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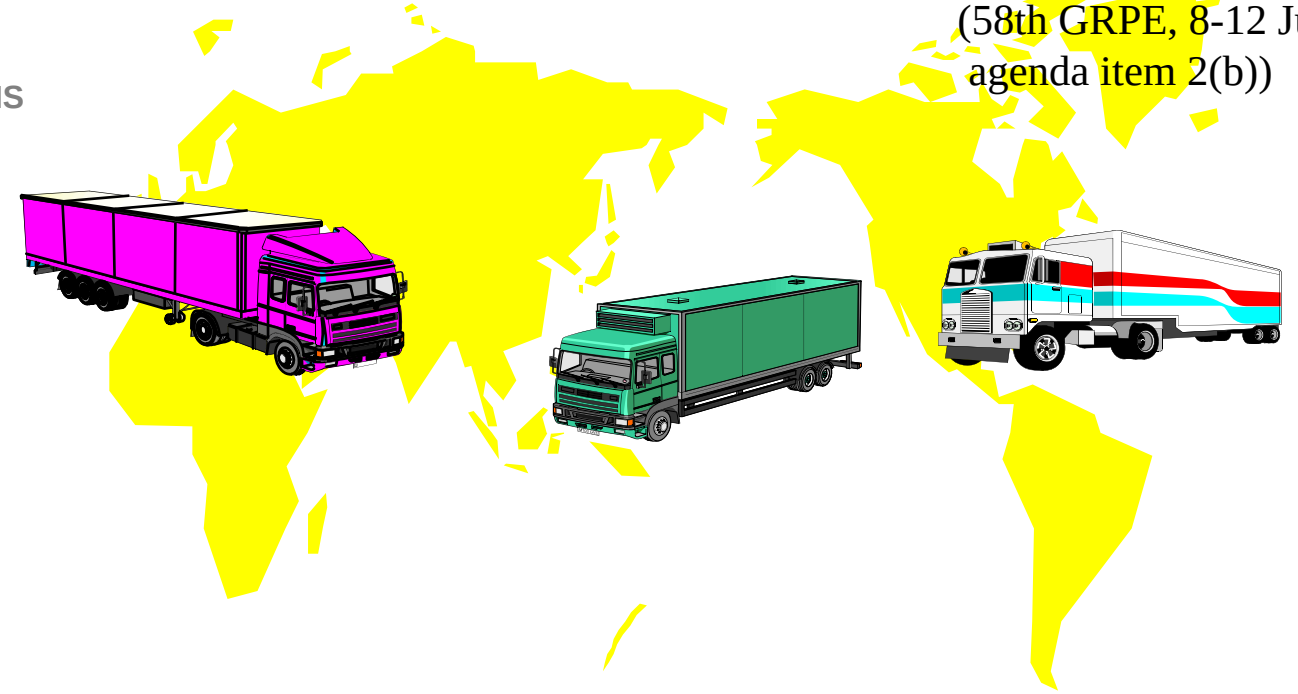
agenda item 2(b))



# Worldwide Harmonized Heavy Duty Emissions Certification Procedure

**58th GRPE, Geneva, 11 June 2009**

# General Overview

- **WHDC approval of document ECE/TRANS/WP.29/GRPE/10 achieved with respect to the following major elements**
  - **Option 1: New structure of § 6.3 (engine power) and new Annex 7**
  - **Option 5: PM measurement**
  - **New structure of § 7 (test procedures)**
  - **Introduction of analyzer drift correction**
  - **Provisions on crankcase gases**

- **WHDC could not reach agreement on the following aspects of Document ECE/TRANS/WP.29/GRPE/10**
  - **Option 2: USA disagreement with Annex 2**
  - **Options 3 and 4: test results not fully available, further discussion after GRPE 58 will be needed**
  - **Dilution air temperature**

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# Option 1 – Principles

- **General engine installation**

  Engine to be tested only with the auxiliaries or equipment listed in Annex 7. Other auxiliaries/equipment should be removed.

- **Auxiliaries/equipment required for the emissions test**

  If auxiliaries/equipment required for the test are not fitted, their power shall be subtracted from engine power

- **Auxiliaries/equipment not required for the emissions test**

  If auxiliaries/equipment not required for the test are fitted, their power may be added to engine power

- **Calculation of reference and actual cycle work must take into account auxiliaries/equipment power, if these are not fitted according to the list of Annex 7**

# Option 2 - Reference Fuel

- Introduction of average reference fuel that covers national reference fuel specifications (Annex 2) is not supported by EPA
- Possible alternatives to be decided by GRPE
  - go back to original gtr with 3 reference fuels (USA, EU, Japan)
  - widen specs of Annex 4 and allow CP's to apply tighter specs
- Test results on engine 2 (US07 engine) were presented by JRC
- Test results of SwRI program (US10 like engine) were presented by EMA
- Overall, influence of fuel on emissions was demonstrated to a more or lesser degree (depending on engine technology), which would not preclude acceptance of average reference fuel

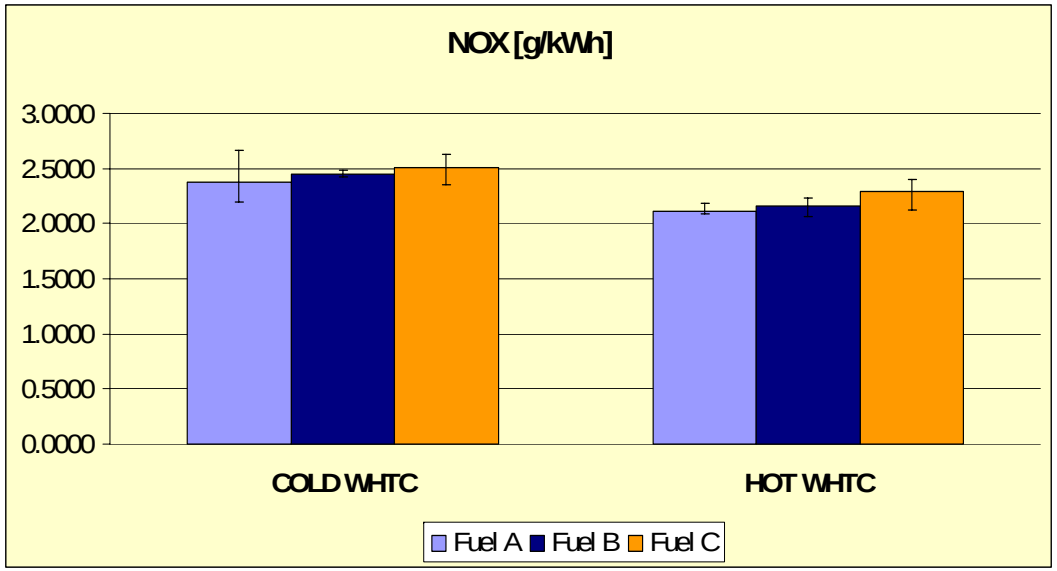
# Option 2 – EMA/SwRI NOx Results

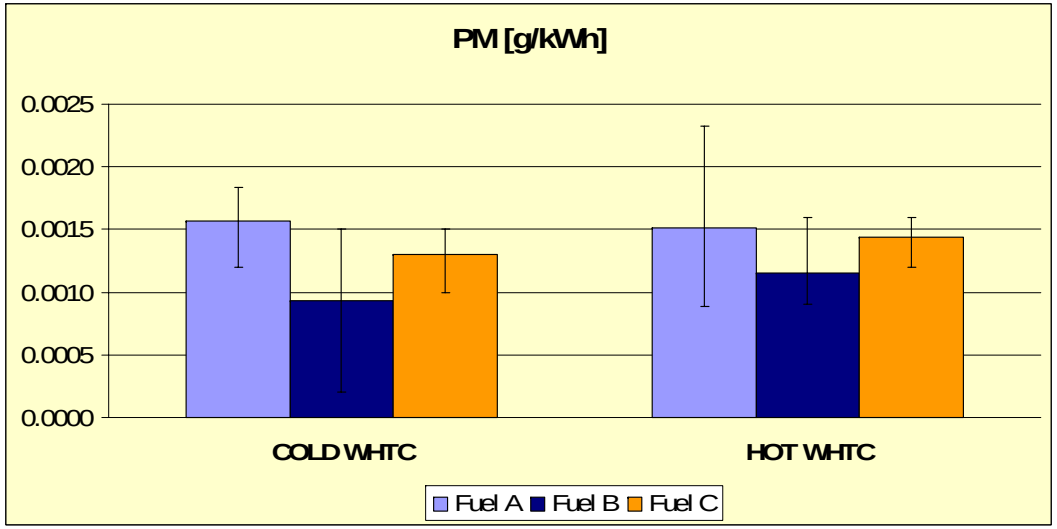
| Morning | | | Afternoon | | | Difference |
|---|---|---|---|---|---|---|
| Average | Stdev | CVar | Average | Stdev | CVar | |
| 0.119 | 0.0176 | 14.7% | 0.151 | 0.0043 | 2.9% | 0.031 |
| 0.190 | 0.0129 | 6.8% | 0.135 | 0.0145 | 10.8% | 0.055 |
| 0.095 | 0.0039 | 4.1% | 0.148 | 0.0075 | 5.0% | 0.053 |

| | **EU** | **U.S.** |
|---|---|---|
| Day 1 | 0.119 | 0.151 |
| Day 2 | 0.135 | 0.190 |
| Day 3 | 0.095 | 0.148 |
| **Average** | **0.117** | **0.163** |
| | | |
| Overall Stdev | 0.0208 | 0.0218 |
| Overall Cvar | 18% | 13% |
| | | |
| Final Difference | | 0.047 |

Emissions with US reference fuel are higher by about 30%

# Option 2 – JRC Results/Engine 2




Emissions with US reference fuel slightly higher for NOx, very similar for PM

# Option 3 – Hot Soak Period

- WP.29/AC.3 had agreed to exclude options 3 (hot soak period) and 4 (cold start weighting factor) from the current mandate
- Automotive industry (EMA/ACEA/JAMA) offered to EPA a test program with 4 engines on soak period in order to find solutions to option 3
- OICA indicated acceptance of the 14% cold start weighting factor in case of a compromise solution on option 3 (soak period)
- Test results of 2 engines were presented at 28th WHDC meeting
- Test results of the remaining engines are not available for GRPE 58
- WHDC is therefore asking GRPE to extend the timeline for further discussions
- Final solution might only be taken at November 2009 WP.29

# Option 3 – EMA/SwRI Results

| | Cold | Hot 1 | Hot 2 | Hot 3 | Hot 4 | Hot 5 | Hot 6 | Hot 7 | Hot 8 |
|---|---|---|---|---|---|---|---|---|---|
| Soak Length | | 10-min | 20-min | 10-min | 20-min | 10-min | 20-min | 10-min | 20-min |
| Day 1 | 0.628 | 0.145 | 0.156 | 0.099 | 0.131 | 0.090 | 0.119 | 0.079 | 0.115 |
| Soak Length | | 20-min | 10-min | 20-min | 10-min | 20-min | 10-min | 20-min | 10-min |
| Day 2 | 0.735 | 0.141 | 0.103 | 0.107 | 0.094 | 0.112 | 0.083 | 0.091 | 0.042 |
| | | 10-min | 0.092 | | | | | | |
| | | 20-min | 0.121 | 0.030 | | | | | |

- Hot-start conversion (1.27 g/hp-hr NOx Engine-out)
  - 10-min soak = 93 %
  - 20-min soak = 90 %

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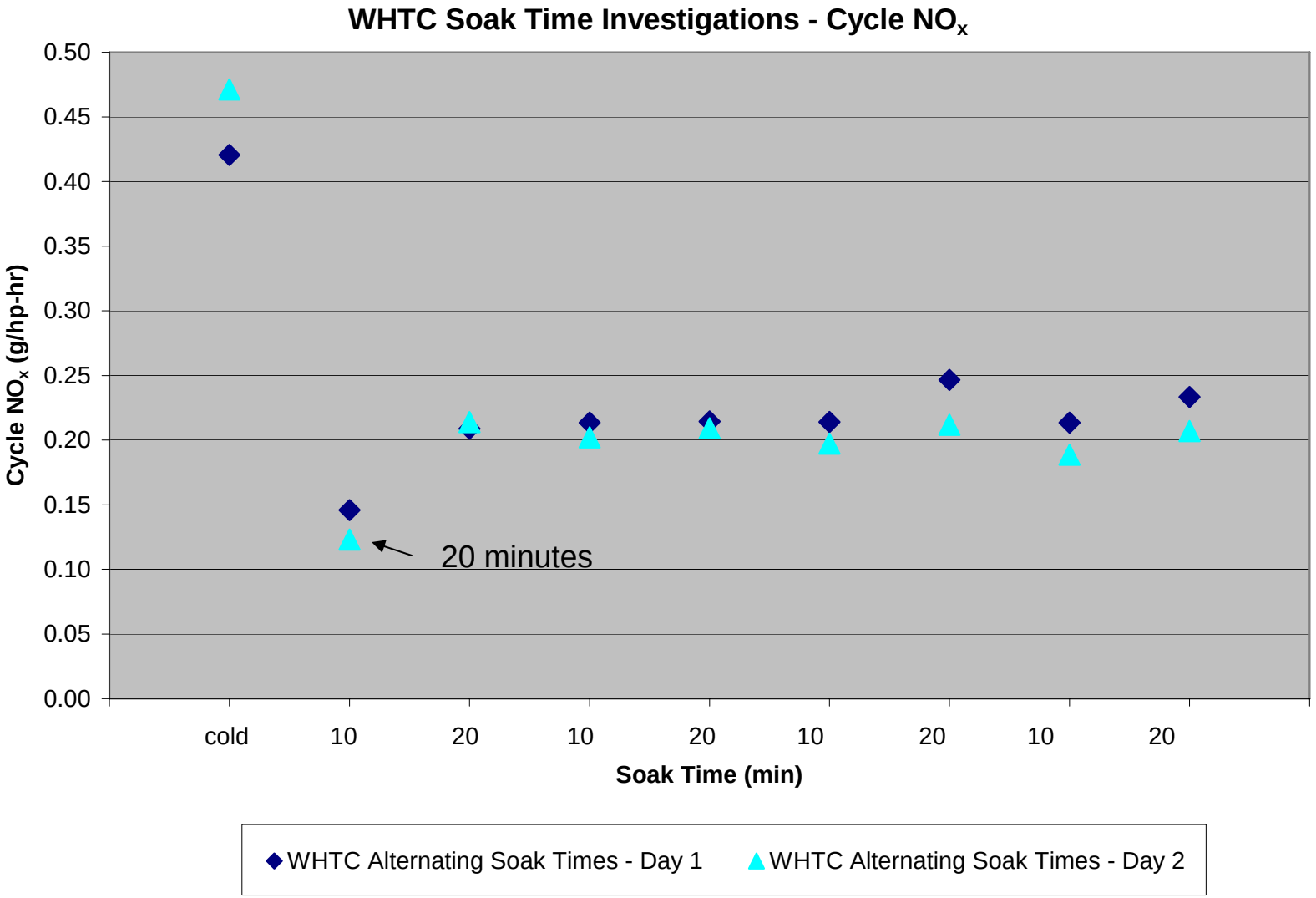
# Option 3 – DDC Results



# Option 5 – PM Measurement

**9.4.4.1.** Filter specification

All filter types shall have a 0.3 $\mu$m DOP (di-octylphthalate) collection efficiency of at least 99 per cent. The filter material shall be either:

(a) fluorocarbon (PTFE) coated glass fiber, or

(b) fluorocarbon (PTFE) membrane.

**9.4.4.2.** Filter size

**The filter shall be circular with a nominal diameter of 47 mm (tolerance of 46.50 ± 0.6 mm) and an exposed diameter (filter stain diameter) of at least 38 mm.**

# Comments and Corrigenda

- **Corrigenda approved by WHDC**
  - **EMA: correction to table 4**
  - **OICA: correction of references**
- **Proposal from Poland approved by WHDC**
  - **more accurate formulae for $CH_4$ and NMHC calculation**
  - **correction of NMHC u value in tables 5 and 6**
- **No further comments received**

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# NMHC/$CH_4$ Calculation

## The following formulae, which take the methane response factor into account, are proposed by Poland

Accurate formulae for calculation of the NMHC concentration

$$\frac{c^S_{HCW/O} \times (1 - E_M) - c^S_{HCW}}{E_E - E_M}$$ - (b)

$$\frac{(c^S_{HCW/O}) \times (1 - E_M) - c^S_{HCW} \times R_f \times (1 - E_M)}{E_E - E_M}$$ - (c)

$$\frac{c^S_{HCW/O} \times (1 - E_M) - c^S_{HCW} \times R_f}{E_E - E_M}$$ - (d)

Formula for calculation of methane concentration

$$\frac{c^S_{HCW} - c^S_{HCW/O} \times (1 - E_E)}{R_f \times (E_E - E_M)}$$ - derived

$$\frac{c^S_{HCW} - c^S_{HCW/O} \times (1 - E_E)}{E_E - E_M}$$ - GTR No. 4

$c^S_{HCW}$ - R.83.06

# Summary

- WHDC in conjunction with OCE is a major step forward for effectively controlling emissions from heavy duty vehicles
- Options 1 and 5 are solved
- Option 2 could not be solved by WHDC; two alternatives are presented to GRPE for discussion
- Option 3 (and 4) test results are not completely available; extension of timeline is requested for solving these 2 options
- GRPE approval is asked for
  - the proposed corrigenda
  - for introduction of more accurate NMHC/CH4 formulae proposed by Poland
- GRPE is asked to disband the informal group on WHDC, which has completed its mandate after 12 years of work and 28 meetings
- The WHDC group especially appreciates Dr. Cornelis Havenith, former chairman and mastermind of the WHDC process, for his contribution to global harmonization
- Chairman and secretary would like to thank all members of the group for their contributions to the success of this ambitious program