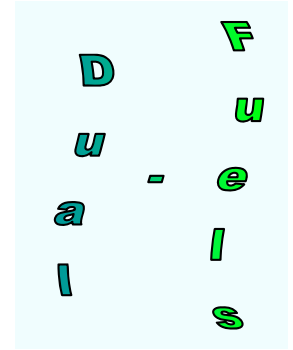


Informal document **GRPE-64-16**  
(64nd GRPE, 4 – 8 June 2012,  
agenda items 4(c))

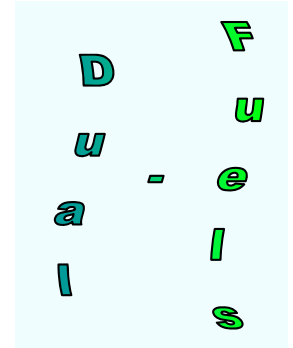


# Type Approval of EURO VI Dual-fuel engines and vehicles

GFV status report to GRPE 64 (June 2012)

Henk Dekker and Jean-Francois Renaudin

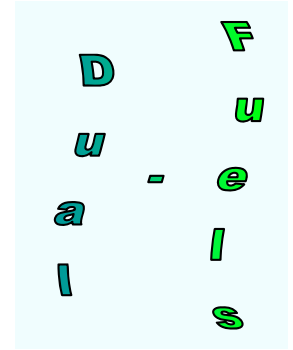
# Provisions for type-approving EURO VI Dual-Fuel engines and vehicles



On the basis of informal documents GRPE-63-21 and GRPE-62-17, GFV and the HDDF-TF developed 5 documents that constitute the proposal submitted to GRPE

- Working Document ECE/TRANS/WP29/GRPE/2012/13 containing the essential supplements to enable the type-approval of dual-fuel engines and vehicles
- Informal document GRPE-64-17 containing corrigenda to the working document
- Informal document GRPE-64-18 containing the missing appendices (calculation formulae) in the working document
- Informal document GRPE-64-19 containing a consolidated version of the 3 previous documents
- Informal document GRPE-64-20 containing the necessary amendments to R85 (power)

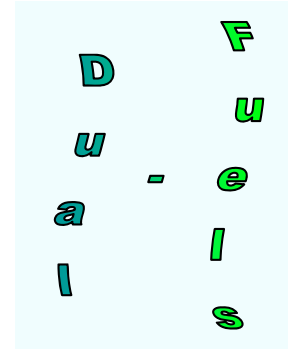
# Amendments to rev.6 of Regulation 49



- Amendments to the main body
- Amendments to the existing Annexes
- Introduction of the dual-fuel dedicated Annex

# Amendments to rev.6 of Regulation 49

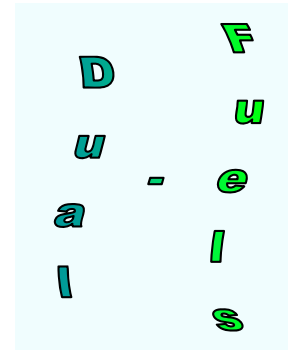
## Amendments to the main body



- Definitions of dual-fuel engines and vehicles and of their operating modes
- Obligation for dual-fuel engines and vehicles to comply with Annex 15
- Allowance of a fuel specific type-approval in case of engines fuelled with liquefied natural gas / liquefied biomethane (LNG)
- Labelling of dual-fuel engines and vehicles
- Installation requirements in case of dual-fuel engines approved as separate technical units
- Extension to include a new engine system into an engine-family
- Summary of the approval process in case of dual-fuel engines

# Amendments to rev.6 of Regulation 49

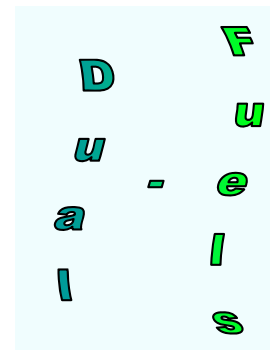
## Amendments to the existing Annexes



- Annex 1: adaptation of the information documents to include dual-fuel engines and vehicles
- Annexes 2A and 2C: adaptation of the communication sheets to include dual-fuel engines and vehicles
- Annex 3: extension of the approval marks
- Annex 4: correction of some equations
- Annex 5: introduction of  $G_{20}$  as reference fuel (for LNG)
- Annex 9B: consideration of dual-fuel specific OBD issues

# Amendments to Annex 4 of rev.6 of R49

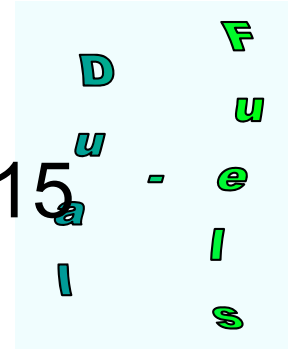
## Correction of some equations



- Some equations have been modified
  - to permit the calculation of emissions when testing dual-fuel engines
  - to avoid possible substantial errors due to the presence of a "," as "thousands" separator
- The use of a "," as thousands separator in the English version of rev.6 or R49 is conform to the guidelines for writing WP29 documents. However the experience shows that "volens nolens" it leads to substantial errors
- GFV wants to make GRPE aware of that fact.

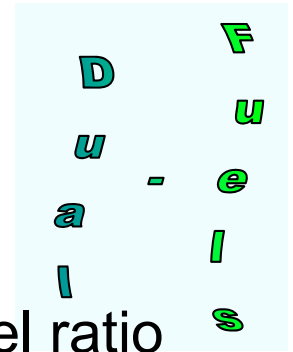
# Amendments to rev.6 of Regulation 49

## Introduction of the dual-fuel dedicated Annex 15



- Dual-fuel specific definitions
- Dual-fuel engine family concept
- Requirements to operate dual-fuel vehicles
- Dual-fuel specific indicators and warnings and associated tests
- Retrievable torque in case of dual-fuel vehicles
- OCE and in-use dual-fuel specific requirements
- Emission limits applicable to dual-fuel engines and vehicles
- Dual-fuel specific OBD and NOx control requirements
- specific requirements for LNG dual-fuel engines
- Additional calculation requirements for emission measurement (laboratory test)
- Additional calculation requirements for emission measurement (PEMS test)

# Annex 15 - Calculation of exhaust emissions (1)

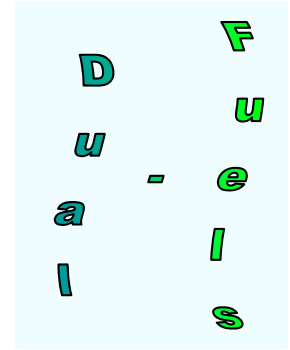


- Due to difficulties to determine the instantaneous gas/fuel ratio the calculation methods described in Annex 4 have been modified.
  - These modifications are introduced in Appendices 4 & 6 of Annex 15
- Especially the raw measurement methods have been changed, in particular
  - Type 1A & B in DF mode: the molar ratios and u-values are those of gaseous fuels,
  - Type 2A & B in DF mode: the tabulated values are based on a 50/50% mixture
  - Type 3B in DF mode: the molar ratios and u-values are those of diesel fuels

Note: These approximations will introduce a deviation compared to the theoretical value but have been considered to be acceptable (similar to those for stoichiometric Methane PI engines).

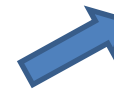


# Annex 15 - Calculation of exhaust emissions (2)



## Raw emissions calculation

$$u_{gas} \times \sum_{i=1}^{i=n} c_{gas, i} \times q_{mew, i} \times \frac{1}{f} \quad (\times k_{w,a})$$



Type I and III: Small errors by using fixed u-factors  
Type II: Mean fixed diesel/gas values give acceptable errors

u-value: all components are fuel dependent

## For analysers on dry basis

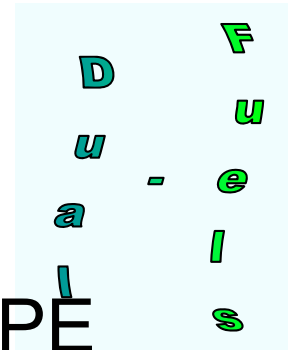
$k_{w,r}$  (dry/wet correction for  $c_{gas}$ ) is fuel dependent



Type I and III: Small errors by using fixed H/C ratio ( $\alpha$ )  
Type II: Mean fixed diesel/gas values give acceptable errors

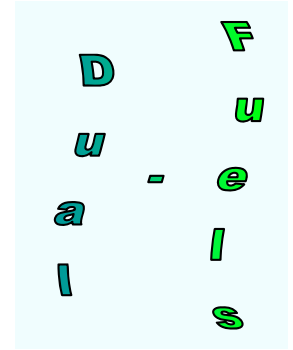
Also partial flow measurement is fuel-dependent but the error remains small due to high air excess with the precautions specified in Annex 15-Appendix 4.

# Amendments to R85



- An informal document was submitted to GRPE in June 2011
  - GFV received some suggestions from the PL delegation
  - Introduction of DF-specific definitions was pending their introduction in R49 (for consistency)
- Informal Document xx4 is submitted to GRPE
  - With the definitions as proposed in the amendments to Rev.6 of R49
  - PL comments were taken into considerations

# Summary regarding EURO VI Dual-Fuel engines



GRPE is kindly requested to consider and validate

- Working Document ECE/TRANS/WP29/GRPE/2012/13 containing the essential supplements to enable the type-approval of dual-fuel engines and vehicles
- Informal document GRPE-64-17 containing corrigenda to the working document
- Informal document GRPE-64-18 containing the missing appendices (calculation formulae) in the working document
- Informal document GRPE-64-19 containing a consolidated version of the 3 previous documents
- Informal document GRPE-64-20 containing the necessary amendments to R85 (power)