10 August 2018

Agreement

Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations*

(Revision 3, including the amendments which entered into force on 14 September 2017)

Addendum 48 – UN Regulation No. 49

Revision 6 - Amendment 5

Supplement 5 to the 06 series of amendments – Date of entry into force: 19 July 2018

Uniform provisions concerning the measures to be taken against the emission of gaseous and particulate pollutants from compression-ignition engines and positive ignition engines for use in vehicles

This document is meant purely as documentation tool. The authentic and legal binding text is: ECE/TRANS/WP.29/2017/130.

UNITED NATIONS

* Former titles of the Agreement:
Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958 (original version);
Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions, done at Geneva on 5 October 1995 (Revision 2).

Paragraph 4.6.2., amend to read:

"4.6.2. If the manufacturer permits the engine family to run on market fuels that do not comply neither with the reference fuels included in Annex 5 nor CEN standard EN 228 (in the case of unleaded petrol) or CEN standard EN 590 (in the case of diesel), such as running on FAME B100 (CEN standard EN14214), FAME diesel blends B20/B30 (CEN standard EN 16709), paraffinic fuel (CEN standard EN 15940) or others the manufacturer shall, in addition to the requirements in paragraph 4.6.1. comply with the following requirements:

(a) Declare the fuels the engine family is capable to run on in paragraph 3.2.2.2.1. of the Information Document as set out in Part 1 of Annex 1, either by reference to an official standard or to a production specification of a brand specific market fuel not meeting any official standard such as those mentioned in paragraph 4.6.2. The manufacturer shall also declare that the functionality of the OBD system is not affected by the use of the declared fuel;

(b) Demonstrate that the parent engine meets the requirements specified in Annex 4 and in Appendix 1 of Annex 10 to this Regulation on the fuels declared; the approval authority may request that the demonstration requirements be further extended to those laid down in Annex 7 and Annex 9A;

(c) Be liable to meet the requirements of in-service conformity specified in Annex 8 on the fuels declared, including any blend between the declared fuels and the relevant market fuels and standards.

At the request of the manufacturer, the requirements set out in this paragraph shall be applied to fuels used for military purposes.

For the purposes of subparagraph 4.6.2.(a) where the emission tests are performed for demonstrating compliance with the requirements of this Regulation, a fuel analysis report of the test fuel shall be attached to the test report and shall comprise at least the parameters specified in the official specification of the fuel manufacturer."

Paragraph 4.11.5., amend to read:

"4.11.5. Replacement pollution control devices shall be type approved according to the specific testing requirements specified in Annex 13 of this Regulation[5]."

Paragraph 4.12.3.3.6., amend to read:

"4.12.3.3.6. For natural gas/biomethane fuelled engines the approval mark shall contain a letter/s after the national symbol, the purpose of which is to distinguish which range of gases the approval has been granted. This letter/s will be as follows:

(a) H in case of the engine being approved and calibrated for the H-range of gases;

(b) L in case of the engine being approved and calibrated for the L-range of gases;

(c) HL in case of the engine being approved and calibrated for both the H-range and L-range of gases;

(d) H_t in case of the engine being approved and calibrated for a specific gas composition in the H-range of gases and transformable to another

specific gas in the H-range of gases by fine tuning of the engine fuelling;

(e) L_t in case of the engine being approved and calibrated for a specific gas composition in the L-range of gases and transformable to another specific gas in the L-range of gases after fine tuning of the engine fuelling;

(f) HL_t in the case of the engine being approved and calibrated for a specific gas composition in either the H-range or the L-range of gases and transformable to another specific gas in either the H-range or the L-range of gases by fine tuning of the engine fueling;

(g) CNG_{fr} in all other cases where the engine is fuelled with CNG/biomethane and designed for operation on one restricted gas fuel range composition;

(h) LNG_{fr} in the cases where the engine is fuelled with LNG and designed for operation on one restricted gas fuel range composition;

(i) LPG_{fr} in the cases where the engine is fuelled with LPG and designed for operation on one restricted gas fuel range composition;

(j) LNG_{20} in case of the engine being approved and calibrated for a specific liquefied natural gas/liquefied biomethane composition resulting in a λ-shift factor not differing by more than 3 per cent the λ-shift factor of the G20 gas specified in Annex 5 to this Regulation, and the ethane content of which does not exceed 1.5 per cent;

(k) LNG in case of the engine being approved and calibrated for any other liquefied natural gas/liquefied biomethane composition."

Paragraph 4.12.3.3.7., amend to read:

"4.12.3.3.7. For dual-fuel engines the approval mark shall contain a series of digits after the national symbol, the purpose of which is to distinguish for which dual-fuel engine type and with which range of gases the approval has been granted.

This series of digits will be constituted of two digits identifying the dual-fuel engine type as defined in Annex 15 followed by the letter(s) specified in paragraphs 4.12.3.3.1. to 4.12.3.3.6. corresponding to the natural gas/biomethane composition used by the engine.

The two digits identifying the dual-fuel engines types according to the definitions of Annex 15 are the following:

(a) 1A for dual-fuel engines of Type 1A;

(b) 1B for dual-fuel engines of Type 1B;

(c) 2A for dual-fuel engines of Type 2A;

(d) 2B for dual-fuel engines of Type 2B;

(e) 3B for dual-fuel engines of Type 3B."

Paragraph 4.12.7.2., amend to read:

"4.12.7.2. The manufacturer's commercial description of the engine"

Insert new paragraphs 13.2.4. and 13.2.5., to read:

"13.2.4. Contracting Parties applying this Regulation may refuse type approval to an engine system or a vehicle if they do not comply with the requirements of this Supplement 5 to the 06 series of amendments of this Regulation with the exception of the requirements specified in paragraphs A.1.4.2.2.2., and A.1.4.3.1.2. of Appendix 1 to Annex 8.

13.2.5. Contracting Parties applying this Regulation shall, from 1 September 2018, grant an ECE type approval to an engine system or a vehicle only if they comply with the requirements of this Supplement 5 to the 06 series of amendments of this Regulation."

Insert a new paragraph 13.3.4., to read:

"13.3.4. As from 1 September 2019, type approvals granted to this Regulation as amended by the 06 series of amendments, which do not comply with the requirements of paragraph 13.2.5., shall cease to be valid."

Insert a new paragraph 13.4.4., to read:

"13.4.4. It is appropriate that modified requirements for the in-service testing according to paragraph 9. do not apply retroactively to engines and vehicles which have not been approved in accordance with those requirements. Therefore, vehicles subject to in-service testing according to paragraph 9. shall always be tested according to the provisions set out in the respective level of this Regulation, which has been applicable at the time of type approval."

Annex 3, Table 1, amend to read:

"

Character	*NO_x OTL*[1]	*PM OTL*[2]	*CO OTL*[6]	*IUPR*[13]	*Reagent quality*	*Additional OBD monitors*[12]	*Power threshold requirements*[14]	*Implementation dates: new types*	*Date when Contracting Parties may refuse type approval*
A[9] [10] B[10]	Row "phase-in period" of Tables 1 and 2 of Annex 9A	Performance monitoring[3]	N/A	Phase-in[7]	Phase-in[4]	N/A	20%	Date of entry into force of 06 series of UN Regulation No. 49	01 September 2015[9] 31 December 2016[10]
B[11]	Row "phase-in period" of Tables 1 and 2 of Annex 9A	N/A	Row "phase-in period" of Table 2 of Annex 9A	N/A	Phase-in[4]	N/A	20%	01 September 2014	31 December 2016
C	Row "general requirements" of Tables 1 and 2 of Annex 9A	Row "general requirements" of Table 1 of Annex 9A	Row "general requirements" of Table 2 of Annex 9A	General[8]	General[5]	Yes	20%	31 December 2015	01 September 2019
D	Row "general requirements" of Tables 1 and 2 of Annex 9A	Row "general requirements" of Table 1 of Annex 9A	Row "general requirements" of Table 2 of Annex 9A	General[8]	General[5]	Yes	10%	01 September 2018	

Notes:

[1] "NO_x OTL" monitoring requirements as set out in Table 1 of Annex 9A for compression ignition and dual-fuel engines and vehicles and in Table 2 of Annex 9A for positive ignition engines and vehicles.

[2] "PM OTL" monitoring requirements as set out in Table 1 of Annex 9A for compression ignition and dual-fuel engines and vehicles.

[3] "Performance monitoring" requirements as set out in paragraph 2.3.2.2. of Annex 9A.

[4] Reagent quality "phase-in" requirements as set out in paragraph 7.1.1.1. of Annex 11.

[5] Reagent quality "general" requirements as set out in paragraph 7.1.1. of Annex 11.

[6] "CO OTL" monitoring requirements as set out in Table 2 of Annex 9A for positive ignition engines and vehicles.

[7] Excluding the statement required by paragraph 6.4.1. of Annex 9A.

[8] Including the statement required by paragraph 6.4.1. of Annex 9A.

[9] For positive-ignition engines and vehicles.

[10] For compression-ignition and dual-fuel engines and vehicles.

[11] Only applicable to positive-ignition engines and vehicles.

[12] "Additional provisions concerning monitoring requirements" as set out in paragraph 2.3.1.2. of Annex 9A.

[13] IUPR specifications are set out in Annexes 9A and 9C of this Regulation. PI engines are not subjected to IUPR."

[14] ISC requirement set out in Appendix 1 to Annex 8"

Annex 4,

Paragraph 7.8.4., amend to read:

"7.8.4. Drift verification

As soon as practical but no later than 30 minutes after the test cycle is complete or during the soak period (for (b) only), the zero and span responses of the gaseous analyser ranges used shall be determined. For the purpose of this paragraph, test cycle is defined as follows:

(a) For the WHTC: the complete sequence cold – soak – hot;

(b) For the WHTC hot start test (paragraph 6.6.): the sequence soak – hot;

(c) For the multiple regeneration WHTC hot start test (paragraph 6.6.): the total number of hot start tests;

(d) For the WHSC: the test cycle.

The following provisions apply for analyser 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 8.4.1.7., amend to read:

"8.4.1.7. Carbon balance method

This involves exhaust mass calculation from the fuel flow and the gaseous exhaust components that include carbon. The calculation of the instantaneous exhaust gas mass flow is as follows:

$$q_{mew,i} = q_{mf,i} \times \left(\frac{w_{BET}^2 \times 1.4}{(1.0828 \times w_{BET} + k_{fd} \times k_c) \times k_c} \left(1 + \frac{H_a}{1000} \right) + 1 \right) \quad (33)$$

With

$k_c = (c_{CO2d} - c_{CO2d,a}) \times 0{,}5441 + c_{COd}/18522 + c_{HCw}/17355$ (34)

And

$k_{fd} = -0{,}055586 \times w_{ALF} + 0{,}0080021 \times w_{DEL} + 0{,}0070046 \times w_{EPS}$ (35)

Where:

$q_{mf,i}$ is the instantaneous fuel mass flow rate, kg/s

H_a is the intake air humidity, g water per kg dry air

w_{BET} is the carbon content of the fuel, per cent mass

w_{ALF} is the hydrogen content of the fuel, per cent mass

w_{DEL} is the nitrogen content of the fuel, per cent mass

w_{EPS} is the oxygen content of the fuel, per cent mass

c_{CO2d} is the dry CO_2 concentration, per cent

$c_{CO2d,a}$ is the dry CO_2 concentration of the intake air, per cent

c_{COd} is the dry CO concentration, ppm

c_{HCw} is the wet HC concentration, ppm"

Paragraph 9.3.9.4.1., amend to read:

"9.3.9.4.1. Sample dryer efficiency

For dry CLD analysers, it shall be demonstrated that for the highest expected water vapour concentration Hm (see paragraph 9.3.9.2.2.), the sample dryer maintains CLD humidity at ≤ 5 g water/kg dry air (or about 0.8 volume per cent H_2O), which is 100 per cent relative humidity at 3.9 °C and 101.3 kPa. This humidity specification is also equivalent to about 25 per cent relative humidity at 25 °C and 101.3 kPa. This may be demonstrated by measuring the temperature at the outlet of a thermal dehumidifier, or by measuring humidity at a point just upstream of the CLD. Humidity of the CLD exhaust might also be measured as long as the only flow into the CLD is the flow from the dehumidifier."

Paragraph 9.4.2., amend to read:

"9.4.2. General requirements of the dilution system

The determination of the particulates requires dilution of the sample with filtered ambient air, synthetic air or nitrogen (the diluent). The dilution system shall be set as follows:

(a) Completely eliminate water condensation in the dilution and sampling systems;

(b) Maintain the temperature of the diluted exhaust gas between 315 K (42 °C) and 325 K (52 °C) within 20 cm upstream or downstream of the filter holder(s);

(c) The diluent temperature shall be between 293 K and 325 K (20 °C to 52 °C) in close proximity to the entrance into the dilution tunnel;

(d) The minimum dilution ratio shall be within the range of 5:1 to 7:1 and at least 2:1 for the primary dilution stage based on the maximum engine exhaust flow rate;

(e) For a partial flow dilution system, the residence time in the system from the point of diluent introduction to the filter holder(s) shall be between 0.5 and 5 seconds;

(f) For a full flow dilution system, the overall residence time in the system from the point of diluent introduction to the filter holder(s) shall be between 1 and 5 seconds, and the residence time in the secondary dilution system, if used, from the point of secondary diluent introduction to the filter holder(s) shall be at least 0.5 seconds.

Dehumidifying the diluent before entering the dilution system is permitted, and especially useful if diluent humidity is high."

Paragraph 9.5.5., amend to read:

"9.5.5. Total system verification

The total accuracy of the CVS sampling system and analytical system shall be determined by introducing a known mass of a pollutant gas into the system while it is being operated in the normal manner. The pollutant is analysed, and the mass calculated according to paragraph 8.5.2.3. except in the case of propane where a u factor of 0.000507 is used in place of 0.000483 for HC. Either of the following two techniques shall be used."

Paragraph 10.4.2., amend to read:

"10.4.2. Determination of particle numbers with a partial flow dilution system

Where particle numbers are sampled using a partial flow dilution system according to the procedures set out in paragraph 8.4., the number of particles emitted over the test cycle shall be calculated by means of the following equation:

$$N = \frac{m_{edf}}{1.293} \cdot k \cdot \overline{c_s} \cdot \overline{f_r} \cdot 10^6 \qquad (95)$$

Where:

N = number of particles emitted over the test cycle,

m_{edf} = mass of equivalent diluted exhaust gas over the cycle, determined according to paragraph 8.4.3.2.1. or 8.4.3.2.2., kg/test,

k = calibration factor to correct the particle number counter measurements to the level of the reference instrument where this is not applied internally within the particle number counter. Where the calibration factor is applied internally within the particle number counter, a value of 1 shall be used for k in the above equation,

$\overline{c_s}$ = average concentration of particles from the diluted exhaust gas corrected to standard conditions (273.2 K and 101.33 kPa), particles per cubic centimetre,

$\overline{f_r}$ = mean particle concentration reduction factor of the volatile particle remover specific to the dilution settings used for the test.

$\overline{c_s}$ shall be calculated from the following equation:

$$\overline{c_s} = \frac{\sum_{i=1}^{i=n} c_{s,i}}{n} \qquad (96)$$

Where:

$c_{s,i}$ = a discrete measurement of particle concentration in the diluted gas exhaust from the particle counter, corrected for coincidence and to standard conditions (273.2 K and 101.33 kPa), particles per cubic centimetre,

n = number of particle concentration measurements taken over the duration of the test."

Appendix 3, paragraph A.3.2., amend to read:

"A.3.2. Regression analysis

The slope of the regression shall be calculated as follows:

$$a_1 = \frac{\sum_{i=1}^{n}\left(y_i - \bar{y}\right)\times\left(x_i - \bar{x}\right)}{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2} \quad (104)$$

The y intercept of the regression shall be calculated as follows:

$$a_0 = \bar{y} - \left(a_1 \times \bar{x}\right) \quad (105)$$

The standard error of estimate (SEE) shall be calculated as follows:

$$SEE = \sqrt{\frac{\sum_{i=1}^{n}[y_i - a_0 - (a_1 \times x_i)]^2}{n-2}} \quad (106)$$

The coefficient of determination shall be calculated as follows:

$$r^2 = 1 - \frac{\sum_{i=1}^{n}\left[y_i - a_0 - \left(a_1 \times x_i\right)\right]^2}{\sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2} \quad (107)"$$

Annex 8

Paragraph 2.1., amend to read:

"2.1. The conformity of in-service vehicles or engines of an engine family shall be demonstrated by testing vehicles on the road operated over their normal driving patterns, conditions and payloads. The in-service conformity test shall be representative for vehicles operated on their real driving routes, with their normal payload and with the usual professional driver of the vehicle. When the vehicle is operated by a driver other than the usual professional driver of the particular vehicle, this alternative driver shall be skilled and trained to operate vehicles of the category subject to be tested."

Paragraph 2.3., amend to read:

"2.3. The manufacturer shall demonstrate to the Type Approval Authority that the chosen vehicle, driving patterns and conditions are representative for the engine family. The requirements as specified in paragraph 4.5. shall be used to determine whether the driving patterns are acceptable for in-service conformity testing."

Paragraph 4.1., amend to read:

"4.1. Vehicle payload

Normal payload is a payload between 10 and 100 per cent of the maximum payload.

The maximum payload is the difference between technically permissible maximum laden mass of the vehicle and the mass of the vehicle in running order as specified in Annex 3 to Special Resolution No. 1 (ECE/TRANS/WP.29/1045, as amended by Amends. 1 and 2).

For the purpose of in- service conformity testing the payload may be reproduced and an artificial load may be used.

Approval authorities may request to test the vehicle with any payload between 10 to 100 per cent of the maximum vehicle payload. In case the mass of the PEMS equipment needed for operation exceeds 10 per cent of the maximum vehicle payload this mass may be considered as minimum payload.

Vehicles of category N_3 shall be tested, when applicable, with a semi-trailer."

Paragraph 4.4.1., amend to read:

"4.4.1. Lubricating oil

The test lubricating oil shall be market oil and must comply with the specifications of the engine manufacturer.

Oil samples shall be taken."

Paragraph 4.4.2., amend to read:

"4.4.2. Fuel

The test fuel shall be market fuel covered by the relevant standards or reference fuel as specified in Annex 5 to this Regulation. Fuel samples shall be taken.

A manufacturer may request not to sample the fuel from a gas engine."

Paragraph 4.4.2.1., amend to read:

"4.4.2.1. If the manufacturer has, in accordance with paragraph 4. to this Regulation declared the capability to meet the requirements of this Regulation on market fuels declared in paragraph 3.2.2.2.1. of the Information Document as set out in Part 1 of Annex 1 to this Regulation, at least one test shall be conducted on each of the declared market fuels."

Paragraph 4.4.3., amend to read:

"4.4.3. Reagent

For exhaust after-treatment systems that use a reagent to reduce emissions, the reagent shall be market reagent and must comply with the specifications of the engine manufacturer. A sample of the reagent shall be taken. The reagent shall not be frozen."

Paragraph 4.5., amend to read:

"4.5. Trip requirements

The shares of operation shall be expressed as a percentage of the total trip duration.

The trip shall consist of urban driving followed by rural and motorway driving according to the shares specified in paragraphs 4.5.1. to 4.5.4. Where another testing order is justified for practical reasons and after the agreement of the

Type Approval Authority another order may be used, however, the test shall always start with the urban driving.

For the purpose of this paragraph, "approximately" shall mean the target value ±5 per cent.

Urban, rural and motorway parts can be determined either on the basis of:

(a) Geographical coordinates (by means of a map); or

(b) First acceleration method.

In case the trip composition is determined on the basis of geographical coordinates, the vehicle should not exceed, for a cumulative period longer than 5 per cent of the total duration of each part of the trip, the following speed:

(a) 50 km/h in the urban part;

(b) 75 km/h in the rural part (90 km/h in the case of vehicles of categories M_1 and N_1).

In case the trip composition is determined by means of the first acceleration method, the first acceleration above 55 km/h (70 km/h in the case of vehicles of categories M_1 and N_1) shall indicate the beginning of the rural part and the first acceleration above 75 km/h (90 km/h in the case of vehicles of categories M_1 and N_1) shall indicate the beginning of the motorway part.

The criteria for differentiation between urban, rural and motorway operation shall be agreed with the approval authority prior to the beginning of the test.

Average speed in urban operation shall be between 15 and 30 km/h.

Average speed in rural operation shall be between 45 and 70 km/h (60 and 90 km/h in the case of vehicles of categories M_1 and N_1).

Average speed in motorway operation shall be above 70 km/h (90 km/h in the case of vehicles of categories M_1 and N_1)."

Paragraph 4.5.1., amend to read:

"4.5.1. For M_1 and N_1 vehicles the trip shall consist of approximately 34 per cent urban, 33 per cent rural and 33 per cent motorway operation."

Paragraph 4.5.2., amend to read:

"4.5.2. For N_2, M_2 and M_3 vehicles the trip shall consist of approximately 45 per cent urban, 25 per cent rural and 30 per cent motorway operation. M_2 and M_3 vehicles of Class I, II or Class A shall be tested in approximately 70 per cent urban and 30 per cent rural operation."

Paragraph 4.5.3. shall be deleted:

Paragraph 4.5.4., renumber as paragraph 4.5.3. and amend to read:

"4.5.3. For N_3 vehicles the trip shall consist of approximately 30 per cent urban, 25 per cent rural and followed by 45 per cent motorway operation."

Insert a new paragraph 4.5.4., to read:

"4.5.4. For the purpose of the assessment of the trip composition, the duration of the share shall be calculated from the moment when the coolant temperature has reached 343 K (70 °C) for the first time or after the coolant temperature is stabilised within ±2 K over a period of 5 minutes whichever comes first but no

later than 15 minutes after engine start. In accordance with paragraph 4.5. the period elapsed to reach the coolant temperature of 343 K (70 °C) shall be operated under urban driving conditions.

Artificial warming up of the emission control systems prior to the test is prohibited."

Paragraph 4.6.5., amend to read:

"4.6.5. The test duration shall be long enough to complete between four and eight times the work performed during the WHTC or produce between four and eight times the CO_2 reference mass in kg/cycle from the WHTC as applicable."

Paragraph 4.6.10., amend to read:

"4.6.10. If the particle exhaust after-treatment system undergoes a non-continuous regeneration event during the trip or an OBD class A or B malfunction occurs during the test, the manufacturer can request the trip to be voided."

Annex 8 - Appendix 1

Paragraph A.1.1., amend to read:

"A.1.1. Introduction

This appendix describes the procedure to determine gaseous emissions from on-vehicle on-road measurements using Portable Emissions Measurement Systems (hereinafter PEMS). The pollutant emissions to be measured from the exhaust of the engine include the following components: carbon monoxide, total hydrocarbons and nitrogen oxides for compression ignition engines and carbon monoxide, non-methane hydrocarbons, methane and nitrogen oxides for positive ignition engines. Additionally, carbon dioxide shall be measured to enable the calculation procedures described in paragraph A.1.4.

For engines fuelled with natural gas, the manufacturer, technical service or Type Approval Authority may choose to measure the total hydrocarbon (THC) emissions only instead of measuring the methane and non-methane hydrocarbon emissions. In that case, the emission limit for the total hydrocarbon emissions is the same as the one shown in paragraph 5.3. of this Regulation for methane emissions. For the purposes of the calculation of the conformity factors pursuant to paragraphs A.1.4.2.3. and A.1.4.3.2., the applicable limit shall in that case be the methane emission limit only.

For engines fuelled with gases other than natural gas, the manufacturer, technical service or Type Approval Authority may choose to measure the total hydrocarbon (THC) emissions instead of measuring the non-methane hydrocarbon emissions. In that case, the emission limit for the total hydrocarbon emissions is the same as shown in paragraph 5.3. of this Regulation for non-methane hydrocarbon emissions. For the purposes of the calculations of the conformity factors pursuant to paragraphs A.1.4.2.3. and A.1.4.3.2., the applicable limit shall in that case be the non-methane emission limit."

Paragraph A.1.2.2., amend to read:

"A.1.2.2. Test parameters

The parameters as specified in Table 1 shall be measured and recorded at a constant frequency of 1.0 Hz or higher. The original raw data shall be kept by

the manufacturer and shall be made available, upon request, to the Type Approval Authority:"

Insert a new paragraph A.1.2.2.1., to read:

"A.1.2.2.1. Data reporting format

Emission values as well as any other relevant parameters shall be reported and exchanged as csv-formatted data file. Parameter values shall be separated by a comma, ASCII-Code #h2C. The decimal marker of numerical values shall be a point, ASCII-Code #h2E. Lines shall be terminated by carriage return, ASCII-Code #h0D. No thousands separators shall be used."

Paragraph A.1.2.6.1., amend to read:

"A.1.2.6.1. Test start

Emissions sampling, measurement of the exhaust parameters and recording of the engine and ambient data shall commence prior to starting the engine. The coolant temperature shall not exceed 303 K (30 °C) at the beginning of the test. In case ambient temperature exceeds 303 K (30 °C) at the beginning of the test, the coolant temperature shall not exceed the ambient temperature by more than 2 °C. The data evaluation shall start after the coolant temperature has reached 343 K (70 °C) for the first time or after the coolant temperature is stabilized within +/-2 K over a period of 5 minutes whichever comes first but no later than 15 minutes after engine start."

Paragraph A.1.2.6.2., amend to read:

"A.1.2.6.2. Test run

Emission sampling, measurement of the exhaust parameters and recording of the engine and ambient data shall continue throughout the normal in-use operation of the engine. The engine may be stopped and started, but emissions sampling shall continue throughout the entire test.

Periodic zero-checks of the PEMS gas analysers may be conducted every two hours and the results may be used to perform a zero drift correction. The data recorded during the checks shall be flagged and shall not be used for the emission calculations.

In case of interrupted GPS signal the GPS data may be calculated based on the ECU vehicle speed and a map, for a consecutive period of less than 60 s. If the cumulative loss of GPS signal exceeds 3 per cent of the total trip duration, the trip should be declared void."

Paragraph A.1.3.2.1., amend to read:

"A.1.3.2.1. Analysers and EFM data

The consistency of the data (exhaust mass flow measured by the EFM and gas concentrations) shall be verified using a correlation between the measured fuel flow from the ECU and the fuel flow calculated using the formula in paragraph 8.4.1.7. of Annex 4 to this Regulation. A linear regression shall be performed for the measured and calculated fuel rate values. The method of least squares shall be used, with the best fit equation having the form:

$y = mx + b$

Where:

y is the calculated fuel flow [g/s]

m is the slope of the regression line

x is the measured fuel flow [g/s]

b is the y intercept of the regression line

The slope (m) and the coefficient of determination (r^2) shall be calculated for each regression line. It is recommended to perform this analysis in the range from 15 per cent of the maximum value to the maximum value and at a frequency greater or equal to 1 Hz. For a test to be considered valid, the following two criteria shall be evaluated:

Table 2
Tolerances

Slope of the regression line, m	0.9 to 1.1 - Recommended
Coefficient of determination	Min. 0.90 - Mandatory

"

Paragraph A.1.4.1., amend to read:

"A.1.4.1. Averaging window principle

The emissions shall be integrated using a moving averaging window method, based on the reference CO_2 mass or the reference work. The principle of the calculation is as follows: the mass emissions are not calculated for the complete data set, but for sub-sets of the complete data set, the length of these sub-sets being determined so as to match the engine CO_2 mass or work measured over the reference laboratory transient cycle. The moving average calculations are conducted with a time increment Δt equal to the data sampling period. These sub-sets used to average the emissions data are referred to as "averaging windows" in the following paragraphs.

Any invalidated data shall not be considered for the calculation of the work or CO_2 mass and the emissions of the averaging window.

The following data shall be considered as not valid data:

(a) Zero drift check of the instruments;

(b) The data outside the conditions specified in paragraphs 4.2. and 4.3. of this annex.

The mass emissions (mg/window) shall be determined as described in paragraph 8.4.2.3. of Annex 4."

Paragraph A.1.4.2.2., amend to read:

"A.1.4.2.2. Selection of valid windows"

Paragraph A.1.4.2.2.1., amend to read:

"A.1.4.2.2.1. Before the dates referred to in paragraph 13.2.5. of this Regulation for new type approvals and paragraph 13.3.4. for new registrations, paragraphs A.1.4.2.2.1.1. to A.4.2.2.1.4. shall apply."

Insert new paragraphs A.1.4.2.2.1.1. to A.1.4.2.2.1.4., to read:

"A.1.4.2.2.1.1. The valid windows are the windows whose average power exceeds the power threshold of 20 per cent of the maximum engine power. The percentage of valid windows shall be equal or greater than 50 per cent.

A.1.4.2.2.1.2. If the percentage of valid windows is less than 50 per cent, the data evaluation shall be repeated using lower power thresholds. The power threshold shall be reduced in steps of 1 per cent until the percentage of valid windows is equal to or greater than 50 per cent.

A.1.4.2.2.1.3. In any case, the lower threshold shall not be lower than 15 per cent.

A.1.4.2.2.1.4. The test shall be void if the percentage of valid windows is less than 50 per cent at a power threshold of 15 per cent."

Paragraph A.1.4.2.2.2., amend to read:

"A.1.4.2.2.2. From the dates referred to in paragraph 13.2.5. of this Regulation for new type approvals and paragraph 13.3.4. for new registrations, paragraphs A.1.4.2.2.2.1. and A.1.4.2.2.2.2. shall apply."

Paragraph A.1.4.2.2.3., renumber as paragraph A.1.4.2.2.2.1. and amend to read:

"A.1.4.2.2.2.1. The valid windows are the windows whose average power exceeds the power threshold of 10 per cent of the maximum engine power."

Insert a new paragraph A.1.4.2.2.2.2., to read:

"A.1.4.2.2.2.2. The test shall be void if the percentage of valid windows is less than 50 per cent or if there are no valid windows in respect of nitrogen oxides (NOx) left in urban only operations after the 90 percentile rule has been applied."

Paragraphs A.1.4.3.1. to A.1.4.3.1.3., amend to read:

"A.1.4.3.1. Selection of valid windows

A.1.4.3.1.1. Before the dates referred to in paragraph 13.2.5. of this Regulation for new type approvals and paragraph 13.3.4. for new registrations, paragraphs A.1.4.3.1.1.1. to A.1.4.3.1.1.4. shall apply.

A.1.4.3.1.1.1. The valid windows shall be the windows whose duration does not exceed the maximum duration calculated from:

$$D_{\max} = 3600 \cdot \frac{W_{ref}}{0.2 \times P_{max}}$$

Where:

D_{max} is the maximum window duration, s;

P_{max} is the maximum engine power, kW.

A.1.4.3.1.1.2. If the percentage of valid windows is less than 50 per cent, the data evaluation shall be repeated using longer window durations. This is achieved by decreasing the value of 0.2 in the formula given in paragraph A.1.4.3.1. by steps of 0.01 until the percentage of valid windows is equal to or greater than 50 per cent.

A.1.4.3.1.1.3. In any case, the lowered value in above formula shall not be lower than 0.15.

A.1.4.3.1.1.4. The test shall be void if the percentage of valid windows is less than 50 % at a maximum window duration calculated in accordance with paragraphs A.1.4.3.1.1.1., A.1.4.3.1.1.2. and A.1.4.3.1.1.3.

A.1.4.3.1.2. From the dates referred to in paragraph 13.2.5. of this Regulation for new type approvals and paragraph 13.3.4. for new registrations, paragraphs A.1.4.3.1.2.1. and A.1.4.3.1.2.2. shall apply.

A.1.4.3.1.2.1. The valid windows shall be the windows whose duration does not exceed the maximum duration calculated from:

$$D_{\max} = 3600 \cdot \frac{W_{ref}}{0.1 \times P_{max}}$$

where:

D_{max} is the maximum window duration, s;

P_{max} is the maximum engine power, kW.

A.1.4.3.1.2.2. The test shall be void if the percentage of valid windows is less than 50 per cent."

Annex 8 - Appendix 2,

Paragraph A.2.2.1., amend to read:

"A.2.2.1. Gas analysers general specifications

The PEMS gas analysers specification shall meet the requirements set out in paragraph 9.3.1 of Annex 4. The rise time of the analyser installed in the PEMS measurement system shall not exceed 3.5 seconds."

Paragraph A.2.3.1., amend to read:

"A.2.3.1. Exhaust Gas Flow Meter (EFM) tailpipe connection

The installation of the EFM shall not increase the backpressure by more than the value recommended by the engine manufacturer, nor increase the length of the tailpipe by more than 2 m. As for the all the components of the PEMS equipment, the installation of the EFM shall comply with the locally applicable road safety regulations and insurance requirements."

Annex 9A,

Paragraph 2.4.1.3., amend to read:

"2.4.1.3. The OBD standard "Final OBD threshold limits" in Table A11/1 of Annex 11 to the 07 series of amendments to UN Regulation No. 83 shall be considered as equivalent to the character**s** C or D of the Table 1 of Annex 3 to this Regulation."

Paragraphs 3.2. to 3.2.2., amend to read:

"3.2. OBD threshold limits

3.2.1. The OBD threshold limits (hereinafter OTLs) applicable to the OBD system are those specified in the rows "general requirements" of Table 1 for compression ignition engines and of Table 2 for gas-fuelled engines and positive ignition engines.

3.2.2. Until the end of the phase-in period set out in paragraph 4.10.7. of this Regulation, the OBD threshold limits specified in rows "phase-in period" of Table 1 for compression ignition engines and of Table 2 for gas fuelled engines and positive ignition engines."

Annex 10 - Appendix 1

Insert a new paragraph A.1.2.3., to read:

"A.1.2.3. Manufacturers shall ensure that vehicles can be tested with PEMS by an independent party on public roads by making available suitable adapters for exhaust pipes, granting access to ECU signals and making the necessary administrative arrangements. The manufacturer may charge a reasonable fee."

Paragraph A.1.3.1., amend to read:

"A.1.3.1. Vehicle payload

For the purpose of the PEMS demonstration test, the payload may be reproduced and an artificial load may be used.

The vehicle payload shall be 50-60 per cent of the maximum vehicle payload**.** The additional requirements set out in Annex 8 shall apply."

Annex 13

Paragraph 4.3.2.4., amend to read:

"4.3.2.4. Durability of emissions performance

The exhaust after-treatment system tested in accordance with paragraph 4.3.2.2. and incorporating the replacement pollution control device shall be subjected to the durability procedures described in Appendix 4 to this annex."

Insert a new paragraph 4.3.5., to read:

"4.3.5. Fuels

In the case described in paragraph 4.6.2. to this Regulation, the test procedure laid down in paragraphs 4.3.1. to 4.3.2.7. of this annex shall be conducted with the fuels declared by the manufacturer of the original engine system. However, in agreement with the Type Approval Authority, the durability procedure set out in Appendix 4 and referred to in paragraph 4.3.2.4. may be performed only with the fuel which represents the worst case in terms of ageing."

Insert new paragraphs 4.6. to 4.6.5., to read:

"4.6. Requirements regarding compatibility with the NO_x control measures (applicable only to replacement pollution control devices to be fitted to vehicles equipped with sensors directly measuring NO_x concentration in the exhaust).

4.6.1. NO_x control measures compatibility demonstration is required only when the original pollution control device was monitored in the original configuration.

4.6.2. The compatibility of the replacement pollution control device with the NO_x control measures shall be demonstrated by using the procedures described in Annex 11 to this Regulation, for replacement pollution control devices intended to be fitted to engines or vehicles type approved in accordance with this Regulation.

4.6.3. Reserved

4.6.4. The replacement pollution control device manufacturer may use the same preconditioning and test procedure as used during the original type approval. In that case, the approval authority which granted original type approval of an engine of a vehicle shall provide, on request and on a non-discriminatory basis, an information document presented as an appendix to the Information Document provided for in Annex I, which contains the number and type of preconditioning cycles and the type of test cycle used by the original equipment manufacturer for NO_x control measures testing of the pollution control device.

4.6.5. Paragraph 4.5.5. shall apply to NO_x control measures monitored by the OBD system."

Appendix 4, amend to read:

"**Annex 13 - Appendix 4**

Durability procedure for evaluation of emissions performance of a replacement pollution control device

1. This Appendix sets out the durability procedure referred to in paragraph 4.3.2.4. of Annex 13, for the purpose of evaluating the emissions performance of a replacement pollution control device.

2. Description of the durability procedure

2.1. The durability procedure shall consist of a data collection phase and a service accumulation schedule.

2.2. Data collection phase

2.2.1. The selected engine, equipped with the complete exhaust after-treatment system incorporating the replacement pollution control device, shall be cooled down to ambient temperature and run one cold start WHTC test-cycle in accordance with paragraphs 7.6.1. and 7.6.2. of Annex 4 to this Regulation.

2.2.2. Immediately after the cold start WHTC test-cycle, the engine shall be run for nine consecutive hot start WHTC test-cycles in accordance with paragraph 7.6.4. of Annex 4 to this Regulation.

2.2.3. The test sequence set out in paragraphs 2.2.1. and 2.2.2. shall be carried out in accordance with the instructions laid down in paragraph 7.6.5. of Annex 4 to this Regulation.

2.2.4. Alternatively, the relevant data can be collected by driving a fully loaded vehicle equipped with the selected exhaust after-treatment system incorporating the replacement pollution control device. The test can be carried out either on the road following the trip requirements of paragraphs 4.5. to 4.5.5. of Annex 8 to this Regulation with comprehensive recording of the driving data, or on a suitable chassis dynamometer. If an on-road test is chosen, the vehicle shall be driven over a cold test-cycle, as set out in Appendix 6 to this annex, followed by nine hot test-cycles, identical to the cold one, in a way that the work developed by the engine is the same as the one achieved under paragraphs 2.2.1. and 2.2.2. If a chassis dynamometer is chosen, the simulated

road gradient of the test-cycle in Appendix 6 shall be adapted to match the work developed by the engine over the WHTC.

2.2.5. The Type Approval Authority shall refuse the temperature data obtained under paragraph 2.2.4. if it deems those data to be unrealistic and shall request either the repetition of the test, or the carrying out of a test pursuant to paragraphs 2.2.1., 2.2.2. and 2.2.3.

2.2.6. Temperatures in the replacement pollution control device shall be recorded during the whole test sequence, at the location with the highest temperature.

2.2.7. In cases where the location with the highest temperature varies over time, or where that location is difficult to define, multiple bed temperatures should be recorded at suitable locations.

2.2.8. The number and locations of the temperature measurements shall be selected by the manufacturer, in agreement with the Type Approval Authority, based on best engineering judgement.

2.2.9. With the agreement of the Type Approval Authority, a single catalyst bed temperature or the catalyst inlet temperature may be used if measuring multiple bed temperatures is proven to be unfeasible or too difficult.

Figure 1
Example of temperature sensors location in a generic after-treatment device

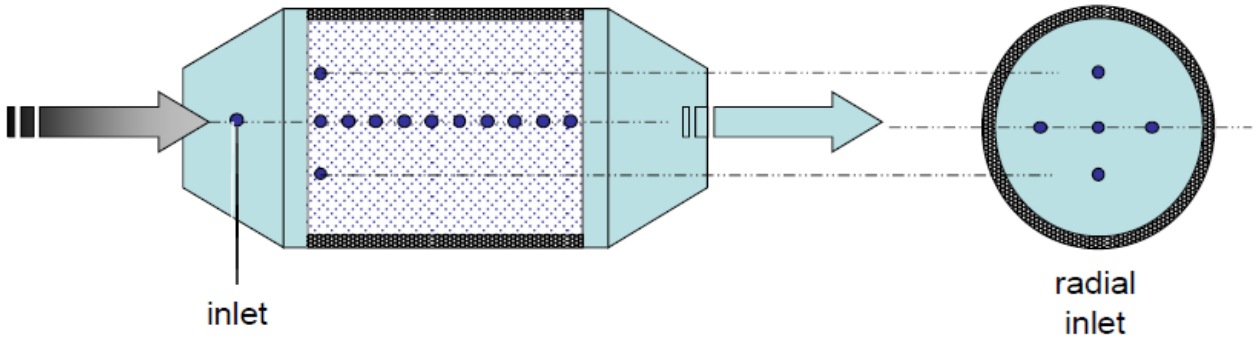
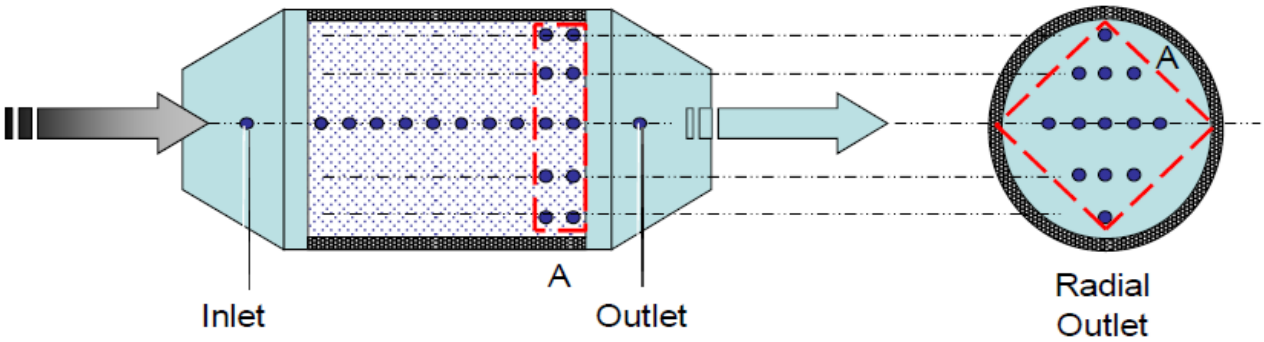


Figure 2
Example of temperature sensors location for DPF



2.2.10. The temperatures shall be measured and recorded at a minimum rate of once every second (1 Hz) during the test sequence.

2.2.11. The measured temperatures shall be tabulated into a histogram with temperature bins no larger than 10 ºC. In the case mentioned in paragraph

2.2.7., the highest temperature each second shall be the one recorded in the histogram. Each bar of the histogram shall represent the cumulated frequency in seconds of the measured temperatures falling in the specific bin.

2.2.12. The time in hours corresponding to each temperature bin must be determined and then extrapolated to the useful life of the replacement pollution control device, in accordance with the values specified in Table 1. The extrapolation shall be based on the assumption that one WHTC cycle corresponds to 20 km driving.

Table 1
Useful life of the replacement pollution control device for each vehicle category, and equivalent WHTC test-cycles and hours of operation

Vehicle category	*Mileage (km)*	*Equivalent number of WHTC test-cycles*	*Equivalent number of hours*
Engine systems fitted to vehicles of category M_1, N_1 and N_2	114 286	5 714	2 857
Engine systems fitted to vehicles of category N_2, N_3 with a maximum technically permissible mass not exceeding 16 tonnes and M_3 Class I, Class II and Class A, and Class B with a maximum technically permissible mass exceeding 7.5 tonnes	214 286	10 714	5 357
Engine systems fitted to vehicles of category N_3 with a maximum technically permissible mass exceeding 16 tonnes, and M_3, Class III and Class B with a maximum technically permissible mass exceeding 7.5 tonnes	500 000	25 000	12 500

2.2.13. It is allowed to perform the data collection phase for different devices at the same time.

2.2.14. In the case of systems operating in the presence of active regeneration, the number, length and temperatures of the regenerations occurring during the test sequence defined in paragraphs 2.2.1. and 2.2.2. shall be recorded. If no active regeneration has occurred, the hot sequence defined in paragraph 2.2.2. shall be extended in order to include at least two active regenerations.

2.2.15. The total lubricant consumed during the data collection period, in g/h, shall be recorded, using any suitable method, as for example the drain and weigh procedure described in Appendix 6. For this purpose, the engine shall be run during 24 hours, performing consecutive WHTC test-cycles. In cases where an accurate measurement of oil consumption cannot be obtained, the manufacturer, in agreement with the Type Approval Authority, may use the following options for the determination of the lubricant consumption:

(a) A default value of 30 g/h;

(b) A value requested by the manufacturer, based on sound data and information, and agreed with the Type Approval Authority.

2.3. Calculation of the equivalent ageing time corresponding to a reference temperature

2.3.1. The temperatures recorded pursuant to paragraphs 2.2. to 2.2.15. shall be reduced to a reference temperature Tr, requested by the manufacturer in agreement with the Type Approval Authority, within the range of the temperatures recorded during the data collection phase.

2.3.2. In the case specified in paragraph 2.2.13., the value of Tr for each one of the devices may vary.

2.3.3. The equivalent ageing time corresponding to the reference temperature shall be calculated, for each bin referred to in 2.2.11., in accordance with the following equation:

Equation 1:

$$t_e^t = t_{bin}^i \times e^{\left(\left(\frac{R}{T_r}\right)-\left(\frac{R}{T_{bin}^i}\right)\right)}$$

Where:

R = thermal reactivity of the replacement pollution control device.

The following values shall be used:

Diesel Oxidation Catalyst (DOC): 18,050

Catalysed DPF: 18,050

SCR or ammonia oxidation catalyst (AMOX) based on iron-zeolite (Fe-Z): 5,175

SCR copper-zeolite (Cu-Z): 11,550

SCR Vanadium (V): 5,175

LNT (lean-NO_x trap): 18,050

Tr = reference temperature, in K.

T_{bin}^i = midpoint temperature, in K, of the temperature bin *i* to which the replacement pollution control device is exposed during the data collection phase, registered in the temperature histogram.

t_{bin}^i = the time, in hours, corresponding to the temperature T_{bin}^i, adjusted to a full useful life basis e.g. if the histogram represented 5 hours, and useful life is 4,000 hours according to Table 1, all histogram time entries would be multiplied by (4,000/5)=800.

t_e^i = the equivalent ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device at the temperature T_{bin}^i during the time t_{bin}^i.

i = bin number, where 1 is number for the bin with the lowest temperature and n the value for the bin with the highest temperature.

Equation 2:

$$AT = \sum_{i=1}^{n} t_e^i$$

AT = total equivalent ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device, over its useful life, to the temperature T_{bin}^i during the time t_{bin}^i of each one of the *i* bins registered in the histogram.

t_e^i = the equivalent ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device at the temperature T_{bin}^i during the time t_{bin}^i.

i = bin number, where 1 is number for the bin with the lowest temperature and n the value for the bin with the highest temperature.

n = total number of temperature bins.

2.3.5. In the case referred to in paragraph 2.2.13., AT shall be calculated for each device.

2.4. Service accumulation schedule

2.4.1. General requirements

2.4.1.1. The service accumulation schedule shall allow acceleration of the ageing of the replacement pollution control device, using the information gathered during the data collection phase set out in paragraph 2.2.

2.4.1.2. The service accumulation schedule shall consist of a thermal accumulation schedule and a lubricant consumption accumulation schedule in accordance with paragraph 2.4.4.6. The manufacturer, in agreement with the Type Approval Authority, may not have to carry out a lubricant consumption accumulation schedule in case the replacement pollution control devices are placed downstream of an after-treatment filter component (e.g. diesel particulate filter). Both the thermal accumulation schedule and the lubricant consumption accumulation schedule shall consist of a repetition of, respectively, a series of thermal and lubricant consumption sequences.

2.4.1.3. In the case of replacement pollution control devices operating in the presence of active regeneration, the thermal sequence shall be complemented with an active regeneration mode.

2.4.1.4. For service accumulation schedules consisting of both thermal and lubricant consumption accumulation schedules, their respective sequences shall be alternated, so that for each thermal sequence that has to be performed, the following sequence corresponds to lubricant consumption.

2.4.1.5. It is allowed to perform the service accumulation schedule at the same time for different devices. In that case, a single service accumulation schedule shall be set for all the devices.

2.4.2. Thermal accumulation schedule

2.4.2.1. The thermal accumulation schedule shall simulate the effect of thermal ageing on the performance of a replacement pollution control device until the end of its lifetime.

2.4.2.2. The engine used for the performance of the service accumulation schedule, fitted with the exhaust after-treatment system incorporating the replacement pollution control device, is operated for a minimum of three consecutive thermal sequences, as set out in Appendix 5.

2.4.2.3. The temperatures shall be recorded over a minimum of two thermal sequences. The first sequence, conducted for warming up, shall not be taken into account for the purpose of temperature gathering.

2.4.2.4. The temperatures shall be recorded at suitable locations, chosen in accordance with paragraphs 2.2.6. to 2.2.9., at a minimum rate of once every second (1 Hz).

2.4.2.5. The effective ageing time corresponding to the thermal sequences referred to in paragraph 2.4.2.3., shall be calculated in accordance with the following equations:

Equation 3:

$$t_e^i = \frac{\sum_{n_c=1}^{C} e^{\left(\left(\frac{R}{T_r}\right) - \left(\frac{R}{T_i}\right)\right)}}{C}$$

Equation 4:

$$\boldsymbol{AE = \sum_{i=1}^{p} t_e^i}$$

Where:

$\boldsymbol{t_e^i}$ = the effective ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device at the temperature T_i during the second *i*.

T_i = the temperature, in K, measured in the second *i*, in each one of the thermal sequences.

R = thermal reactivity of the replacement pollution control device. The manufacturer shall agree with the Type Approval Authority on the R value to be used. It will also be possible, as alternative, to use the following default values:

Diesel Oxidation Catalyst (DOC): 18,050

Catalysed DPF: 18,050

SCR or ammonia oxidation catalyst (AMOX) based on iron-zeolite (Fe-Z): 5,175

SCR copper-zeolite (Cu-Z): 11,550

SCR Vanadium (V): 5,175

LNT (lean-NOx trap): 18,050

Tr = reference temperature, in K, being the same value as in equation 1.

AE = effective ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount

of ageing as the one that would result from exposure of the replacement pollution control device during the duration of the thermal sequence.

AT = total equivalent ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device, over its useful life, to the temperature $\boldsymbol{T_{bin}^{i}}$ during the time $\boldsymbol{t_{bin}^{i}}$ of each one of the *i* bins registered in the histogram.

i = number of temperature measurement.

p = total number of temperature measurements.

n_c = thermal sequence number, of those conducted for the purpose of temperature gathering, in accordance with paragraph 2.4.2.3.

C = total number of thermal sequences conducted for the purpose of temperature gathering.

2.4.2.6. The total number of thermal sequences to be included in the service accumulation schedule shall be determined by applying the following equation:

Equation 5:

$N_{TS} = AT/AE$

Where:

N_{TS} = total number of thermal sequences to be carried out during the service accumulation schedule.

AT = total equivalent ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device, over its useful life, to the temperature $\boldsymbol{T_{bin}^{i}}$ during the time $\boldsymbol{t_{bin}^{i}}$ of each one of the *i* bins registered in the histogram.

AE = effective ageing time, in hours, needed to achieve, by exposing the replacement pollution control device at the temperature Tr, the same amount of ageing as the one that would result from exposure of the replacement pollution control device during the duration of the thermal sequence.

2.4.2.7. It is allowed to reduce N_{TS} and, consequently the service accumulation schedule, by increasing the temperatures at which each device is exposed at each mode of the ageing cycle through the application of one or several of the following measures:

(a) Insulating the exhaust pipe;

(b) Moving the replacement pollution control device closer to the exhaust manifold;

(c) Artificially heating up the temperature of the exhaust;

(d) Optimizing the engine settings without substantially changing the emission behaviour of the engine.

2.4.2.8. When applying the measures referred to in paragraphs 2.4.4.6. and 2.4.4.7., the total ageing time calculated from N_{TS} shall not be less than 10 per cent of the

useful life listed in Table 1, e.g. the vehicle category N_1 shall not have an N_{TS} of less than 286 thermal sequences, assuming that each sequence is 1 hour long.

2.4.2.9. It is allowed to increase N_{TS} and, consequently, the duration of the service accumulation schedule, by lowering the temperatures at each mode of the ageing cycle through the application of one or several of the following measures:

(a) Moving the replacement pollution control device further away from the exhaust manifold;

(b) Artificially cooling down the temperature of the exhaust;

(c) Optimizing the engine settings.

2.4.2.10. In the case referred to in paragraph 2.4.1.5., the following shall apply:

2.4.2.10.1. N_{TS} shall be the same for each device, so that a single service accumulation schedule can be set up.

2.4.2.10.2. In order to achieve the same N_{TS} for each device, a first N_{TS} value shall be calculated for each device, with its own AT and AE values.

2.4.2.10.3. If the calculated N_{TS} values are different, one or more of the measures set out in paragraphs 2.4.2.7. to 2.4.2.10. may be applied on the device or devices for which N_{TS} needs to be modified, over the thermal sequences referred to in paragraph 2.4.2.3., in order to influence the measured T_i and therefore conveniently speed up or slow down the artificial ageing of the targeted device or devices.

2.4.2.10.4. The new N_{TS} values corresponding to the new temperatures T_i obtained in paragraph 2.4.2.10.3. shall be calculated.

2.4.2.10.5. The steps set out in paragraphs 2.4.2.10.3. and 2.4.2.10.4. shall be repeated until the N_{TS} values obtained for each device in the system match.

2.4.2.10.6. The Tr values used for obtaining the different N_{TS} in paragraphs 2.4.2.10.4. and 2.4.2.10.5. shall be the same ones as those used in paragraphs 2.3.2. and 2.3.5. for calculating AT for each device.

2.4.2.11. In the case of an assembly of replacement pollution control devices constituting a system which is to be approved as a separate technical unit, one of the following two options may be considered for the thermal ageing of the devices:

2.4.2.11.1. The devices within the assembly may be either separately or jointly aged, in accordance with paragraph 2.4.2.10.

2.4.2.11.2. If the assembly is built in such a way that it is not possible to decouple the devices (e.g. DOC + SCR in a can), the thermal ageing of the assembly shall be carried out with the highest N_{TS}.

2.4.3. Modified thermal accumulation schedule for devices operating in the presence of active regeneration

2.4.3.1. The modified thermal accumulation schedule for devices operating in the presence of active regeneration shall simulate the effect of ageing due to both thermal load and active regeneration on a replacement pollution control device at the end of its lifetime.

2.4.3.2. The engine used for the service accumulation schedule, fitted with the exhaust after-treatment system incorporating the replacement pollution control device, is operated for a minimum of three modified thermal sequences, consisting each sequence of a thermal sequence as set out in Appendix 5, followed by a complete active regeneration, during which the peak temperature reached in the after-treatment system should be not lower than the peak temperature recorded in the data collection phase.

2.4.3.3. The temperatures shall be recorded over a minimum of two modified thermal sequences. The first sequence, conducted for warming up, shall not be taken into account for the purpose of temperature gathering.

2.4.3.4. In order to minimize the time elapsed between the thermal sequence as set out in Appendix 5 and the subsequent active regeneration, the manufacturer may artificially trigger the active regeneration by running, after each thermal sequence as set out in Appendix 5, the engine at a steady mode that enables a high production of soot by the engine. In that case, the steady mode shall also be considered as part of the modified thermal sequence set out in paragraph 2.4.3.2.

2.4.3.5. The effective ageing time corresponding to each modified thermal sequence shall be calculated using equations 3 and 4.

2.4.3.6. The total number of modified thermal sequences to be conducted during the service accumulation schedule shall be calculated using equation 5.

2.4.3.7. It is allowed to reduce N_{TS}, and consequently the duration of the service accumulation schedule, by increasing the temperatures at each mode of the modified thermal sequence, applying one or several of the measures set out in paragraph 2.4.2.7.

2.4.3.8. In addition to the measures referred to in paragraph 2.4.3.7., N_{TS} can also be reduced by increasing the peak temperature of the active regeneration within the modified thermal sequence, without exceeding a bed temperature of 800 ºC under any circumstances.

2.4.3.9. NTS shall never be less than 50 per cent of the number of active regenerations to which the replacement pollution control device is subjected during its useful life, calculated in accordance with the following equation:

Equation 5:

$$\boldsymbol{N_{AR} = \frac{t_{WHTC}}{t_{AR} + t_{BAR}}}$$

Where:

N_{AR} = number of active regeneration sequences over the useful life of the replacement pollution control device.

t_{WHTC} = equivalent number of hours corresponding to the vehicle category for which the replacement pollution control device is intended, obtained from Table 1.

t_{AR} = duration, in hours, of an active regeneration.

$\boldsymbol{t_{BAR}}$ = time, in hours, between two consecutive active regenerations.

2.4.3.10. If, as consequence of the application of the minimum number of modified thermal sequences as set out in paragraph 2.4.3.9., $\times \boldsymbol{N_{TS}}$, calculated using

equation 4 exceeds the AT calculated using equation 2, the time of each mode of the thermal sequence set out in Appendix 5, and embedded in the modified thermal sequence as set out in paragraph 2.4.3.2., may be reduced in the same proportion, in order to make $\boldsymbol{AE \times N_{TS} = AT}$.

2.4.3.11. It is allowed to increase N_{TS} and consequently the duration of the service accumulation schedule, by lowering the temperatures at each mode of the thermal-active regeneration sequence by applying one or several of the measures set out in paragraph 2.4.2.9.

2.4.3.12. In the case referred to in paragraphs 2.4.1.5., 2.4.2.10. and 2.4.2.11. shall apply.

2.4.4. Lubricant consumption accumulation schedule

2.4.4.1. The lubricant consumption accumulation schedule shall simulate the effect of ageing due to chemical poisoning or deposit formation as a result of lubricant consumption, on the performance of a replacement pollution control device at the end of its lifetime.

2.4.4.2. The lubricant consumed, in g/h, shall be determined over a minimum of 24 thermal sequences or a corresponding number of modified thermal sequences, using any suitable method, as for example the drain and weigh procedure described in Appendix 7. Fresh lubricant shall be used.

2.4.4.3. The engine shall be equipped with a constant volume oil sump in order to avoid the need of "top-offs", since oil level influences the oil consumption rate. Any suitable method, as for example the one described in the ASTM standard D7156-09, may be used.

2.4.4.4. The theoretical time, in hours, that the thermal accumulation schedule or modified thermal accumulation schedule, as it corresponds, would have to be conducted, in order to obtain the same lubricant consumption as the one corresponding to the useful life of the replacement control device, shall be calculated by applying the following equation:

Equation 6:

$$\boldsymbol{t_{TAS} = \frac{LCR_{WHTC} \times t_{WHTC}}{LCR_{TAS}}}$$

Where:

t_{TAS} = theoretical duration, in hours, of the service accumulation schedule required to obtain the same lubricant consumption as the one corresponding to the useful life of the replacement pollution control device, provided that the service accumulation schedule is only made up of a series of consecutive thermal sequences or consecutive modified thermal sequences.

LCR_{WHTC} = lubricant consumption rate, in g/h determined as set out in paragraph 2.2.15.

t_{WHTC} = equivalent number of hours corresponding to the vehicle category for which the replacement pollution control device is intended, obtained from Table 1.

LCR_{TAS} = lubricant consumption rate, in g/h, determined as set out in paragraph 2.4.4.2.

2.4.4.5. The number of thermal sequences or modified thermal sequences corresponding to t_{TAS} shall be calculated by applying the following ratio:

Equation 7:

$$N = \frac{t_{TAS}}{t_{TS}}$$

Where:

N = number of thermal sequences or modified thermal sequences corresponding to t_{TAS}.

t_{TAS} = theoretical duration, in hours, of the service accumulation schedule required to obtain the same lubricant consumption as the one corresponding to the useful life of the replacement pollution control device, provided that the service accumulation schedule was only made up of a series of consecutive thermal sequences or consecutive modified thermal sequences.

t_{TS} = duration, in hours, of a single thermal sequence or modified thermal sequence.

2.4.4.6. The value of N shall be compared to the value of N_{TS} calculated in accordance with paragraph 2.4.2.6. or, for devices operating in the presence of active regeneration, in accordance with paragraph 2.4.3.5. If $N \leq NTS$, it is not necessary to add a lubricant consumption accumulation schedule to the thermal accumulation schedule. If $N > N_{TS}$, a lubricant consumption accumulation schedule shall be added to the thermal accumulation schedule.

2.4.4.7. A lubricant consumption accumulation schedule may not have to be added if, by increasing the lubricant consumption as described in paragraph 2.4.4.8.4., the needed lubricant consumption is already achieved with the conduction of the corresponding thermal accumulation schedule consisting of the performance of NTS thermal sequences or modified thermal sequences.

2.4.4.8. Development of the lubricant consumption accumulation schedule

2.4.4.8.1. The lubricant consumption accumulation schedule shall consist of a number of lubricant consumption sequences repeated several times, each lubricant consumption sequence being alternated with each thermal sequence or each modified thermal sequence.

2.4.4.8.2. Each lubricant consumption sequence shall consist of a steady mode at constant load and speed, the load and the speed being selected in such a way that the lubricant consumption is maximized and effective thermal aging is minimized. The mode shall be determined by the manufacturer in agreement with the Type Approval Authority, based on best engineering judgement.

2.4.4.8.3. The duration of each lubricant consumption sequence shall be determined as follows:

2.4.4.8.3.1. The engine shall be run for an appropriate period of time at the load and speed determined by the manufacturer in accordance with paragraph 2.4.4.8.2. and the lubricant consumed, in g/h, shall be determined using any suitable method, as for example the drain and weigh procedure described in Appendix 7. Lubricant changes are to be completed at the recommended intervals.

2.4.4.8.3.2. The duration of each lubricant consumption sequence shall be calculated by applying the following equation:

Equation 8:

$$t_{LS} = \frac{LCR_{WHTC} \times t_{WHTC} - LCR_{TAS} \times N_{TS} \times t_{TS}}{LCR_{LAS} \times N_{TS}}$$

Where:

t_{LS} = the duration, in hours, of a single lubricant consumption sequence LCR_{WHTC} = lubricant consumption rate, in g/h determined as set out in paragraph 2.2.15.

t_{WHTC} = equivalent number of hours corresponding to the vehicle category for which the replacement pollution control device is intended, obtained from Table 1.

LCR_{TAS} = lubricant consumption rate, in g/h, determined as set out in paragraph 2.4.4.2.

LCR_{LAS} = lubricant consumption rate, in g/h, determined as set out in paragraph 2.4.4.8.3.1.

t_{TS} = duration, in hours, of a single thermal sequence, as set out in Appendix 4, or modified thermal sequence, as set out in paragraph 2.4.3.2.

N_{TS} = total number of thermal sequences or modified thermal sequences to be carried out during the service accumulation schedule.

2.4.4.8.4. The lubricant consumption rate shall always remain below 0.5 per cent of the engine fuel consumption rate in order to avoid excessive ash accumulation on the front face of the replacement pollution control device.

2.4.4.8.5. It is allowed to add the thermal ageing due to the conduction of the lubricant consumption sequence to the AE calculated in equation 4.

2.4.5. Development of the complete service accumulation schedule

2.4.5.1. The service accumulation schedule shall be built up alternating a thermal or a modified thermal sequence, as appropriate, with a lubricant consumption sequence. The aforementioned pattern shall be repeated NTS times, being the NTS value the one calculated either in accordance with section 2.4.2. or with section 2.4.3., as appropriate. An example of a complete service accumulation schedule is given in Appendix 8. A flowchart describing the development of a complete service accumulation schedule is given in Appendix 9.

2.4.6. Operation of the service accumulation schedule

2.4.6.1. The engine, fitted with the exhaust after-treatment system incorporating the replacement pollution control device, shall run the service accumulation schedule set out in paragraph 2.4.5.1.

2.4.6.2. The engine used for the performance of the service accumulation schedule may be different to the engine used in the data collection phase, being the latter always the one for which the replacement pollution control device to be type approved has been designed, and the one to be tested for emissions under paragraph 2.4.3.2.

2.4.6.3. If the engine used for the performance of the service accumulation schedule features a larger displacement by 20 per cent or more than the engine used in the data collection phase, the exhaust system of the former should be equipped

with a by-pass in order to replicate as closely as possible the exhaust flow rate of the latter at the ageing conditions selected.

2.4.6.4. In the case referred to in paragraph 2.4.6.2., the engine used for the performance of the service accumulation schedule shall be type approved under this Regulation. In addition, if the device or devices under test are intended for being fitted in an engine system with Exhaust Gas Recirculation (EGR), the engine system used for the service accumulation schedule shall also be fitted with an EGR. If the device or devices under test are intended for not being fitted in an engine system with EGR, the engine system used for the service accumulation schedule shall also not be fitted with an EGR.

2.4.6.5. The lubricant and the fuel used in the service accumulation schedule shall be as similar as possible to those used during the data collection phase set out in paragraph 2.2. The lubricant must be in line with the recommendation of the engine manufacturer for which the pollution control device is designed. The fuels used should be market fuels fulfilling the corresponding requirements of the European Directive 98/70/EC. On the request of the manufacturer also reference fuels in accordance with this Regulation can be used.

2.4.6.6. The lubricant shall be changed for maintenance, at the intervals scheduled by the manufacturer of the engine used in the data collection phase.

2.4.6.7. In the case of an SCR, the urea injection shall be performed in accordance with the strategy defined by the manufacturer of the replacement pollution control device."

Insert new Appendices 5 to 9, to read:

"Annex 13 - Appendix 5

Sequence for thermal ageing

Mode	*Speed (% of high idle)*	*Load (% for a given speed)*	*Time (s)*
1	2.92	0.58	626
2	45.72	1.58	418
3	38.87	3.37	300
4	20.23	11.36	102
5	11.37	14.90	62
6	32.78	18.52	370
7	53.12	20.19	410
8	59.53	34.73	780
9	78.24	54.38	132
10	39.07	62.85	212
11	47.82	62.94	188
Regeneration mode (if applicable)	To be defined (see paragraph 2.4.3.4.)	To be defined (see paragraph 2.4.3.4.)	To be defined (see paragraph 2.4.3.4.)
Lubricant consumption mode (if applicable)	To be defined according to paragraph 2.4.4.8.2.	To be defined according to paragraph 2.4.4.8.2.	To be defined according to paragraph 2.4.4.8.3.

Note: The sequence of the modes 1 to 11 has been arranged by ascending load in order to maximize the temperature of the exhaust gas in the high load modes. With the agreement of the Type Approval Authority, this order can be modified in order to optimize the temperature of the exhaust gas if this can help in reducing the actual aging time.

Annex 13 - Appendix 6

Test-cycle for chassis dynamometer or on-road data gathering

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
1	0	261	22.38	521	35.46	781	18.33	1 041	39.88	1 301	66.39	1 561	86.88
2	0	262	24.75	522	36.81	782	18.31	1 042	41.25	1 302	66.74	1 562	86.7
3	0	263	25.55	523	37.98	783	18.05	1 043	42.07	1 303	67.43	1 563	86.81
4	0	264	25.18	524	38.84	784	17.39	1 044	43.03	1 304	68.44	1 564	86.81
5	0	265	23.94	525	39.43	785	16.35	1 045	44.4	1 305	69.52	1 565	86.81
6	0	266	22.35	526	39.73	786	14.71	1 046	45.14	1 306	70.53	1 566	86.81
7	2.35	267	21.28	527	39.8	787	11.71	1 047	45.44	1 307	71.47	1 567	86.99
8	5.57	268	20.86	528	39.69	788	7.81	1 048	46.13	1 308	72.32	1 568	87.03
9	8.18	269	20.65	529	39.29	789	5.25	1 049	46.79	1 309	72.89	1 569	86.92
10	9.37	270	20.18	530	38.59	790	4.62	1 050	47.45	1 310	73.07	1 570	87.1
11	9.86	271	19.33	531	37.63	791	5.62	1 051	48.68	1 311	73.03	1 571	86.85
12	10.18	272	18.23	532	36.22	792	8.24	1 052	50.13	1 312	72.94	1 572	87.14
13	10.38	273	16.99	533	34.11	793	10.98	1 053	51.16	1 313	73.01	1 573	86.96
14	10.57	274	15.56	534	31.16	794	13.15	1 054	51.37	1 314	73.44	1 574	86.85
15	10.95	275	13.76	535	27.49	795	15.47	1 055	51.3	1 315	74.19	1 575	86.77
16	11.56	276	11.5	536	23.63	796	18.19	1 056	51.15	1 316	74.81	1 576	86.81
17	12.22	277	8.68	537	20.16	797	20.79	1 057	50.88	1 317	75.01	1 577	86.85
18	12.97	278	5.2	538	17.27	798	22.5	1 058	50.63	1 318	74.99	1 578	86.74
19	14.33	279	1.99	539	14.81	799	23.19	1 059	50.2	1 319	74.79	1 579	86.81
20	16.38	280	0	540	12.59	800	23.54	1 060	49.12	1 320	74.41	1 580	86.7
21	18.4	281	0	541	10.47	801	24.2	1 061	48.02	1 321	74.07	1 581	86.52
22	19.86	282	0	542	8.85	802	25.17	1 062	47.7	1 322	73.77	1 582	86.7
23	20.85	283	0.5	543	8.16	803	26.28	1 063	47.93	1 323	73.38	1 583	86.74
24	21.52	284	0.57	544	8.95	804	27.69	1 064	48.57	1 324	72.79	1 584	86.81
25	21.89	285	0.6	545	11.3	805	29.72	1 065	48.88	1 325	71.95	1 585	86.85
26	21.98	286	0.58	546	14.11	806	32.17	1 066	49.03	1 326	71.06	1 586	86.92
27	21.91	287	0	547	15.91	807	34.22	1 067	48.94	1 327	70.45	1 587	86.88
28	21.68	288	0	548	16.57	808	35.31	1 068	48.32	1 328	70.23	1 588	86.85
29	21.21	289	0	549	16.73	809	35.74	1 069	47.97	1 329	70.24	1 589	87.1
30	20.44	290	0	550	17.24	810	36.23	1 070	47.92	1 330	70.32	1 590	86.81
31	19.24	291	0	551	18.45	811	37.34	1 071	47.54	1 331	70.3	1 591	86.99
32	17.57	292	0	552	20.09	812	39.05	1 072	46.79	1 332	70.05	1 592	86.81
33	15.53	293	0	553	21.63	813	40.76	1 073	46.13	1 333	69.66	1 593	87.14

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
34	13.77	294	0	554	22.78	814	41.82	1 074	45.73	1 334	69.26	1 594	86.81
35	12.95	295	0	555	23.59	815	42.12	1 075	45.17	1 335	68.73	1 595	86.85
36	12.95	296	0	556	24.23	816	42.08	1 076	44.43	1 336	67.88	1 596	87.03
37	13.35	297	0	557	24.9	817	42.27	1 077	43.59	1 337	66.68	1 597	86.92
38	13.75	298	0	558	25.72	818	43.03	1 078	42.68	1 338	65.29	1 598	87.14
39	13.82	299	0	559	26.77	819	44.14	1 079	41.89	1 339	63.95	1 599	86.92
40	13.41	300	0	560	28.01	820	45.13	1 080	41.09	1 340	62.84	1 600	87.03
41	12.26	301	0	561	29.23	821	45.84	1 081	40.38	1 341	62.21	1 601	86.99
42	9.82	302	0	562	30.06	822	46.4	1 082	39.99	1 342	62.04	1 602	86.96
43	5.96	303	0	563	30.31	823	46.89	1 083	39.84	1 343	62.26	1 603	87.03
44	2.2	304	0	564	30.29	824	47.34	1 084	39.46	1 344	62.87	1 604	86.85
45	0	305	0	565	30.05	825	47.66	1 085	39.15	1 345	63.55	1 605	87.1
46	0	306	0	566	29.44	826	47.77	1 086	38.9	1 346	64.12	1 606	86.81
47	0	307	0	567	28.6	827	47.78	1 087	38.67	1 347	64.73	1 607	87.03
48	0	308	0	568	27.63	828	47.64	1 088	39.03	1 348	65.45	1 608	86.77
49	0	309	0	569	26.66	829	47.23	1 089	40.37	1 349	66.18	1 609	86.99
50	1.87	310	0	570	26.03	830	46.66	1 090	41.03	1 350	66.97	1 610	86.96
51	4.97	311	0	571	25.85	831	46.08	1 091	40.76	1 351	67.85	1 611	86.96
52	8.4	312	0	572	26.14	832	45.45	1 092	40.02	1 352	68.74	1 612	87.07
53	9.9	313	0	573	27.08	833	44.69	1 093	39.6	1 353	69.45	1 613	86.96
54	11.42	314	0	574	28.42	834	43.73	1 094	39.37	1 354	69.92	1 614	86.92
55	15.11	315	0	575	29.61	835	42.55	1 095	38.84	1 355	70.24	1 615	87.07
56	18.46	316	0	576	30.46	836	41.14	1 096	37.93	1 356	70.49	1 616	86.92
57	20.21	317	0	577	30.99	837	39.56	1 097	37.19	1 357	70.63	1 617	87.14
58	22.13	318	0	578	31.33	838	37.93	1 098	36.21	1 358	70.68	1 618	86.96
59	24.17	319	0	579	31.65	839	36.69	1 099	35.32	1 359	70.65	1 619	87.03
60	25.56	320	0	580	32.02	840	36.27	1 100	35.56	1 360	70.49	1 620	86.85
61	26.97	321	0	581	32.39	841	36.42	1 101	36.96	1 361	70.09	1 621	86.77
62	28.83	322	0	582	32.68	842	37.14	1 102	38.12	1 362	69.35	1 622	87.1
63	31.05	323	0	583	32.84	843	38.13	1 103	38.71	1 363	68.27	1 623	86.92
64	33.72	324	3.01	584	32.93	844	38.55	1 104	39.26	1 364	67.09	1 624	87.07
65	36	325	8.14	585	33.22	845	38.42	1 105	40.64	1 365	65.96	1 625	86.85
66	37.91	326	13.88	586	33.89	846	37.89	1 106	43.09	1 366	64.87	1 626	86.81
67	39.65	327	18.08	587	34.96	847	36.89	1 107	44.83	1 367	63.79	1 627	87.14
68	41.23	328	20.01	588	36.28	848	35.53	1 108	45.33	1 368	62.82	1 628	86.77
69	42.85	329	20.3	589	37.58	849	34.01	1 109	45.24	1 369	63.03	1 629	87.03
70	44.1	330	19.53	590	38.58	850	32.88	1 110	45.14	1 370	63.62	1 630	86.96
71	44.37	331	17.92	591	39.1	851	32.52	1 111	45.06	1 371	64.8	1 631	87.1

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
72	44.3	332	16.17	592	39.22	852	32.7	1 112	44.82	1 372	65.5	1 632	86.99
73	44.17	333	14.55	593	39.11	853	33.48	1 113	44.53	1 373	65.33	1 633	86.92
74	44.13	334	12.92	594	38.8	854	34.97	1 114	44.77	1 374	63.83	1 634	87.1
75	44.17	335	11.07	595	38.31	855	36.78	1 115	45.6	1 375	62.44	1 635	86.85
76	44.51	336	8.54	596	37.73	856	38.64	1 116	46.28	1 376	61.2	1 636	86.92
77	45.16	337	5.15	597	37.24	857	40.48	1 117	47.18	1 377	59.58	1 637	86.77
78	45.64	338	1.96	598	37.06	858	42.34	1 118	48.49	1 378	57.68	1 638	86.88
79	46.16	339	0	599	37.1	859	44.16	1 119	49.42	1 379	56.4	1 639	86.63
80	46.99	340	0	600	37.42	860	45.9	1 120	49.56	1 380	54.82	1 640	86.85
81	48.19	341	0	601	38.17	861	47.55	1 121	49.47	1 381	52.77	1 641	86.63
82	49.32	342	0	602	39.19	862	49.09	1 122	49.28	1 382	52.22	1 642	86.77
83	49.7	343	0	603	40.31	863	50.42	1 123	48.58	1 383	52.48	1 643	86.77
84	49.5	344	0	604	41.46	864	51.49	1 124	48.03	1 384	52.74	1 644	86.55
85	48.98	345	0	605	42.44	865	52.23	1 125	48.2	1 385	53.14	1 645	86.59
86	48.65	346	0	606	42.95	866	52.58	1 126	48.72	1 386	53.03	1 646	86.55
87	48.65	347	0	607	42.9	867	52.63	1 127	48.91	1 387	52.55	1 647	86.7
88	48.87	348	0	608	42.43	868	52.49	1 128	48.93	1 388	52.19	1 648	86.44
89	48.97	349	0	609	41.74	869	52.19	1 129	49.05	1 389	51.09	1 649	86.7
90	48.96	350	0	610	41.04	870	51.82	1 130	49.23	1 390	49.88	1 650	86.55
91	49.15	351	0	611	40.49	871	51.43	1 131	49.28	1 391	49.37	1 651	86.33
92	49.51	352	0	612	40.8	872	51.02	1 132	48.84	1 392	49.26	1 652	86.48
93	49.74	353	0	613	41.66	873	50.61	1 133	48.12	1 393	49.37	1 653	86.19
94	50.31	354	0.9	614	42.48	874	50.26	1 134	47.8	1 394	49.88	1 654	86.37
95	50.78	355	2	615	42.78	875	50.06	1 135	47.42	1 395	50.25	1 655	86.59
96	50.75	356	4.08	616	42.39	876	49.97	1 136	45.98	1 396	50.17	1 656	86.55
97	50.78	357	7.07	617	40.78	877	49.67	1 137	42.96	1 397	50.5	1 657	86.7
98	51.21	358	10.25	618	37.72	878	48.86	1 138	39.38	1 398	50.83	1 658	86.63
99	51.6	359	12.77	619	33.29	879	47.53	1 139	35.82	1 399	51.23	1 659	86.55
100	51.89	360	14.44	620	27.66	880	45.82	1 140	31.85	1 400	51.67	1 660	86.59
101	52.04	361	15.73	621	21.43	881	43.66	1 141	26.87	1 401	51.53	1 661	86.55
102	51.99	362	17.23	622	15.62	882	40.91	1 142	21.41	1 402	50.17	1 662	86.7
103	51.99	363	19.04	623	11.51	883	37.78	1 143	16.41	1 403	49.99	1 663	86.55
104	52.36	364	20.96	624	9.69	884	34.89	1 144	12.56	1 404	50.32	1 664	86.7
105	52.58	365	22.94	625	9.46	885	32.69	1 145	10.41	1 405	51.05	1 665	86.52
106	52.47	366	25.05	626	10.21	886	30.99	1 146	9.07	1 406	51.45	1 666	86.85
107	52.03	367	27.31	627	11.78	887	29.31	1 147	7.69	1 407	52	1 667	86.55
108	51.46	368	29.54	628	13.6	888	27.29	1 148	6.28	1 408	52.3	1 668	86.81
109	51.31	369	31.52	629	15.33	889	24.79	1 149	5.08	1 409	52.22	1 669	86.74

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
110	51.45	370	33.19	630	17.12	890	21.78	1 150	4.32	1 410	52.66	1 670	86.63
111	51.48	371	34.67	631	18.98	891	18.51	1 151	3.32	1 411	53.18	1 671	86.77
112	51.29	372	36.13	632	20.73	892	15.1	1 152	1.92	1 412	53.8	1 672	87.03
113	51.12	373	37.63	633	22.17	893	11.06	1 153	1.07	1 413	54.53	1 673	87.07
114	50.96	374	39.07	634	23.29	894	6.28	1 154	0.66	1 414	55.37	1 674	86.92
115	50.81	375	40.08	635	24.19	895	2.24	1 155	0	1 415	56.29	1 675	87.07
116	50.86	376	40.44	636	24.97	896	0	1 156	0	1 416	57.31	1 676	87.18
117	51.34	377	40.26	637	25.6	897	0	1 157	0	1 417	57.94	1 677	87.32
118	51.68	378	39.29	638	25.96	898	0	1 158	0	1 418	57.86	1 678	87.36
119	51.58	379	37.23	639	25.86	899	0	1 159	0	1 419	57.75	1 679	87.29
120	51.36	380	34.14	640	24.69	900	0	1 160	0	1 420	58.67	1 680	87.58
121	51.39	381	30.18	641	21.85	901	0	1 161	0	1 421	59.4	1 681	87.61
122	50.98	382	25.71	642	17.45	902	2.56	1 162	0	1 422	59.69	1 682	87.76
123	48.63	383	21.58	643	12.34	903	4.81	1 163	0	1 423	60.02	1 683	87.65
124	44.83	384	18.5	644	7.59	904	6.38	1 164	0	1 424	60.21	1 684	87.61
125	40.3	385	16.56	645	4	905	8.62	1 165	0	1 425	60.83	1 685	87.65
126	35.65	386	15.39	646	1.76	906	10.37	1 166	0	1 426	61.16	1 686	87.65
127	30.23	387	14.77	647	0	907	11.17	1 167	0	1 427	61.6	1 687	87.76
128	24.08	388	14.58	648	0	908	13.32	1 168	0	1 428	62.15	1 688	87.76
129	18.96	389	14.72	649	0	909	15.94	1 169	0	1 429	62.7	1 689	87.8
130	14.19	390	15.44	650	0	910	16.89	1 170	0	1 430	63.65	1 690	87.72
131	8.72	391	16.92	651	0	911	17.13	1 171	0	1 431	64.27	1 691	87.69
132	3.41	392	18.69	652	0	912	18.04	1 172	0	1 432	64.31	1 692	87.54
133	0.64	393	20.26	653	0	913	19.96	1 173	0	1 433	64.13	1 693	87.76
134	0	394	21.63	654	0	914	22.05	1 174	0	1 434	64.27	1 694	87.5
135	0	395	22.91	655	0	915	23.65	1 175	0	1 435	65.22	1 695	87.43
136	0	396	24.13	656	0	916	25.72	1 176	0	1 436	66.25	1 696	87.47
137	0	397	25.18	657	0	917	28.62	1 177	0	1 437	67.09	1 697	87.5
138	0	398	26.16	658	2.96	918	31.99	1 178	0	1 438	68.37	1 698	87.5
139	0	399	27.41	659	7.9	919	35.07	1 179	0	1 439	69.36	1 699	87.18
140	0	400	29.18	660	13.49	920	37.42	1 180	0	1 440	70.57	1 700	87.36
141	0	401	31.36	661	18.36	921	39.65	1 181	0	1 441	71.89	1 701	87.29
142	0.63	402	33.51	662	22.59	922	41.78	1 182	0	1 442	73.35	1 702	87.18
143	1.56	403	35.33	663	26.26	923	43.04	1 183	0	1 443	74.64	1 703	86.92
144	2.99	404	36.94	664	29.4	924	43.55	1 184	0	1 444	75.81	1 704	87.36
145	4.5	405	38.6	665	32.23	925	42.97	1 185	0	1 445	77.24	1 705	87.03
146	5.39	406	40.44	666	34.91	926	41.08	1 186	0	1 446	78.63	1 706	87.07
147	5.59	407	42.29	667	37.39	927	40.38	1 187	0	1 447	79.32	1 707	87.29

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
148	5.45	408	43.73	668	39.61	928	40.43	1 188	0	1 448	80.2	1 708	86.99
149	5.2	409	44.47	669	41.61	929	40.4	1 189	0	1 449	81.67	1 709	87.25
150	4.98	410	44.62	670	43.51	930	40.25	1 190	0	1 450	82.11	1 710	87.14
151	4.61	411	44.41	671	45.36	931	40.32	1 191	0	1 451	82.91	1 711	86.96
152	3.89	412	43.96	672	47.17	932	40.8	1 192	0	1 452	83.43	1 712	87.14
153	3.21	413	43.41	673	48.95	933	41.71	1 193	0	1 453	83.79	1 713	87.07
154	2.98	414	42.83	674	50.73	934	43.16	1 194	0	1 454	83.5	1 714	86.92
155	3.31	415	42.15	675	52.36	935	44.84	1 195	0	1 455	84.01	1 715	86.88
156	4.18	416	41.28	676	53.74	936	46.42	1 196	1.54	1 456	83.43	1 716	86.85
157	5.07	417	40.17	677	55.02	937	47.91	1 197	4.85	1 457	82.99	1 717	86.92
158	5.52	418	38.9	678	56.24	938	49.08	1 198	9.06	1 458	82.77	1 718	86.81
159	5.73	419	37.59	679	57.29	939	49.66	1 199	11.8	1 459	82.33	1 719	86.88
160	6.06	420	36.39	680	58.18	940	50.15	1 200	12.42	1 460	81.78	1 720	86.66
161	6.76	421	35.33	681	58.95	941	50.94	1 201	12.07	1 461	81.81	1 721	86.92
162	7.7	422	34.3	682	59.49	942	51.69	1 202	11.64	1 462	81.05	1 722	86.48
163	8.34	423	33.07	683	59.86	943	53.5	1 203	11.69	1 463	80.72	1 723	86.66
164	8.51	424	31.41	684	60.3	944	55.9	1 204	12.91	1 464	80.61	1 724	86.74
165	8.22	425	29.18	685	61.01	945	57.11	1 205	15.58	1 465	80.46	1 725	86.37
166	7.22	426	26.41	686	61.96	946	57.88	1 206	18.69	1 466	80.42	1 726	86.48
167	5.82	427	23.4	687	63.05	947	58.63	1 207	21.04	1 467	80.42	1 727	86.33
168	4.75	428	20.9	688	64.16	948	58.75	1 208	22.62	1 468	80.24	1 728	86.3
169	4.24	429	19.59	689	65.14	949	58.26	1 209	24.34	1 469	80.13	1 729	86.44
170	4.05	430	19.36	690	65.85	950	58.03	1 210	26.74	1 470	80.39	1 730	86.33
171	3.98	431	19.79	691	66.22	951	58.28	1 211	29.62	1 471	80.72	1 731	86
172	3.91	432	20.43	692	66.12	952	58.67	1 212	32.65	1 472	81.01	1 732	86.33
173	3.86	433	20.71	693	65.01	953	58.76	1 213	35.57	1 473	81.52	1 733	86.22
174	4.17	434	20.56	694	62.22	954	58.82	1 214	38.07	1 474	82.4	1 734	86.08
175	5.32	435	19.96	695	57.44	955	59.09	1 215	39.71	1 475	83.21	1 735	86.22
176	7.53	436	20.22	696	51.47	956	59.38	1 216	40.36	1 476	84.05	1 736	86.33
177	10.89	437	21.48	697	45.98	957	59.72	1 217	40.6	1 477	84.85	1 737	86.33
178	14.81	438	23.67	698	41.72	958	60.04	1 218	41.15	1 478	85.42	1 738	86.26
179	17.56	439	26.09	699	38.22	959	60.13	1 219	42.23	1 479	86.18	1 739	86.48
180	18.38	440	28.16	700	34.65	960	59.33	1 220	43.61	1 480	86.45	1 740	86.48
181	17.49	441	29.75	701	30.65	961	58.52	1 221	45.08	1 481	86.64	1 741	86.55
182	15.18	442	30.97	702	26.46	962	57.82	1 222	46.58	1 482	86.57	1 742	86.66
183	13.08	443	31.99	703	22.32	963	56.68	1 223	48.13	1 483	86.43	1 743	86.66
184	12.23	444	32.84	704	18.15	964	55.36	1 224	49.7	1 484	86.58	1 744	86.59
185	12.03	445	33.33	705	13.79	965	54.63	1 225	51.27	1 485	86.8	1 745	86.55

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
186	11.72	446	33.45	706	9.29	966	54.04	1 226	52.8	1 486	86.65	1 746	86.74
187	10.69	447	33.27	707	4.98	967	53.15	1 227	54.3	1 487	86.14	1 747	86.21
188	8.68	448	32.66	708	1.71	968	52.02	1 228	55.8	1 488	86.36	1 748	85.96
189	6.2	449	31.73	709	0	969	51.37	1 229	57.29	1 489	86.32	1 749	85.5
190	4.07	450	30.58	710	0	970	51.41	1 230	58.73	1 490	86.25	1 750	84.77
191	2.65	451	29.2	711	0	971	52.2	1 231	60.12	1 491	85.92	1 751	84.65
192	1.92	452	27.56	712	0	972	53.52	1 232	61.5	1 492	86.14	1 752	84.1
193	1.69	453	25.71	713	0	973	54.34	1 233	62.94	1 493	86.36	1 753	83.46
194	1.68	454	23.76	714	0	974	54.59	1 234	64.39	1 494	86.25	1 754	82.77
195	1.66	455	21.87	715	0	975	54.92	1 235	65.52	1 495	86.5	1 755	81.78
196	1.53	456	20.15	716	0	976	55.69	1 236	66.07	1 496	86.14	1 756	81.16
197	1.3	457	18.38	717	0	977	56.51	1 237	66.19	1 497	86.29	1 757	80.42
198	1	458	15.93	718	0	978	56.73	1 238	66.19	1 498	86.4	1 758	79.21
199	0.77	459	12.33	719	0	979	56.33	1 239	66.43	1 499	86.36	1 759	78.48
200	0.63	460	7.99	720	0	980	55.38	1 240	67.07	1 500	85.63	1 760	77.49
201	0.59	461	4.19	721	0	981	54.99	1 241	68.04	1 501	86.03	1 761	76.69
202	0.59	462	1.77	722	0	982	54.75	1 242	69.12	1 502	85.92	1 762	75.92
203	0.57	463	0.69	723	0	983	54.11	1 243	70.08	1 503	86.14	1 763	75.08
204	0.53	464	1.13	724	0	984	53.32	1 244	70.91	1 504	86.32	1 764	73.87
205	0.5	465	2.2	725	0	985	52.41	1 245	71.73	1 505	85.92	1 765	72.15
206	0	466	3.59	726	0	986	51.45	1 246	72.66	1 506	86.11	1 766	69.69
207	0	467	4.88	727	0	987	50.86	1 247	73.67	1 507	85.91	1 767	67.17
208	0	468	5.85	728	0	988	50.48	1 248	74.55	1 508	85.83	1 768	64.75
209	0	469	6.72	729	0	989	49.6	1 249	75.18	1 509	85.86	1 769	62.55
210	0	470	8.02	730	0	990	48.55	1 250	75.59	1 510	85.5	1 770	60.32
211	0	471	10.02	731	0	991	47.87	1 251	75.82	1 511	84.97	1 771	58.45
212	0	472	12.59	732	0	992	47.42	1 252	75.9	1 512	84.8	1 772	56.43
213	0	473	15.43	733	0	993	46.86	1 253	75.92	1 513	84.2	1 773	54.35
214	0	474	18.32	734	0	994	46.08	1 254	75.87	1 514	83.26	1 774	52.22
215	0	475	21.19	735	0	995	45.07	1 255	75.68	1 515	82.77	1 775	50.25
216	0	476	24	736	0	996	43.58	1 256	75.37	1 516	81.78	1 776	48.23
217	0	477	26.75	737	0	997	41.04	1 257	75.01	1 517	81.16	1 777	46.51
218	0	478	29.53	738	0	998	38.39	1 258	74.55	1 518	80.42	1 778	44.35
219	0	479	32.31	739	0	999	35.69	1 259	73.8	1 519	79.21	1 779	41.97
220	0	480	34.8	740	0	1 000	32.68	1 260	72.71	1 520	78.83	1 780	39.33
221	0	481	36.73	741	0	1 001	29.82	1 261	71.39	1 521	78.52	1 781	36.48
222	0	482	38.08	742	0	1 002	26.97	1 262	70.02	1 522	78.52	1 782	33.8
223	0	483	39.11	743	0	1 003	24.03	1 263	68.71	1 523	78.81	1 783	31.09

Time	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*	*Time*	*Speed*
s	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*	*s*	*km/h*
224	0	484	40.16	744	0	1 004	21.67	1 264	67.52	1 524	79.26	1 784	28.24
225	0	485	41.18	745	0	1 005	20.34	1 265	66.44	1 525	79.61	1 785	26.81
226	0.73	486	41.75	746	0	1 006	18.9	1 266	65.45	1 526	80.15	1 786	23.33
227	0.73	487	41.87	747	0	1 007	16.21	1 267	64.49	1 527	80.39	1 787	19.01
228	0	488	41.43	748	0	1 008	13.84	1 268	63.54	1 528	80.72	1 788	15.05
229	0	489	39.99	749	0	1 009	12.25	1 269	62.6	1 529	81.01	1 789	12.09
230	0	490	37.71	750	0	1 010	10.4	1 270	61.67	1 530	81.52	1 790	9.49
231	0	491	34.93	751	0	1 011	7.94	1 271	60.69	1 531	82.4	1 791	6.81
232	0	492	31.79	752	0	1 012	6.05	1 272	59.64	1 532	83.21	1 792	4.28
233	0	493	28.65	753	0	1 013	5.67	1 273	58.6	1 533	84.05	1 793	2.09
234	0	494	25.92	754	0	1 014	6.03	1 274	57.64	1 534	85.15	1 794	0.88
235	0	495	23.91	755	0	1 015	7.68	1 275	56.79	1 535	85.92	1 795	0.88
236	0	496	22.81	756	0	1 016	10.97	1 276	55.95	1 536	86.98	1 796	0
237	0	497	22.53	757	0	1 017	14.72	1 277	55.09	1 537	87.45	1 797	0
238	0	498	22.62	758	0	1 018	17.32	1 278	54.2	1 538	87.54	1 798	0
239	0	499	22.95	759	0	1 019	18.59	1 279	53.33	1 539	87.25	1 799	0
240	0	500	23.51	760	0	1 020	19.35	1 280	52.52	1 540	87.04	1 800	0
241	0	501	24.04	761	0	1 021	20.54	1 281	51.75	1 541	86.98		
242	0	502	24.45	762	0	1 022	21.33	1 282	50.92	1 542	87.05		
243	0	503	24.81	763	0	1 023	22.06	1 283	49.9	1 543	87.1		
244	0	504	25.29	764	0	1 024	23.39	1 284	48.68	1 544	87.25		
245	0	505	25.99	765	0	1 025	25.52	1 285	47.41	1 545	87.25		
246	0	506	26.83	766	0	1 026	28.28	1 286	46.5	1 546	87.07		
247	0	507	27.6	767	0	1 027	30.38	1 287	46.22	1 547	87.29		
248	0	508	28.17	768	0	1 028	31.22	1 288	46.44	1 548	87.14		
249	0	509	28.63	769	0	1 029	32.22	1 289	47.35	1 549	87.03		
250	0	510	29.04	770	0	1 030	33.78	1 290	49.01	1 550	87.25		
251	0	511	29.43	771	0	1 031	35.08	1 291	50.93	1 551	87.03		
252	0	512	29.78	772	1.6	1 032	35.91	1 292	52.79	1 552	87.03		
253	1.51	513	30.13	773	5.03	1 033	36.06	1 293	54.66	1 553	87.07		
254	4.12	514	30.57	774	9.49	1 034	35.5	1 294	56.6	1 554	86.81		
255	7.02	515	31.1	775	13	1 035	34.76	1 295	58.55	1 555	86.92		
256	9.45	516	31.65	776	14.65	1 036	34.7	1 296	60.47	1 556	86.66		
257	11.86	517	32.14	777	15.15	1 037	35.41	1 297	62.28	1 557	86.92		
258	14.52	518	32.62	778	15.67	1 038	36.65	1 298	63.9	1 558	86.59		
259	17.01	519	33.25	779	16.76	1 039	37.57	1 299	65.2	1 559	86.92		
260	19.48	520	34.2	780	17.88	1 040	38.51	1 300	66.02	1 560	86.59		

Annex 13 - Appendix 7

Drain and weigh procedure

1. The engine shall be filled with new oil. If a constant volume oil sump system (as described in ASTM standard D7156-09) is used, the oil pump shall be turned on while filling the engine. Enough oil charge shall be added to fill up both the engine and external sump.

2. The engine shall be started and operated over the desired test cycle (see paragraphs 2.2.15. and 2.4.4.8.3.1.) for a minimum of 1 hour.

3. Once the cycle is complete, oil temperature shall be allowed to stabilize at a steady state engine condition before shutting the engine down.

4. A clean, empty oil drain pan shall be weighed.

5. Any clean supplies that are to be used during the oil drain (e.g. rags) shall be weighed.

6. The oil shall be drained for 10 minutes with the external oil pump (if equipped) powered on followed by an additional ten minutes with the pump powered off. If a constant volume sump system is not used, the oil shall be drained from the engine for a total of 20 minutes.

7. The drained oil shall be weighed.

8. The weight determined in accordance with step 7 shall be subtracted from the weight determined in accordance with step 4. The difference corresponds to the total weight of the oil removed from the engine and collected in the drain pan.

9. The oil shall be carefully returned to the engine.

10. The empty drain pan shall be weighted.

11. The weight determined in accordance with step 10 shall be subtracted from the weight determined in accordance with step 4. The result corresponds to the weight of the residual oil in the drain pan that was not returned to the engine.

12. Any dirty supplies which have previously been weighed pursuant to step 5, shall be weighed.

13. The weight determined in accordance with step 12 shall be subtracted from the weight determined in accordance with step 5. The result corresponds to the weight of the residual oil which remained on the dirty supplies that was not returned to the engine.

14. The residual oil weights calculated in accordance with steps 11 and 13 shall be subtracted from the total weight of the oil removed, calculated in accordance with step 8. The difference between those weights corresponds to the total weight of the oil returned to the engine.

15. The engine shall be operated under the desired test cycle(s) (see paragraphs 2.2.15. and 2.4.4.8.3.1.)

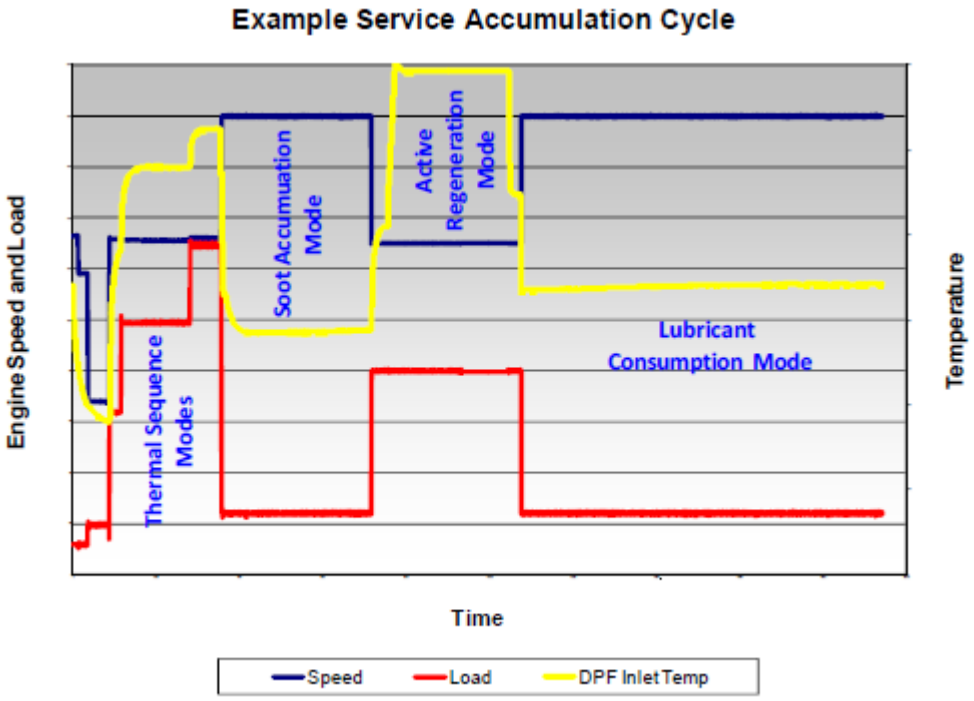
16. Steps 3 – 8 shall be repeated.

17. The weight of the oil drained pursuant to step 16 shall be subtracted from the weight obtained in accordance with step 14. The difference between those weights corresponds to the total weight of the oil consumed.

18. The total weight of the oil consumed calculated pursuant to step 14 shall be divided by the duration, in hours, of the test cycles carried out in accordance with step 15. The result is the lubricant consumption rate.

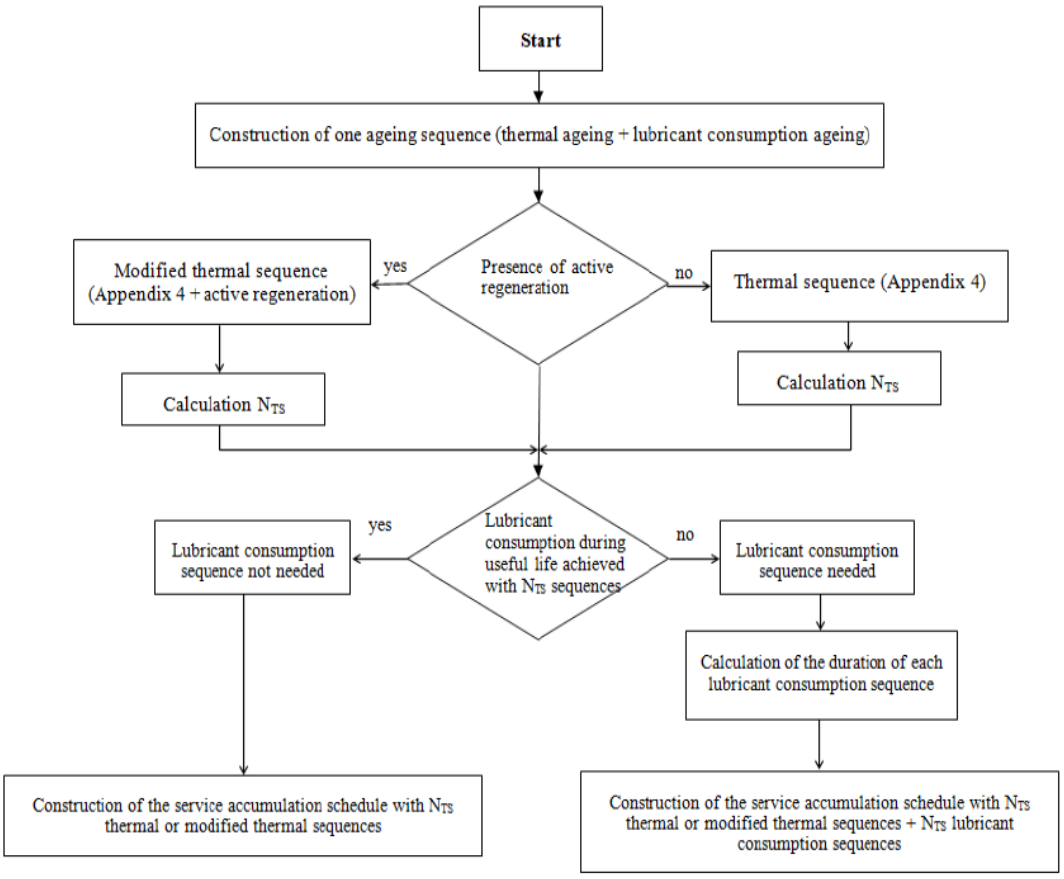
Annex 13 - Appendix 8

Example of service accumulation schedule including thermal, lubricant consumption and regeneration sequences



Annex 13 - Appendix 9

Flowchart on the performance of the service accumulation schedule



"