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|  |  | 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[[1]](#footnote-2)\*

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

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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.

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**UNITED NATIONS**

*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 Regulation5."

*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) Ht 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) Lt 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) HLt 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) CNGfr in all other cases where the engine is fuelled with CNG/biomethane and designed for operation on one restricted gas fuel range composition;

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

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

(j) LNG20 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* | *NOx OTL1* | *PM OTL2* | *CO OTL6* | *IUPR13* | *Reagent quality* | *Additional OBD monitors12* | *Power threshold requirements14* | *Implementation dates: new types* | *Date when Contracting Parties may refuse type approval* |
| A9 10  B10 | Row "phase-in period" of Tables 1 and 2 of Annex 9A | Performance monitoring3 | N/A | Phase-in7 | Phase-in4 | N/A | 20% | Date of entry into force of 06 series of UN Regulation No. 49 | 01 September 20159  31 December 201610 |
| B11 | 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-in4 | 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 | General8 | General5 | 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 | General8 | General5 | Yes | 10% | 01 September 2018 |  |

*Notes:*

1 "NOx 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:

1. For the WHTC: the complete sequence cold – soak – hot;
2. For the WHTC hot start test (paragraph 6.6.): the sequence soak – hot;
3. For the multiple regeneration WHTC hot start test (paragraph 6.6.): the total number of hot start tests;
4. For the WHSC: the test cycle.

The following provisions apply for analyser drift:

1. 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;
2. 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.;
3. 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:

 (33)

With

*k*c= (cCO2d – cCO2d,a) x 0,5441 + cCOd/18522 + cHCw/17355 (34)

And

*k*fd = - 0,055586 x *w*ALF + 0,0080021 x *w*DEL + 0,0070046 x *w*EPS (35)

Where:

qmf,i is the instantaneous fuel mass flow rate, kg/s

Ha 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 CO2 concentration, per cent

*c*CO2d,a is the dry CO2 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 H2O), 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:

1. Completely eliminate water condensation in the dilution and sampling systems;
2. 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);
3. 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;
4. 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;
5. 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;
6. 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:

(95)



Where:

*N* = number of particles emitted over the test cycle,

*medf* = 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,

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



= mean particle concentration reduction factor of the volatile particle remover specific to the dilution settings used for the test.



shall be calculated from the following equation:



(96)



Where:

*cs,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:

 (104)

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

 (105)

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

(106)

The coefficient of determination shall be calculated as follows:

 (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 N3 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 M1 and N1).

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 M1 and N1) 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 M1 and N1) 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 M1 and N1).

Average speed in motorway operation shall be above 70 km/h (90 km/h in the case of vehicles of categories M1 and N1)."

*Paragraph 4.5.1.,* amend to read:

"4.5.1. For M1 and N1 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 N2, M2 and M3 vehicles the trip shall consist of approximately 45 per cent urban, 25 per cent rural and 30 per cent motorway operation. M2 and M3 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 N3 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 CO2 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 calculation~~s~~ 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 (r²) 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 CO2 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 CO2 mass or work measured over the reference laboratory transient cycle. The moving average calculations are conducted with a time increment  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 CO2 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:

Where:

 is the maximum window duration, s;

 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:

where:

 is the maximum window duration, s;

 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 NOx control measures (applicable only to replacement pollution control devices to be fitted to vehicles equipped with sensors directly measuring NOx concentration in the exhaust).

4.6.1. NOx 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 NOx 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 NOx control measures testing of the pollution control device.

4.6.5. Paragraph 4.5.5. shall apply to NOx 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 M1, N1 and N2 | 114 286 | 5 714 | 2 857 |
| Engine systems fitted to vehicles of category N2, N3 with a maximum technically permissible mass not exceeding 16 tonnes and M3 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 N3 with a maximum technically permissible mass exceeding 16 tonnes, and M3, 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:

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-NOx trap): 18,050

Tr = reference temperature, in K.

= 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.

= the time, in hours, corresponding to the temperature , 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.

= 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 during the time .

*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 = 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 during the time of each one of the *i* bins registered in the histogram.

= 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 during the time .

*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.

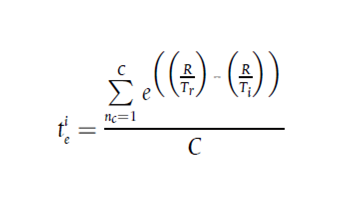
2.4.2.2. The engine used for the performance of the service accumulation schedule, fitted with the exhaust after-treatment system incorporating the replacement pollution control device, is operated for a minimum of three consecutive thermal sequences, as set out in Appendix 5.

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:



Equation 4:

Where:

= 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 Ti during the second *i*.

Ti = 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 during the time of each one of the *i* bins registered in the histogram.

*i* = number of temperature measurement.

p = total number of temperature measurements.

nc = 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:

NTS = AT/AE

Where:

NTS = 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 during the time 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 NTS 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 NTS shall not be less than 10 per cent of the useful life listed in Table 1, e.g. the vehicle category N1 shall not have an NTS of less than 286 thermal sequences, assuming that each sequence is 1 hour long.

2.4.2.9. It is allowed to increase NTS 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. NTS 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 NTS for each device, a first NTS value shall be calculated for each device, with its own AT and AE values.

2.4.2.10.3. If the calculated NTS 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 NTS needs to be modified, over the thermal sequences referred to in paragraph 2.4.2.3., in order to influence the measured Ti and therefore conveniently speed up or slow down the artificial ageing of the targeted device or devices.

2.4.2.10.4. The new NTS values corresponding to the new temperatures Ti 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 NTS values obtained for each device in the system match.

2.4.2.10.6. The Tr values used for obtaining the different NTS 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 NTS.

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 NTS, 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., NTS 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:

Where:

NAR = number of active regeneration sequences over the useful life of the replacement pollution control device.

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

tAR = duration, in hours, of an active regeneration.

= 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., , 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 .

2.4.3.11. It is allowed to increase NTS 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:

Where:

tTAS = 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.

LCRWHTC = lubricant consumption rate, in g/h determined as set out in paragraph 2.2.15.

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

LCRTAS = 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 tTAS shall be calculated by applying the following ratio:

Equation 7:

Where:

N = number of thermal sequences or modified thermal sequences corresponding to tTAS.

tTAS = 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.

tTS = 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 NTS 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 ≤ NTS, it is not necessary to add a lubricant consumption accumulation schedule to the thermal accumulation schedule. If N > NTS, 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:

Where:

tLS = the duration, in hours, of a single lubricant consumption sequence LCRWHTC = lubricant consumption rate, in g/h determined as set out in paragraph 2.2.15.

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

LCRTAS = lubricant consumption rate, in g/h, determined as set out in paragraph 2.4.4.2.

LCRLAS = lubricant consumption rate, in g/h, determined as set out in paragraph 2.4.4.8.3.1.

tTS = 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.

NTS = 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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



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1. \* 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). [↑](#footnote-ref-2)