Chapter 6

Euro 6 engine
# Emission improvement

**Euro 6**

## Toxic content

<table>
<thead>
<tr>
<th>Toxic content</th>
<th>Unit</th>
<th>From</th>
<th>To</th>
<th>Decreased by</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (Carbon Monoxide)</td>
<td>g/kwh</td>
<td>1.5</td>
<td>1.5</td>
<td>-</td>
</tr>
<tr>
<td>HC (Hydrocarbon)</td>
<td>g/kwh</td>
<td>0.5</td>
<td>0.1</td>
<td>80%</td>
</tr>
<tr>
<td>Nox (Nitrogen oxides)</td>
<td>g/kwh</td>
<td>2.0</td>
<td>0.4</td>
<td>80%</td>
</tr>
<tr>
<td>PH (particles)</td>
<td>g/kwh</td>
<td>0.02</td>
<td>0.01</td>
<td>50%</td>
</tr>
<tr>
<td>Smokes</td>
<td>m-1</td>
<td>0.5</td>
<td>0.1</td>
<td>80%</td>
</tr>
</tbody>
</table>

## General features:

1. **New EDC 17**
2. **EGR + Double stage Turbo charger + low temperature cooling system**
3. **AdBlue concept**
4. **A Selective Catalytic Reduction (SCRT). (Truck)**
Design innovations with the D20/D26 EU V SCR

- Electrically controlled charge-air throttle valve
- Electrically controlled exhaust gas recirculation
- Two-stage charging, high-pressure/low-pressure turbo charger
- Two-circuit cooling system with air/water intercooling
- Water-bearing engine support
- Separation of oil mist in the blow-by-gas due to centrifugal force (disc separator)
- Dethrottling of distributor housing and thermostat housing, silicate cartridge
- Ring fan Dm. 810 with corresponding fan clutch
- Flame-start system with electronic relay
- Raw NOX sensor fixed to the engine
- Disengageable air compressor
- Exhaust gas aftertreatment with particulate filter and SCRT
Euro 6 engine views
Front side
**Engine views**
Component overview, right side. D2676LF25 SCRT

- EGR module with electric adjusting cylinder
- Turbo charger (HP/LP)
- Oil module with disc separator
- Single-flow coolant pump for low-temperature/high-temperature circuit
- Exhaust manifold with HCI metering point
- Injection unit HCI
- HCl fuel line
- Coolant lines, low-temperature circuit
- High-pressure intercooler
- Isolated exhaust piping
- NO\textsubscript{x} sensors
- HCI proportional valve

[Diagram of engine components]
Engine views
Component overview, left side, D2676LF25 SCRT

- Thermostat housing with silicate cartridge
- Low-temperature circuit line to vehicle radiator
- Electronic relay Flame-start system
- Drive housing
- High pressure pump
- Low-temperature circuit piping
- Temp. sensor (EGR)
- Injection lines
- Rail
- EDC17
- Charge-air pipe
- Charge-air throttle valve
EDC control unit task 3
Socket assignment

Chamber 1:
*Primarily* power supply, CAN, exhaust gas sensor systems/actuators

Chamber 2:
Empty at mainstream

Chamber 3:
*Primarily* engine sensors/actuators

Chamber 4:
Injectors
## Overview of transfers of functions

<table>
<thead>
<tr>
<th></th>
<th>PTM</th>
<th>ZBR</th>
<th>EDC17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame-start system</td>
<td>OLD</td>
<td>-</td>
<td>NEW</td>
</tr>
<tr>
<td>Engine brake</td>
<td>OLD</td>
<td>-</td>
<td>NEW</td>
</tr>
<tr>
<td>Fan control</td>
<td>OLD</td>
<td>-</td>
<td>NEW</td>
</tr>
<tr>
<td>Sensing of oil level</td>
<td>OLD</td>
<td>-</td>
<td>NEW</td>
</tr>
<tr>
<td>Oil-pressure warning</td>
<td>-</td>
<td>OLD</td>
<td>NEW</td>
</tr>
<tr>
<td>Coolant temperature warning</td>
<td>-</td>
<td>OLD</td>
<td>NEW</td>
</tr>
</tbody>
</table>
Cooling system – silicate depot
View from the front
Silicate depot

Designed for the service life of the engine
Replaceable silicate cartridge
Chapter 7

Euro 6 Dust Particle Filter maintenance
Selective Catalytic Reduction (SCR)

1. DOC
2. CRT / DPF
3. Mixing Tube
4. SCR
5. AMOX
Selective Catalytic Reduction (SCR)

1. Diesel oxidation catalyst (DOC)
   - Formation of NO2 for CRT effect in the DPF
   - Catalytic combustion of hydrocarbons for regeneration
2. Diesel particulate filter (DPF/ CRT):
   - Separation of soot and ash
3. Hydrolysis catalytic converter (mixing tube):
   - Evaporation of the AdBlue®
   - Mixing with exhaust gas
   - Conversion of AdBlue® into ammonia NH3 and CO2
4. SCR catalytic converter:
   - Conversion of nitrogen oxides into nitrogen and water
5. AMOX (ammonia oxidation catalyst):
   - Catalyst coating on SCR catalytic converter to avoid NH3 slip
   - Excessive NH3 will be trapped and converted to N2 + H2O
Temperature and Pressure sensors mounted on SCR

![Diagram of SCR with labeled temperature and pressure sensors](image-url)
To detect blockage of DPF

Measurement of differential pressure prior to and behind DPF = 0-800 mbar

From engine

\[ \text{NO}_{x1} \rightarrow \text{DOC} \rightarrow \text{DPF} \rightarrow \text{SCR} \]

\[ \text{AdBlue} \rightarrow \text{Mixing tube} \rightarrow \text{N2 + H2O} \]
HCI (Hydrocarbon Injection)

- Metering unit
- Coolant distributor

- Diesel injection into exhaust gas
- Water-cooled injection nozzle
HCI (Hydrocarbon Injection)

Metering unit for HCI

Fuel line

Coolant return line

Coolant supply line

HCI injection nozzle with coolant lines
HCI (Hydrocarbon Injection)
HCl (Hydrocarbon Injection)

Fuel from the fuel service centre

Fuel to the injection nozzle

Coolant supply line

Fuel injection nozzle

Coolant return line
HCl (Hydrocarbon Injection)

MU= metering unit __ Metering unit for HCl

- Shut-off valve
- Return line pressure sensor
- Metering valve
- Supply line pressure and temperature sensor
DPF regeneration
Phase 1 – Passive regeneration

No indication

Phase 2 – Active regeneration

Exhaust temperature above configurable threshold & speed below configurable threshold

Check lamp – "High exhaust temperatures"

Yellow
Phase 3 – Warning stage 1

The particulate load has exceeded a critical level or it has not been possible to complete regeneration successfully several times.

Display can be confirmed:

- Exhaust temperature above configurable threshold & speed below configurable threshold
- Check lamp – "Engine exhaust filter"
- Check lamp – "High exhaust temperatures"
Phase 4 – Warning stage 2 (regeneration while standing)

Filter load very critical (consequential damage to be expected) – regeneration while standing required

Check lamp – "Engine exhaust filter"

Display can be confirmed

Filter load very critical – regeneration while standing started by means of push button

Check lamp – "High exhaust temperatures"

Display cannot be confirmed

Exhaust temperature above configurable threshold & speed below configurable threshold
Phase 5 – Warning stage 3 (service regeneration)
Filter load very critical (consequential damage to be expected)
– Service workshop should be visited

Phase 6 – Engine protection functions

No specific DPF display
HD OBD – Heavy Duty On-Board Diagnosis
Function

• Permanent monitoring of functions and components of a vehicle that are relevant for emissions including injection system, exhaust-gas recirculation and exhaust-gas after treatment.

• Registering and flagging of considerable increases of emission during the entire operating time of the vehicle.

• Faults are indicated by a yellow warning lamp in the instruments panel, Malfunction Indicator Lamp (MIL).

• Storing data of occurred errors in form of P codes (Powertrain codes). This code is universal (manufacturer independent).

• Using International Standardized X200 socket (OBD socket), faults can be read out either with MANCats II in the form of SPN, or with external scanning tools in the form of P codes.
Emission related error memory in OBD

The OBD fault memory is designed as an additional integrated memory inside of the EDC control unit for the already existed and emission related errors.

- In Euro 5 engines with MAN AdBlue, these OBD fault memory is also copied into the AdBlue control unit as well.
- Emissions-related faults are always stored in the "normal" fault memory with the SPN error number, date and time and also stored in the OBD fault memory with the standardized 5 digits P code.
- The Malfunction Indicator Light (MIL) begins to illuminate at the same time when the error is stored in the OBD fault memory.
- After an emissions-related error is no longer actively present in the emissions system (except those NOx verification measurement), the MIL will continue illuminating for 3 more driving cycles or 24 hours of engine operating time before it is extinguished.
- If an error continues to be inactive, it will be classified as "OK" after 40 heating cycles or 100 operating hours, and will be deleted from the error memory.
MIL Malfunction Indicator Lamp

1 - Display of AdBlue supply (Euro5)
2 - Display of fuel supply

MIL will illuminate for max. 10 sec. after “Ignition on”, It will distinguish if no operation fault has been found.
MIL will provide difference information to the drive when:
• Lamp continuously on – warning of fault regarding emission related components connected to EDC, as well as Catalytic converter.
• Lamp flashing – warning of fault regarding Nox emission level, AdBlue tank level & quality, lambda probe or Nox sensor.
**HD-OBD development**

**OBD stages**

**OBD1a Euro 4**  
(first registration as from 10/2006)

**OBD1b Euro 4**  
(first registration as from 10/2007)

**MAN Exhaust gas After treatment**

- Exhaust limits: NOx < 7 g/kWh, particulate < 0.1 g/kWh by ESC cycle test
- monitoring of exhaust gas after-treatment to prevent "Major Functional Failure", e.g. whether a catalytic converter is fitted

For EGR engines, Lamda sensor is used in monitoring the NOx emission level. For AdBlue engines, NOx sensor is used.

- If Nox emission is 1.5g/kwh higher than limit → MIL flashes + Fault deletable memory will be kept for 400 days or 9600 hours.
- If Nox emission is > 7g/kwh → MIL flash + Different engine mapping to reduce Nox emission < 7g/kwh.
- If Urea tank is empty → MIL flash + Torque reduction immediately when engine in idle speed. Rated engine torque will be reduced down to 60% for >=16 tons vehicle, and down to 75% for <16tons vehicle.
- If electrical fault occurred with Urea level, Nox or lambda sensor → MIL flash + Rated engine torque will be reduced to 60% if problem is not fixed in 50 operation hours.
**OBD stages**

OBD 2 Euro 5  
(first registration as from 10/2009)

**MAN Exhaust gas After treatment**

In addition to OBD1b,
- Monitoring of the effectiveness of catalytic converters.
- If NOx emission is > 7g/kwh → MIL flash + torque is reduced to 60% or 75% (depending on the vehicle class) in addition to the flashing MIL if the fault is not rectified within 35 operating hours after indication.
- If the urea tank is empty the fault is displayed and torque is immediately reduced to 60% of engine torque as soon as idling speed has been reached. (empty AdBlue® tank and no pressure build-up in the supply module possible).

OBD 2 Euro 6  
(first registration as from 10/2014)

- Additional measures to ensure continuous monitoring of the exhaust gas management system, and these have far-reaching consequences for the customer:
  - Continuous monitoring of AdBlue® tank content, quality and consumption and the injection system as well as NOx values when driving

- More stringent on-board diagnosis for NOx deviations with driving restrictions in three warning stages
  - First stage: only visual alarm indication
  - Second stage: "Low level inducement" forces torque reduction to 75%
  - Third stage: "Severe inducement" forces creep mode at a maximum speed of 20 km/h
There are three escalation levels relating to the driving restriction:

1st level: Driver warning
- Visual alarm (Text message + Warning lamp)

2nd level: Low-level inducement
- Torque reduction to 75% after vehicle standstill

3rd level: Severe inducement
- Creep mode (< 20 km/h)
## 1. Driver warning

**Visual alarm : Text message displayed + Central warning Lamp Red (no MIL, no SPN)**

<table>
<thead>
<tr>
<th>Defects</th>
<th>Status</th>
<th>Text message displayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdBlue level</td>
<td>level &lt; 10 %</td>
<td>AdBlue system fault</td>
</tr>
<tr>
<td>AdBlue quality</td>
<td>after confirmed active fault (acknowledgeable)</td>
<td>AdBlue system fault</td>
</tr>
<tr>
<td>Reagent consumption</td>
<td>for 20% deviation (after max. 48 h or 15 l fuel consumption) (not acknowledgeable)</td>
<td>AdBlue system fault</td>
</tr>
<tr>
<td>Metering interruption</td>
<td>after confirmed active fault (acknowledgeable)</td>
<td>AdBlue system fault</td>
</tr>
<tr>
<td>Blocked EGR valve</td>
<td>after confirmed active fault</td>
<td>Exhaust system fault</td>
</tr>
<tr>
<td>Fault in monitoring system</td>
<td>after confirmed active fault</td>
<td>Exhaust system fault</td>
</tr>
</tbody>
</table>
2. Low-level inducement

Torque reduction to 75% after vehicle standstill

- AdBlue level: Level < 2.5%
- AdBlue quality: > 10 h after confirmed active fault (debounced)
- Reagent consumption: > 10 h after possible fault (not debounced)
- Metering interruption: > 10 h after confirmed active fault (debounced)
- Blocked EGR valve: > 36 h after confirmed active fault
- Fault in monitoring system: > 36 h after confirmed active fault
3. Severe inducement

Creep mode (< 20 km/h)

- AdBlue level
  Level between 2.5%...0% (empty tank)
- AdBlue quality:
  > 20 h after confirmed active fault
- Reagent consumption:
  > 20 h after possible fault (not debounced)
- Metering interruption
  > 20 h after confirmed active fault (debounced)
- Blocked EGR valve
  > 100 h after confirmed active fault
- Fault in monitoring system:
  > 100 h after confirmed active fault
**Low level**

1. Level $< 10\%$  
**EDC17 SPN 3456**

- Display can be confirmed

2. Level $2.5 < X < 10\%$  
**EDC17 SPN 3457**

- Display can be confirmed

Automatic switchover to AdBlue® level

AdBlue® level display is maintained
Low level

3. Level < 2.5% + vehicle standstill
   Engine torque reduction:
   - Display can be confirmed

4. Level = 0% + after parking the vehicle
   Creep mode:
   - Display can be confirmed

→ The AdBlue® level display is maintained (even if the fuel level falls into the reserve range)
→ Manual switchover to fuel display is possible for 3 seconds
Inadequate AdBlue quality: metering interruption/implausible consumption

1. Upon detection

- Display can be confirmed

2. 10 h engine operating hours after detection + vehicle standstill

   Engine torque reduction:

   - Display can be confirmed

3. 20 h engine operating hours after detection + after parking the vehicle

   Creep mode:
Thank you for your attention