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Global registry

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Addendum 4: Global technical regulation No. 4

Test procedure for compression ignition (C.I.) engines and positive-ignition (P.I.) engines fuelled with natural gas (NG) or liquefied petroleum gas (LPG) with regard to the emission of pollutants

Amendment 2

Established in the Global Registry on 23 June 2010



UNITED NATIONS

Paragraph 3.2., insert new symbols and correct the following symbols, to read:

| Symbol | Unit | Term |
|------------------|------------------|--|
| a_1 | - | Slope of the regression |
| a_0 | - | y intercept of the regression |
| c_{gas} | ppm/Vol per cent | Concentration on the gaseous components |
| e_r | g/kWh | Specific emission during regeneration |
| $k_{r,u}$ | - | Upward regeneration adjustment factor |
| $k_{r,d}$ | - | Downward regeneration adjustment factor |
| m_b | mg | Particulate sample mass of the dilution air collected |
| m_f | mg | Particulate sampling filter mass |
| m_p | mg | Particulate sample mass collected |
| M_d | g/mol | Molar mass of the dilution air |
| M_f | Nm | Torque absorbed by auxiliaries/equipment to be fitted |
| M_r | Nm | Torque absorbed by auxiliaries/equipment to be removed |
| n_r | - | Number of measurements with regeneration |
| P_f | kW | Power absorbed by auxiliaries/equipment to be fitted |
| P_r | kW | Power absorbed by auxiliaries/equipment to be removed |
| r^2 | - | Coefficient of determination |
| s | | Standard deviation” |

Paragraph 6.3.5., amend to read:

“6.3.5. Engine cycle work

The calculation of reference and actual cycle work (see paragraphs 7.4.8. and 7.8.6.) shall be based upon engine power according to paragraph 6.3.1. In this case, P_f and P_r of equation 4 are zero, and P equals P_m .

If auxiliaries/equipment are installed according to paragraphs 6.3.2. and/or 6.3.3., the power absorbed by them shall be used to correct each instantaneous cycle power value $P_{m,i}$, as follows:

$$P_i = P_{m,i} - P_{f,i} + P_{r,i} \quad (4)$$

where:

$P_{m,i}$ is the measured engine power, kW

$P_{f,i}$ is the power absorbed by auxiliaries/equipment to be fitted, kW

$P_{r,i}$ is the power absorbed by auxiliaries/equipment to be removed, kW”

Paragraph 6.6.2., amend to read:

“6.6.2. Periodic regeneration

...

With reference to the specific emission calculations in paragraph 8.6.3., the regeneration adjustment factors shall be applied, as follows:

(e) for a test without regeneration, $k_{r,u}$ shall be multiplied with or be added to, respectively, the specific emission e in equations 69 or 70,

(f) for a test with regeneration, $k_{r,d}$ shall be multiplied with or be added to, respectively, the specific emission e in equations 69 or 70.

At the request of the manufacturer ...”

Paragraph 7.3., the flowchart, the last box, amend the line “Data collection and evaluation” to read:

“Data collection and evaluation paragraph 7.6.6./7.7.4.”

Paragraph 7.4.7., amend to read:

“7.4.7. Denormalization of engine torque

... shall be denormalized, using the mapping curve determined according to paragraph 7.4.3., as follows:

$$M_{\text{ref},i} = \frac{M_{\text{norm},i}}{100} \times M_{\text{max},i} + M_{\text{f},i} - M_{\text{r},i} \quad (10)$$

where:

$M_{\text{norm},i}$ is the normalized torque, per cent

$M_{\text{max},i}$ is the maximum torque from the mapping curve, Nm

$M_{\text{f},i}$ is the torque absorbed by auxiliaries/equipment to be fitted, Nm

$M_{\text{r},i}$ is the torque absorbed by auxiliaries/equipment to be removed, Nm

If auxiliaries/equipment are fitted in accordance with paragraph 6.3.1. and Annex 7, M_{f} and M_{r} are zero.

...”

Paragraph 7.6.3., amend to read:

“7.6.3. Hot soak period

Immediately upon completion of the cold start test, the engine shall be conditioned for the hot start test using a 10 ± 1 minutes hot soak period.”

Paragraph 7.8.4., amend to read:

“7.8.4. Drift verification

...

The following provisions apply for analyzer drift:

- (a) The pre-test zero and span and post-test zero and span responses may be directly inserted into equation 66 of paragraph 8.6.1. without determining the drift;
- (b) If the drift between the pre-test and post-test results is less than 1 per cent of full scale, the measured concentrations may be used uncorrected or may be corrected for drift according to paragraph 8.6.1.;
- (c) If the drift difference between the pre-test and post-test results is equal to or greater than 1 per cent of full scale, the test shall be voided or the measured concentrations shall be corrected for drift according to paragraph 8.6.1.”

Paragraph 7.8.7., amend to read:

“7.8.7. Validation statistics of the test cycle

Linear regressions of the actual values (n_{act} , M_{act} , P_{act}) on the reference values (n_{ref} , M_{ref} , P_{ref}) shall be performed for both the WHTC and the WHSC.

To minimize the biasing effect of the time lag between the actual and reference cycle values, the entire engine speed and torque actual signal sequence may be advanced or delayed in time with respect to the reference speed and torque sequence. If the actual signals are shifted, both speed and torque shall be shifted by the same amount in the same direction.

The method of least squares shall be used, with the best-fit equation having the form:

$$y = a_1x + a_0 \quad (11)$$

where:

y is the actual value of speed (min^{-1}), torque (Nm), or power (kW)

a_1 is the slope of the regression line

x is the reference value of speed (min^{-1}), torque (Nm), or power (kW)

a_0 is the y intercept of the regression line

The standard error ...”

Paragraph 8.4.2.1., amend to read:

“8.4.2.1. Introduction

...

Two calculation procedures are described in paragraphs 8.4.2.3. and 8.4.2.4., which are equivalent for the reference fuels of Annex 2. The procedure ...”

Paragraph 8.6.3., amend to read:

“8.6.3. Calculation of the specific emissions

The specific emissions e_{gas} or e_{PM} (g/kWh) shall be calculated for each individual component in the following ways depending on the type of test cycle.

For the WHSC, hot WHTC, or cold WHTC, the following equation shall be applied:

$$e = \frac{m}{W_{act}} \quad (69)$$

where:

m is the mass emission of the component, g/test

W_{act} is the actual cycle work as determined according to paragraph 7.8.6., kWh

For the WHTC, the final test result shall be a weighted average from cold start test and hot start test according to the following equation:

$$e = \frac{(0.14 \times m_{\text{cold}}) + (0.86 \times m_{\text{hot}})}{(0.14 \times W_{\text{act,cold}}) + (0.86 \times W_{\text{act,hot}})} \quad (70)$$

where:

m_{cold} is the mass emission of the component on the cold start test, g/test

m_{hot} is the mass emission of the component on the hot start test, g/test

$W_{\text{act,cold}}$ is the actual cycle work on the cold start test, kWh

$W_{\text{act,hot}}$ is the actual cycle work on the hot start test, kWh

If periodic regeneration in accordance with paragraph 6.6.2 applies, the regeneration adjustment factors $k_{r,u}$ or $k_{r,d}$ shall be multiplied with or be added to, respectively, the specific emissions result e as determined in equations 69 and 70.”

Paragraphs 3.1.10., 3.1.20., 3.2., 7.5.6., 7.6.6., 7.7.4, 8.1.2., 8.1.3., 8.4.3.1., 8.4.3.2.2., 8.5.2.3.1., 8.5.2.3.2., 8.5.2.3.3., 8.5.3.1., 9.2. table 7, 9.3.11., 9.4.6.3., A.3.1.3., A.3.2.1., A.3.2.2., A.3.2.3., A.3.2.4., A.3.2.5., replace dilution air by diluent.