Submitted by the expert from OICA

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Agenda item 4(a)

Proposal for a new Supplement to UN Regulation No. 49 series 05 of amendments (Emissions of compression ignition and positive ignition (LPG and CNG) engines)

Submitted by the expert from the International Organization of Motor Vehicle manufacturers

The text reproduced below was prepared by the expert from OICA to correct the provisions described in current text of UN 49 series 05 of amendments.

The modification of the current text of UNR 49-05 are marked in bold for new or strikethrough for deleted characters.

I. Proposal

Annex 4B, paragraph 8.2.; amend to read:

"8.2. NOx correction for humidity

As the NOx emission depends on ambient air conditions, the NOx concentration shall be corrected for humidity with the factors given in paragraph 8.2.1. or 8.2.2. The intake air humidity Ha may be derived from relative humidity measurement, dew point measurement, vapour pressure measurement or dry/wet bulb measurement using generally accepted equations.

For all humidity calculations (for example Ha, Hd) using generally accepted equations the saturation vapour pressure is required. For calculating the saturation vapour pressure which is in general a function of the temperature (at the humidity measurement point) the equation D.15 specified in Annex D to ISO Standard 8178-4 should be used."

Annex 4B - Scope, paragraph 9.2; amend to read:

"9.2. Linearity requirements

…..

Table 7

Linearity requirements of instruments and measurement systems

Measurement system	$\chi min \times (a1 - 1) + a0$	Slope a1	Standard error SEE	*Coefficient of Determination* r^2
Engine speed	≤ 0.05 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Engine torque	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Fuel flow	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Airflow	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Exhaust gas flow	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Diluent flow	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Diluted exhaust gas flow	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Sample flow	≤ 1 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990

~~**Gas analyzers**~~ **Gas dividers**	≤ 0.5 % max	0.99 - 1.01	≤ 1 % max	≥ 0.998
~~**Gas dividers**~~ **Gas analyzers**	≤ 0.5 % max	0.98 - 1.02	≤ 2 % max	≥ 0.990
Temperatures	≤ 1 % max	0.99 - 1.01	≤ 1 % max	≥ 0.998
Pressures	≤ 1 % max	0.99 - 1.01	≤ 1 % max	≥ 0.998
PM balance	≤ 1 % max	0.99 - 1.01	≤ 1 % max	≥ 0.998
Humidity measurement device	**≤ 2 % max.**	**0.98 – 1.02**	**≤ 2 %**	**≥ 0.95**

”

Annex 4B, paragraph 9.3.3.1; amend to read:

“9.3.3.1 Pure gas
Hydrogen~~-helium~~ mixture (FID burner fuel)
(40 ± 1 per cent hydrogen, balance helium **or alternatively nitrogen, or argon**)
(Contamination ≤ 1 ppm C1, ≤ 400 ppm CO2)”

Annex 4A, Appendix 1 paragraph 5.3.; amend to read:

“5.3. NOx correction for humidity and temperature

As the NOx emission depends on ambient air conditions, the NOx concentration shall be corrected for ambient air temperature and humidity with the factors given in the following formulae. The factors are valid in the range between 0 and 25 g/kg dry air.

(a) For compression ignition engines:

$$k_{h,D} = \frac{1}{1 - 0.0182 \times (H_a - 10.71) + 0.0045 \times (T_a - 298)}$$

With:

Ta = temperature of the intake air, K
Ha = humidity of the intake air, g water per kg dry air

Where:

Ha may be derived from relative humidity measurement, dewpoint measurement, vapour pressure measurement or dry/wet bulb measurement using the generally accepted formulae.

(b) For spark ignition engines

$$k_{h,G} = 0.6272 + 44.030 \times 10^{-3} \times H_a - 0.862 \times 10^{-3} \times H_a^2$$

Where:

Ha may be derived from relative humidity measurement, dew point measurement, vapour pressure measurement or dry/wet bulb measurement using the generally accepted formulae.

For all humidity calculations (for example Ha, Hd) using generally accepted equations the saturation vapour pressure is required. For calculating the saturation vapour pressure which is in general a function of the temperature (at the humidity measurement point) the equation D.15 specified in Annex D to ISO Standard 8178-4 should be used."

Annex 4A. Appendix 5, paragraph 1.2.1; amend to read:

"1.2.1 Pure gas
Hydrogen ~~**helium**~~ mixture (FID burner fuel)
(40 ± 1 per cent hydrogen, balance helium **or alternatively nitrogen, or argon**)
(Contamination ≤ 1 ppm C1, ≤ 400 ppm CO2)"

Annex 4A, Appendix 5, paragraph 1.7.2; amend to read:

"1.7.2 Calibration

The CLD and the HCLD shall be calibrated in the most common operating range following the manufacturer's specifications using zero and span gas (the NO content of which shall amount to about 80 per cent of the operating range and the NO2 concentration of the gas mixture to less than 5 per cent of the NO concentration). **With the ozonator deactivated**, the NOx analyzer shall be in the NO mode so that the span gas does not pass through the converter. The indicated concentration has
to be recorded."

Annex 4A, Appendix 5, paragraphs 1.7.7 and 1.7.8; amend to read:

"1.7.7. Deactivation of the ozonator

The ozonator is now deactivated. The mixture of gases described in paragraph 1.7.6. passes through the converter into the detector. The indicated concentration "b" shall be recorded (the analyzer is in the NOx mode).

1.7.8. NO**x** mode

~~**Switched to**~~ **Keeping** NO**x** mode with the ozonator deactivated, the flow of oxygen or synthetic air is also shut off. The NOx reading of the analyzer shall not deviate by more than ±5 per cent from the value measured according to paragraph 1.7.2. (the analyzer is in the NO**x** mode)"

II. Justification

1. Annex 4B – Amendments to paragraph 9.2

2. The reasoning for adding a row is the following.
Regulation 49 defines no linearity requirements for humidity sensors. As the humidity content of the intake air is an essential measure for the calculation of the specific exhaust emission, it is important to add requirement for humidity sensor (Reference: ISO 16183 the accuracy of the absolute humidity shall be +- 5%).

3. The reasoning for the other amendments to Table 7 is the following.
As the gas divider is a necessary tool to verify the linearization of the gas analyzer it is mandatory that the deviation of the gas divider is lower than that of the instrument under test. In combination with a calibration gas which has an accuracy of 1 % and a gas divider, which has an accuracy of 1 % it is only possible to reach a guaranteed analyzer accuracy of 2 %.

This is confirmed in chapter 9.3.1.2 by the required analyzer accuracy of 2%.
According to these, it is obvious, that in lines 10 and 11 of In Table 7 of Annex 4 Chapter 9.2 the linearity requirements for gas dividers and gas analyzers are reversed.

4. Annex 4B – Amendments to paragraph 9.3.3.1

Helium is produced with high energy consumption by fractioning natural gas. It is already classified as a critical resource by the EU as well as USA. In the automotive industry Helium is used as so fuel gas for flame ionization detectors (FID) to measure Hydrocarbon emissions. In the FID fuel gas Helium is mixed with Hydrogen in a ratio of 40 % H2 and 60 % He. The annual fluctuations of the helium global market lead to an insufficient supply with FID fuel gas, like happened lately during summer 2018. In order to prevent the industry from the fluctuations of the global helium market, the US legislation reacted already in 2014 and allowed the usage of Nitrogen as batch gas for the FID fuel gas (§1065.750 (2i) [https://ecfr.io/Title-40/pt40.37.1065#se40.37.1065_1260].

5. Annex 4A. Appendix 5, Amendments to paragraph 1.2.1

Same reasoning as previous for Annex 4B, paragraph 9.3.3.1.

6. Annex 4A, Appendix 5, Amendments to paragraph 1.7.2

To clarify the operation procedure, make the text easier to be understood.

7. Annex 4A, Appendix 5, Amendments to paragraphs 1.7.7 and 1.7.8

Typo error, the instrument should be now in NOx mode.