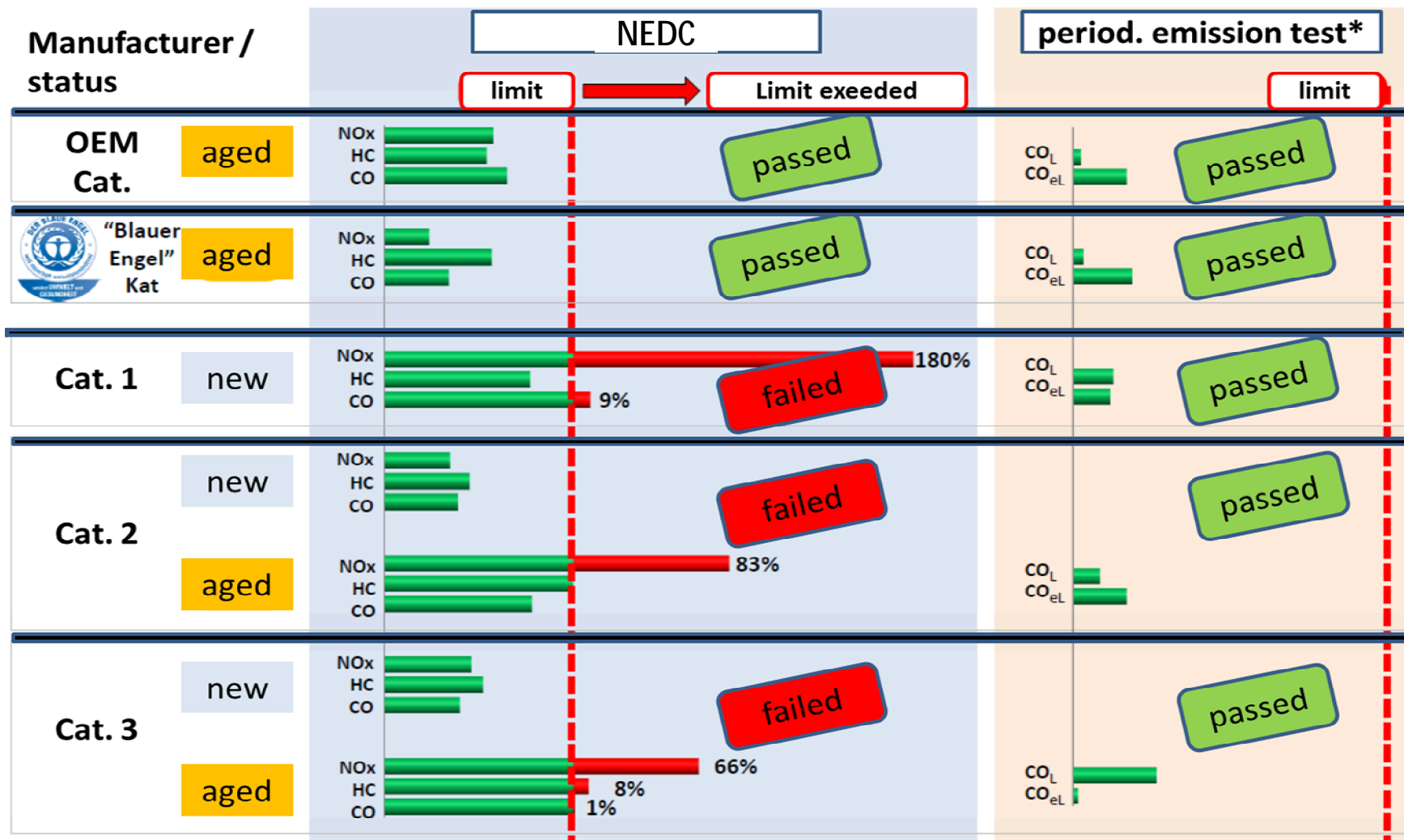


## Main findings:

- With a load of 200 N
  - ∅ only EGR is working
  - ∅ EGR is reducing most of NO<sub>x</sub> emissions
- With a load of 1000 N
  - ∅ the EGR rate and the urea injection are significantly high
  - ∅ EGR is not able to reduce NO<sub>x</sub> sufficiently
- Different after treatment systems interact

To evaluate the different **NO<sub>x</sub> emission** systems during a ASM2050 cycle a **minimum load is necessary**.

### 3.2 Petrol emissions 3-way catalysts: tests of TÜV NORD



\*Messung der CO-Gehalts in Volumenprozent im Leerlauf (L) bei ca. 850 [1/min] mit einem Grenzwert von 0,3 Vol.% und im erhöhten Leerlauf (eL) bei 2.500 bis 3.000 [1/min] mit einem Grenzwert von 0,2 Vol.%. Messergebnisse des TÜV Nord; August 2015. Prüfstandsmessung nach Alterung des EEC Systems nicht durchgeführt, da bereits im Neuzustand durchgefallen. Prüffahrzeug: Euro-4 mit Ottomotor

## Main findings:

- The current periodic emission test procedures are not able to detect deteriorated or manipulated 3-way catalysts of petrol vehicles
- To measure only CO is not sufficient
- A loaded test seems applicable for a proper evaluation of a 3-way catalyst

Also emission systems of **petrol vehicles** need to be tested periodically with a **loaded test**.

## **4. Recommendation**

- There is an urgent need to **adopt the periodic emission test** to the development of modern **petrol and diesel vehicles**:
  - to develop meaningful **loaded emission measurement procedures** and thresholds
  - to include **NO<sub>x</sub>- and PN-** measurements
  - to use improved **diagnostic tools** and **extensive information via EOBD** in a standardized version
- Specific **reference values** for later periodic emission tests should be defined at the time of type approval (Euro 6 and further)
- **Vehicle specific information** provided by the OEM
- Efforts are needed against sale of **tampering devices**



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