Regulation proposal: Determination of evaporative emissions from vehicles with positive-ignition engines

Article 1

Regulation (EC) No 692/2008 is amended as follows:

From three years after the dates specified in Article 10(4) and (5) of Regulation (EC) No 715/2007 for new type approvals and new vehicles respectively, a new procedure for determination of evaporative emissions from vehicles with positive-ignition engines described in Annex I shall be applied.

Annex I of this Regulation will replace Annex VI of Regulation (EC) No 692/2008.

Article 2

Regulation (EC) No 692/2008 is hereby amended as follows

1. Article 2 is amended as follows:

   The following points are added:

   40. “Fuel System” means the devices which allow to store the fuel. It covers the fuel tank, the fuel filler, the filler cap and the fuel pump.

   Comment: Fuel System is not defined in R83 or 692/2008 regulations. Due to the permeability factor procedure, a definition of Fuel system I needed.

   41. “The Butane Working Capacity (BWC)” is a measure of the ability of an activated carbon to adsorb and desorb butane from dry air under specified conditions

   42. “The Fuel Working Capacity (FWC)” is a measure of the ability of an activated carbon to adsorb and desorb Fuel Vapor from dry air under specified conditions

   43. “The Permeability Factor (PF)” is an additive factor which reflects the hydrocarbon emissions due to the permeability of the fuel system.

Article 3

This Regulation shall enter into force on the twentieth day following that of its publication in the Official Journal of the European Union.

This Regulation shall be binding in its entirety and directly applicable in all Member States.
ANNEX I

Determination of evaporative emissions
(Type 4 test)

1. INTRODUCTION

1.1. This Annex describes the procedure for the Type 4 test, which determines the emission of hydrocarbons by evaporation from the fuel systems of vehicles.

2. TECHNICAL REQUIREMENTS

(Determination of evaporative emissions from vehicles with positive-ignition engines)

1. Introduction

The evaporative emissions test (Figure 1 below) is designed to determine hydrocarbon evaporative emissions as a consequence of diurnal temperatures fluctuation, hot soaks during parking, and urban driving. The test consists of these phases:

2.1. Test preparation including an urban (Part One) and extra-urban (Part Two) driving cycle,

2.2. Hot soak loss determination,

2.3. Diurnal loss determination.

Mass emissions of hydrocarbons from the hot soak and the diurnal loss phases are added up to provide an overall result for the test.

3. Vehicle and fuel

3.1. Vehicle

3.1.1. The vehicle shall be in good mechanical condition and have been run in and driven at least 3,000 km before the test. For the purpose of the determination of the Permeability Factor, the mileage and the age of the vehicle used for certification shall be recorded. The evaporative emission control system shall be connected and have been functioning correctly over this period and the carbon canister(s) shall have been subject to normal use, neither undergoing abnormal purging nor abnormal loading. The carbon canister(s) aged according to the Procedure described in paragraph 5.1 of this Regulation shall be connected.

3.2. Fuel

3.2.1. The Type I reference fuel specified in Annex IX to Regulation (EC) N° 692/2008 shall be used. In this Regulation, E10 reference means always the Type I reference fuel.

4. Test equipment for evaporative test

4.1. Chassis dynamometer

The chassis dynamometer shall meet the requirements of Appendix 1 of Annex 4a of UN/ECE Regulation No 83.

4.2. Evaporative emission measurement enclosure

The evaporative emission measurement enclosure shall meet the requirements of paragraph 4.2. of Annex 7 to UN/ECE Regulation No 83.
Figure 1
Determination of evaporative emissions
3000 km run-in period (no excessive purge/load)
Use of aged of canister(s)
Steam-clean of vehicle (if necessary)

Notes:
1. Evaporative emission control families - details clarified.
2. Exhaust emissions may be measured during Type I test drive but these are not used for legislative purposes. Exhaust emission legislative test remains separate.

4.3. Analytical systems
The analytical systems shall meet the requirements of paragraph 4.3. of Annex 7 to UN/ECE Regulation No 83.

4.4. Temperature recording
The temperature recording shall meet the requirements of paragraph 4.5. of Annex 7 to UN/ECE Regulation No 83.

4.5. Pressure recording

The pressure recording shall meet the requirements of paragraph 4.6. of Annex 7 to UN/ECE Regulation No 83.

4.6. Fans

The fans shall meet the requirements of paragraph 4.7. of Annex 7 to UN/ECE Regulation No 83.

4.7. Gases

The gases shall meet the requirements of paragraph 4.8. of Annex 7 to UN/ECE Regulation No 83.

4.8. Additional Equipment

The additional equipment shall meet the requirements of paragraph 4.9. of Annex 7 to UN/ECE Regulation No 83.

5. Test procedure

5.1. Canister(s) bench aging

Before to perform the hot soak and diurnal losses sequences, the canister(s) must be aged according the following procedure described in Figure 2. If Manufacturers intend to use canister(s) aged for the development, test reports have to be provided to the Type Approval Authorities.

Figure 2 : Canister bench aging procedure

5.1.1. Temperature conditioning test
In a dedicated temperature chamber, the canister(s) is (are) brought to ambient temperatures from -15°C to 60°C. The cycle shall last 4 hours (240 min) (Figure 3).

The temperature gradient shall not exceed 1°C/min. No air flow has to pass through the canister(s).

The cycle is repeated 50 times. In total, this operation will last approximately 200 hours.

Figure 3 : Temperature conditioning cycle

5.1.2. Canister vibration conditioning test

After the temperature aging procedure, the canister(s) is (are) shaked along the vertical axis with the canister(s) mounted as per its orientation in the vehicle with overall Grms > 1.5 with frequency between 10 to 50 Hz. The test shall last 12 hours.

5.1.3. Canister Fuel aging test

For fuel aging test, the Manufacturer can select option A or option B to age the canister depending on the quality of the charcoal.

5.1.3.1. Option A : Fuel Aging up to 300 cycles (BWC criteria) (figure 4)

5.1.3.1.1. After the temperature aging procedure and vibration test, the canister(s) will be aged with a mixture of Type I reference fuel and nitrogen or air with a 50 +/- 15 percent fuel vapour volume. The fuel vapour fill rate has to be kept between 40 g/h to 80 g/h.

The canister(s) is (are) loaded to the breakthrough corresponding. Breakthrough is here defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams. As an alternative, the loading is deemed completed when the equivalent concentration level at the vent hole reaches 3000 ppm.

5.1.3.1.2. The canister(s) shall be purged according the procedure of paragraph 5.1.3.8. of Annex 7 to UN/ECE Regulation No 83. The standard conditions are 273.2 K and 101.33 kPa.

The canister must be purged between 5 minutes to 1 hour maximum after loading.
5.1.3.1.3. The steps of the procedure in paragraphs 5.1.3.1.1. and 5.1.3.1.2. shall be repeated 50 times.

5.1.3.1.4. After the first 50 Fuel aging cycles, a measurement of Butane Working Capacity (BWC) is performed. This measure consists of loading the canister according paragraph 7.5.1.6.3., Annex 7 to UN/ECE Regulation No 83 until breakthrough. The BWC is recorded.

Then, the canister(s) shall be purged according the procedure of paragraph 5.1.3.8. of Annex 7 to UN/ECE Regulation No 83. The standard conditions are 273.2 K and 101.33 kPa.

The canister must be purged between 5 minutes to 1 hour maximum after loading.

The operation of butane loading is repeated 5 times. The BWC is recorded after each butane loading step. The $BWC_{50}$ is calculated as the average of the 3 BWC and recorded.

5.1.3.1.5. The steps described in paragraphs 5.1.3.1. to 5.1.3.1.4. are repeated twice in order to obtain 2 additional BWC: $BWC_{100}$ and $BWC_{150}$. In total, the canister(s) is (are) aged with a minimum of 150 fuel aging cycles and 15 butane cycles.

5.1.3.1.6. The canister(s) is (are) deemed stabilized if the 2 below criteria are met:
If the last BWC measurement \( (BWC_{150}) \) has to kept below 95% of the two previous BWC (\( BWC_{50} \) and \( BWC_{100} \))

If \( BWC_{100} - BWC_{150} \leq BWC_{50} - BWC_{100} \).

If one of the two criteria is not met, an additional BWC, i.e. \( BWC_{200} \) shall be determined or switch to option B.

5.1.3.1.7 The canister(s) is(are) deemed stabilized if the 2 below criteria are met:

- If the last BWC measurement \( (BWC_{200}) \) has to kept below 95% of the two previous BWC (\( BWC_{100} \) and \( BWC_{150} \))
- If \( BWC_{150} - BWC_{200} \leq BWC_{100} - BWC_{150} \).

If one of the two criteria is not met, an additional BWC, i.e. \( BWC_{250} \) shall be determined or switch to option B.

5.1.3.1.8 The canister(s) is (are) deemed stabilized if the 2 below criteria are met:

- If the last BWC measurement \( (BWC_{250}) \) has to kept below 95% of the two previous BWC (\( BWC_{150} \) and \( BWC_{200} \))
- If \( BWC_{200} - BWC_{250} \leq BWC_{150} - BWC_{200} \).

If one of the two criteria is not met, a final 50 fuel aging cycles step will be performed according to paragraphs 5.1.3.1.1. and 5.1.3.1.2. In total, the canister(s) will be aged with 300 fuel aging cycles + 25 butane cycles and considered as stabilized.

5.1.3.2. Option B : Fuel Aging up to 300 cycles (FWC criteria) (figure 5)

Figure 5 : Option B fuel aging based on FWC window criteria Fuel Aging up to 300 cycles (FWC criteria)

Option B is an alternative to option A. It consists of aging directly the canister(s) with the same fuel aging procedure described in option A up to the 300 cycles (5.1.3.1.1. and 5.1.3.1.2.). No BWC is performed during the fuel aging.

The weight of the canister(s) is (are) recorded after each breakthrough. Its weight corresponds to the Fuel Working Capacity. Because the repeatability of the FWC is less robust than BWC, the FWC is averaged over a 50 cycles moving window.

\[
\text{degradation FWC}_i [\%] = \frac{\sum_{i=1}^{50} \text{FWC}}{50} - \frac{\sum_{i=1}^{99} \text{FWC}}{50} \times 100
\]
i... number of FWC cycle, \( i \geq 150 \)

If the degradation is greater than -2\% the fuel aging can be stopped. The minimum number of FWC cycles is 150.

5.1.3.3. If the canister(s) is (are) provided by the Suppliers, the Manufacturers shall inform in advance the Type Approval Authorities to allow witness check in Supplier’s facilities. Test reports have to be provided to the Type Approval Authorities.

5.2. Determination of the Permeability Factor of the Fuel System (Figure 6)

Figure 6 : Determination of the Permeability Factor

The permeability test provides a permeability factor which will be added to the result of HC determined for each day of the diurnal losses test.
The fuel system representative of a family is selected and fixed to a rig, then soaked with reference fuel for 20 weeks at 40°C +/- 2°C. The orientation of the fuel system on the rig has to be similar to the original orientation on the vehicle.

5.2.1. The tank is filled with fresh reference fuel at a temperature of 291K ±8K (18°C±8 °C). The tank is filled at 40 +/-2 % of the nominal tank capacity. Then, the rig with the fuel system is placed in a specific and secure room with a controlled temperature of 40°C +/-2 °C for 4 weeks.

5.2.2. At the end of the 4th week, the tank is drained and refilled with fresh reference fuel at a temperature of 291K ±8K (18°C±8 °C) at 40 +/-2 % of the nominal tank capacity. Within 6 to 36 hours, the last 6h at 293 K ± 2 K, the rig with the fuel system is placed in a VT-SHED a diurnal procedure is performed over a period of 24 hours, according to the procedure described according to paragraph 5.7. Annex 7 of UN/ECE Regulation No 83. The fuel system is vented to the outside of the VT-SHED to eliminate the possibility of the tank venting emissions being counted as permeation. The HC emissions are measured and the value is recorded as HC_{4W}.

5.2.3. The rig with the fuel system is placed again in a specific and secure room with a controlled temperature of 40°C +/-2 °C for the remaining 16 weeks.

5.2.4. At the end of the remaining 16th week, the tank is drained and refilled with fresh reference fuel at a temperature of 291K ±8K (18°C±8 °C) at 40 +/-2 % of the nominal tank capacity. Within 6 to 36 hours, the last 6h at 293 K ± 2 K, the rig with the fuel system is placed in a VT-SHED a diurnal procedure is performed over a period of 24 hours, according to the procedure described according to paragraph 5.7. Annex 7 of UN/ECE Regulation No 83. The fuel system is vented to the outside of the VT-SHED to eliminate the possibility of the tank venting emissions being counted as permeation. The HC emissions are measured and the value is recorded as HC_{20W}.

5.2.5. The Permeability Factor is the difference between HC_{20W} and HC_{4W} in g/24h with 3 digits.

5.2.6. If the Permeability Factor is determined by the Suppliers, the Manufacturers shall inform in advance the Type Approval Authorities to allow witness check in Supplier’s facilities. Test reports have to be provided to the Type Approval Authorities.

5.3. Sequence of measurement of hot soak and diurnal losses

The vehicle is prepared according to paragraph 5.1.1. and 5.1.2. of Annex 7 Regulation No 83.

5.3.1. Soak
The vehicle is parked for a minimum of 12 hours and a maximum of 36 hours in the soak area. The engine oil and coolant temperatures shall have reached the temperature of the area or within ±3 K of it at the end of the period.

5.3.2. Fuel drain and refill
The fuel drain and refill is performed according the procedure of paragraph 5.1.7. of Annex 7 Regulation No 83.

5.3.3. Preconditioning drive
Within one hour from the completing of fuel drain and refill, the vehicle is placed on the chassis dynamometer and driven through one Part One and two Part Two driving cycles of Type I according to Annex 4a Regulation No 83. Exhaust emissions are not sampled during this operation.
5.3.4. Soak
Within five minutes of completing the preconditioning operation the vehicle is parked for a minimum of 12 hours and a maximum of 36 hours in the soak area. The engine oil and coolant temperatures shall have reached the temperature of the area or within ±3 K of it at the end of the period.

5.3.5. Canister breakthrough
The canister(s) aged according to the sequence described in paragraph 5.1 of this regulation is loaded to breakthrough according to the procedure paragraph 5.1.4 of Annex 7 Regulation No 83.

5.3.6. Dynamometer test

5.3.6.1. Within one hour from the completing of canister loading, the vehicle is placed on the chassis dynamometer and driven through one Part One and one Part Two driving cycles of Type I according to Annex 4a Regulation No 83. Then the engine is shut off. Exhaust emissions may be sampled during this operation but the results shall not be used for the purpose of exhaust emission type approval.

5.3.6.2. Within two minutes of completing the Type I Test drive specified in paragraph 5.3.6.1. above the vehicle is driven a further conditioning drive consisting of two Part one test cycles (hot start) of Type I. Then the engine is shut off again. Exhaust emissions need not be sampled during this operation.

5.3. 7. Hot Soak
After the Dynamometer test, hot soak evaporative emissions test is performed according to paragraph 5.5 of Annex 7 Regulation No 83. The hot soak losses result is calculated according to paragraph 6 of Annex 7 Regulation No 83 and recorded as HSL.

5.3. 8. Soak
After hot soak evaporative emissions test, a soak is performed according to paragraph 5.6 of Annex 7 Regulation No 83.

5.3. 9. Diurnal test

5.3.9.1. After the soak, a first measurement of Diurnal Losses over 24 hours is performed according to paragraph 5.7 of Annex 7 Regulation No 83. Emissions are calculated according to paragraph 6 of Annex 7 Regulation No 83. Permeability Factor determined in paragraph 5.2.5 of this Regulation is added to the Diurnal test result. The combined value is recorded as DL 1st day.

5.3.9.2. After the first 24 hours diurnal test, a second measurement of Diurnal Losses over 24 hours is performed according to paragraph 5.7 of Annex 7 Regulation No 83. Emissions are calculated according to paragraph 6 of Annex 7 Regulation No 83. Permeability Factor determined in paragraph 5.2.5 of this Regulation is also added to the Diurnal test result. The combined value is recorded as DL 2nd day.

5.3. 10. Calculation
The result of the worst day of diurnal test + HSL shall be below the limit defined in Table 3 of Annex 1 of Regulation (EC) No 715/2007.