The new Iran Heavy Duty Diesel Environmental Regulation

Karsten Mathies, TÜV Hessen
Prof. Vahid Hosseini, AQCC Tehran

19th ETH-Conference on Combustion Generated Nanoparticles
June 28th – July 1st, 2015 ETH Zürich, Switzerland
Private Public Partnership for elimination of ultrafine particle emissions in Iran

Proposals for Detailing the Cabinet of Ministry’s Decision

IRAN PEEV: Iran Particle Emission Enhanced Vehicles

Compression Ignition Commercial Vehicles DPF Proposal  Regulation for new Heavy Duty Vehicles
Motivation

Tehran annual PM emission sources

Reference: "Ultrafine particles, black carbon and soot emissions in Tehran", Vahid Hosseini, Ph.D. FCE, Sharif University of Technology, Tehran Air Quality Control Co., The first public private partnership (PPP) for clean diesel future in Iran, April 15th, 2015, BoostaneGoftegoo, Tehran, I.R. Iran
Iran Status and Solution

- Can not introduce EURO VI within at least 2 years for Heavy Duty because of
  - Fuel quality
  - Technology Level in Industry
- Following Emission steps EURO 1-2-3-4-5-6 takes a long time and creates no benefit for Ultra-Fine-Particle Emission up to EURO VI
- Iran must act now, because of the PN particulate air pollution problem.

Solution: Not the holistic approach: from EURO III to EURO IV, but pick and choose elements from EURO emission regulations that match the requirements for Industry feasibility and UFP particle emission limitation:

- PN Emission Limit from EURO VI (& PN instrument and procedure definition)
- PM Emission Limit from EURO IV
- Gaseous pollutant from EURO III
- ++ stay with European regulation elements to use existing experience, known processes and lab equipment
How to implement a new HD DPF regulation: The stakeholder process

The solution for this problem can only be solved to get all major stakeholders to one negotiating table, to cover:

- How to define an emission legislation with PN Limit additional to a non current EURO HD standard
- The issue of potential high sulphur content diesel fuel of domestic production
- Protection of the national motor vehicle production
- Importation of European and Japanese engine manufacturers with “CKD” ”completely knocked down” vehicle production in Iran or from outside countries
- Interests of environmental Iran organizations like AQCC, the Air Quality Control Company of Tehran and “DOE” the Department of Environment” for Iran
- Interests of the Ministry of Industry
- Organisation for the domestic Industry and
- Representatives of the domestic and foreign engine producers.

The stakeholder process produced proposal for „hard facts“ successfully after 2 PPP Stakeholder Meetings:
The stakeholder process II

Moderation and Drafting Proposal by TÜV SÜD

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>OEM International</th>
<th>OEM IRAN</th>
<th>Associations Authorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daimler</td>
<td></td>
<td>Iran Khodro Diesel</td>
<td>DOE</td>
</tr>
<tr>
<td>Scania</td>
<td></td>
<td>Saipa Diesel</td>
<td>MOI</td>
</tr>
<tr>
<td>Isuzu</td>
<td></td>
<td>Bahman</td>
<td>AQCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VERT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Iran manufacturing Association</td>
</tr>
</tbody>
</table>
Structure of Guidance Documents

Four Guidance Documents for the DPF Regulation drafted for discussion to outline the structure for new engine certification:

- Heavy Duty Truck and Bus Iran Production
- Light Duty Commercial Vehicle Iran Production
- Heavy Duty Truck and Bus Import
- Light Duty Commercial Vehicle Import

Table: BUS* TYPE M3 Class I & II with earlier application Date *2001/85/EC Bus Directive
**IRAN III PEEV PARTICULATE EMISSION ENHANCED VEHICLE**
**IRAN PRODUCTION VEHICLES**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck N2, N3</td>
<td>Bus* M2 Class A,B; M3 Class III (Coach)</td>
<td>March 21st, 2017</td>
</tr>
</tbody>
</table>

**ENGINE TYPE:** COMPRESSION IGNITION ONLY

**Application Type Date:** ISSUE LICENSE PLATE BY POLICE

**Reference Fuel:** EURO III; max. 300ppm Sulphur

**Emission Limits:**

<table>
<thead>
<tr>
<th>Test Cycle *2)</th>
<th>CO [g/kWh]</th>
<th>NOx [g/kWh]</th>
<th>THC [g/kWh]</th>
<th>NMHC [g/kWh]</th>
<th>PM [g/kWh]</th>
<th>PN*1) [#/kWh]</th>
<th>Smoke [m^-1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC</td>
<td>2,1</td>
<td>5,0</td>
<td>0,66</td>
<td>--</td>
<td>0,02</td>
<td>1E12</td>
<td>--</td>
</tr>
<tr>
<td>ETC</td>
<td>5,45</td>
<td>5,0</td>
<td>--</td>
<td>0,78</td>
<td>0,03</td>
<td>1E12</td>
<td>--</td>
</tr>
<tr>
<td>ELR***</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>Not required</td>
</tr>
</tbody>
</table>

*1) Definition of particle number measurement equipment and result calculation from ECE-R49-06, annex 4
*2) Test cycles according to ECE-R49-05, annex 4A: ESC, ETC
IRAN III PEEV PARTICULATE ENHANCED ENVIRONMENTAL VEHICLE

**VEHICLE CATEGORY:** All Heavy Duty N2, N3, M2 and M3

**ENGINE TYPE:** COMPRESSION IGNITION ONLY

**Deterioration Factors DF* **:**

<table>
<thead>
<tr>
<th>Test Cycle</th>
<th>CO</th>
<th>NOx</th>
<th>THC</th>
<th>NMHC</th>
<th>PM</th>
<th>PN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC</td>
<td>1,1</td>
<td>1,05</td>
<td>1,05</td>
<td>--</td>
<td>1,1</td>
<td>1,0</td>
</tr>
<tr>
<td>ETC</td>
<td>1,1</td>
<td>1,05</td>
<td>1,05</td>
<td>--</td>
<td>1,1</td>
<td>1,0</td>
</tr>
</tbody>
</table>

* DPF Durability from ECE-R132 or FOEN/SN277206 Approval
**Emission Durability or Fixed DF from table
Euro III PEEV for Iran

- IRAN follows EU system for WVTA whole vehicle type approval system.
- Heavy Duty Emissions are a system approval and follow 2005/55/EC as base.
- There will be two choices of possible ways to obtain a system approval set for an updated of the motor vehicle type approval:
  - Choice Annex OE (OEM): this a the set of system approvals for an Iran domestic vehicle manufacturer that uses an Iran domestic engine manufacturer that develops and certifies an engine system equipped with wall-flow DPF.
  - Choice Annex OF (Option-Fit): this a the set of system approvals for an Iran domestic vehicle manufacturer that uses a base EURO III certified engine, where he does not own the engineering rights and production and engine certification, but engineers the wall-flow DPF application for the vehicle application. This may include minor engine modifications, deleting of certified catalysts (DOC), mufflers and exhaust components.
Type OF (Option-Fit DPF) System Approvals

Those vehicles use base EURO III certified engines, that are obtained in this base EURO III condition. In order certify and possibly verify the emissions of those engines, the base engine certification remains intact. Possible engine and vehicle changes are certified with the other approvals, DPF emissions are certified with ISIRI 6746 Annex OF

<table>
<thead>
<tr>
<th>ISRI IRAN INSO Standard</th>
<th>DOE Approval</th>
<th>ECE Directive Equivalent</th>
<th>EEC Approval Directive Equivalent</th>
<th>Certification</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>6924-02 * * * * * * * * *</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>WVIA IRAN Whole vehicle type approval</td>
<td>1</td>
</tr>
<tr>
<td>4243 * * * * * * * * *</td>
<td>--</td>
<td>R51-02</td>
<td>70/157/EEC</td>
<td>Noise *2)</td>
<td>2</td>
</tr>
<tr>
<td>6746</td>
<td>--</td>
<td>R49-02</td>
<td>2005/55/EC</td>
<td>Base Engine EURO III</td>
<td>3</td>
</tr>
<tr>
<td>6746-01 Annex OF</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>DPF Application Emissions</td>
<td>4</td>
</tr>
<tr>
<td>6502 * * * * * * * * *</td>
<td>R10-02</td>
<td>72/245/EEC</td>
<td>EMC vehicle</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R10-03</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6673</td>
<td>--</td>
<td>R24-03</td>
<td>72/306/EEC</td>
<td>Diesel-Smoke in case of FBC application Approval</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Required (only for FBC)</td>
<td>SNR277206 / FOEN Approval</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6483 * * * * * * * * *</td>
<td>--</td>
<td>R85-00</td>
<td>80/1269/EEC</td>
<td>Engine Power</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 4: Newly required vehicle family approvals

*1) For new vehicle EMC approval including electronic DPF Control additional EMC approvals are not required
*2) Noise comparison test allowed
IRAN IV PEEV* PARTICULATE EMISSION ENHANCED VEHICLE: IMPORT VEHICLES

**VEHICLE CATEGORY: Application Date**
N1 Light Duty Vehicles May 22nd, 2015

**ENGINE TYPE:** COMPRESSION IGNITION ONLY; CDY CERT.

**Application Type Date:** ISSUE LICENSE PLATE BY POLICE

**Reference Fuel:** EURO IV; max. 10ppm Sulphur

**Emission Limits in TYPE I (NEDC) Test:**

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Group</th>
<th>Reference weight (RW) [kg]</th>
<th>CO [g/km]</th>
<th>NOx [g/km]</th>
<th>HC+NOx [g/km]</th>
<th>PM [g/km]</th>
<th>PN [#/km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1 Diesel</td>
<td>I</td>
<td>RW ≤ 1305</td>
<td>0,50</td>
<td>0,25</td>
<td>0,30</td>
<td>0,005</td>
<td>6E11</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>1305 &lt; RW ≤ 1760</td>
<td>0,63</td>
<td>0,33</td>
<td>0,39</td>
<td>0,005</td>
<td>6E11</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>1760 &lt; RW</td>
<td>0,74</td>
<td>0,39</td>
<td>0,46</td>
<td>0,005</td>
<td>6E11</td>
</tr>
<tr>
<td>N2, M2 Diesel</td>
<td>-</td>
<td>all</td>
<td>0,74</td>
<td>0,39</td>
<td>0,46</td>
<td>0,005</td>
<td>6E11</td>
</tr>
</tbody>
</table>

*EURO 5b 715/2007/EC or higher emission level acceptable (with PN Number E/M limit)
IRAN IV PEEV PARTICULATE EMISSION ENHANCED VEHICLE

VEHICLE CATEGORY: All Light Duty N1, N2, M2

ENGINE TYPE: COMPRESSION IGNITION ONLY

Deterioration Factors DF* ** for TYPE I NEDC Test:

<table>
<thead>
<tr>
<th>Test Cycle</th>
<th>CO</th>
<th>NOx</th>
<th>HC+NOx</th>
<th>PM</th>
<th>PN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEDC</td>
<td>1,1</td>
<td>1,0</td>
<td>1,0</td>
<td>1,2</td>
<td>1,0</td>
</tr>
</tbody>
</table>

* DPF Durability from ECE-R132 or FOEN/SN277206 Approval
** Emission Type V Durability 80,000 km or Fixed DF from table
Summary and Outlook

- IRAN has made in depth homework on emission monitoring, inventories, source apportionment and health effects. From this they have drawn a crystal-clear conclusion about PN being the air pollutant number one.
- This leads to the target to eliminate PN emission from all Diesel engines with DPF Technology as soon as possible. This must be implemented for all vehicles, domestic and import and also retrofitted to public transport buses.
- Fuel will remain a problem for some time. It is requested to come up with solutions for the current fuel quality situation. Waiting for ULSD is not an option.

New HD Emission legislation for Iran “Euro III PEEV” developed out of European regulation elements (EURO III to EURO VI) with the PN measurement from EURO VI being the most important. We see this DPF OEM Emission regulation as a role model for more countries with air pollution problems.

A Stakeholder process was used to adapt the regulation to the requirements, built a forum for discussion and broaden the support for the regulation.
Summary and Outlook II

With “Euro III PEEV” we will speed up introduction of low PN emitting Heavy Duty Vehicles, fulfill exactly what is required and – important – that we can implement it within the shortest possible time.

- We are open for: Exchange of emission regulation experience and ideas
- We offer: Help for Your emission regulation projects

- This shift we see as a big step forwards towards improving air quality
Discussions are welcome
Thank you for your attention

Contact:
Dr. Christof Gietzelt
cristof.gietzelt@tuevhusen.de
Karsten Mathies
karsten.mathies@tuevhusen.de

Prof. Vahid Hosseini
vhosseini@sharif.edu