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Item 3(b) of the provisional agenda

**Light vehicles – Global Technical****Regulation No. 15 on Worldwide harmonized****Light vehicles Test Procedure (WLTP)****Proposal for a new global technical regulation on  
Evaporative emission test procedure for the Worldwide  
harmonized Light vehicles Test Procedure (WLTP EVAP)****Submitted by the Informal Working Group on Worldwide harmonized  
Light vehicles Test Procedure (WLTP)\***

The text reproduced below was prepared by the Evaporative Task Force of the Informal Working Group (IWG) on Worldwide harmonized Light vehicles Test Procedure (WLTP) in line with Phase 2 of its mandate (ECE/TRANS/WP.29/AC.3/44). The IWG on WLTP referred to a first draft of this proposal (GRPE-73-12) at the seventy-third session of GRPE (see report ECE/TRANS/WP.29/GRPE/73, para. 12).

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\* In accordance with the programme of work of the Inland Transport Committee for 2014–2018 (ECE/TRANS/240, para. 105 and ECE/TRANS/2014/26, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

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# **Draft global technical regulation on Evaporative emission test procedure for the Worldwide harmonized Light vehicle Test Procedure (WLTP EVAP)**

## **I. Statement of technical rationale and justification**

### **A. Introduction**

1. The compliance with emission standards is a central issue of vehicle certification worldwide. Emissions comprise criteria pollutants having a direct (mainly local) negative impact on health and environment, as well as pollutants having a negative environmental impact on a global scale. Regulatory emission standards typically are complex documents, describing measurement procedures under a variety of well-defined conditions, setting limit values for emissions, but also defining other elements such as the durability and on-board monitoring of emission control devices.

2. Most manufacturers produce vehicles for a global clientele or at least for several regions. Albeit vehicles are not identical worldwide since vehicle types and models tend to cater to local tastes and living conditions, the compliance with different emission standards in each region creates high burdens from an administrative and vehicle design point of view. Vehicle manufacturers, therefore, have a strong interest in harmonizing vehicle emission test procedures and performance requirements as much as possible on a global scale. Regulators also have an interest in global harmonization since it offers more efficient development and adaptation to technical progress, potential collaboration at market surveillance and facilitates the exchange of information between authorities.

3. As a consequence stakeholders launched the work on the Worldwide harmonized Light vehicle Test Procedure (WLTP) which aims at harmonizing emission-related test procedures for light duty vehicles to the extent this is possible. One of the aspects covered within the mandate for WLTP is the evaporative emission test procedure.

4. Evaporative emissions from vehicles is a complex phenomenon which depends on multiple factors, that ranges from climate conditions to fuel properties, from driving and parking patterns to the technology used to control these emissions.

5. Evaporative emissions from a vehicle can be defined, in a very generic way, as Volatile Organic Compounds (VOCs) emitted by the vehicle itself in different operating conditions but not directly deriving from the combustion process. In petrol vehicles the most important potential source of evaporative emissions is the loss of fuel through the evaporation and permeation mechanisms from the fuel storing system. Fuel related evaporative emissions may occur during any vehicle operation including parking events, normal driving and vehicle refuelling.

6. VOCs may also be emitted by specific components of the vehicle like tyres, interior trim or by other fluids (e.g. windshield washer fluid). These emissions are usually quite low and do not depend on how the vehicle is used or on the quality of the fuel. Evaporative emissions in general do not represent a significant problem for diesel vehicles due to the very low vapour pressure of the diesel fuel.

7. During parking events, an increase of the temperature of the fuel in the tank due to rising ambient temperature and solar radiation may lead to the evaporation of the lightest petrol fractions with a corresponding increase of the pressure inside the tank. The fuel tank, by design, is usually vented to the atmosphere through a pressure relief valve, so that the tank pressure is maintained slightly above atmospheric pressure. If the pressure inside the

tank rises above that value a mixture of air and petrol vapours may be released into the air. In modern vehicles the tank is vented through an activated carbon canister which adsorbs and stores the hydrocarbons (HC) preventing emissions to the air. This carbon canister has a limited adsorbing capacity (depending on several factors of which the most important are the carbon quality and mass as well as the temperature) and has to be periodically purged to desorb the stored hydrocarbons. This occurs during vehicle driving since part of the combustion air flows through the canister removing the adsorbed hydrocarbons which are then burned inside the engine.

8. In normal vehicle driving conditions, in addition to the ambient air and solar radiation, the temperature of the fuel in the tank may increase as a consequence of the heat coming from other sources (hot engine and exhaust system, fuel pump, fuel return if present, road surface that may be significantly hotter than the air). The balance among the fuel evaporation rate, the amount of fuel being pumped to the engine and the purge flow rate through the canister will determine the carbon canister loading which could lead to excessive emissions in case of breakthrough/saturation. These emissions are known as running losses.

9. Hydrocarbons also escapes the vehicle's fuel system by permeation through the plastic and rubber components; e.g., hoses, seals, and in vehicles with a non-metallic tank, the fuel tank itself. Permeation does not occur through an opening; instead individual fuel molecules penetrate (i.e. they effectively mix with) the walls of the various components and eventually find their way to the outside. Fuel permeation is significant mainly for plastic or elastomeric materials, depends strongly from the temperature and usually occurs in any vehicle operating conditions.

10. Another important source of evaporative emissions is the refuelling operation. When liquid fuel is delivered into the tank the air/petrol vapour mixture present in the tank is displaced and may be released into the air. Refuelling emissions are partially controlled through the maximum allowed fuel vapour pressure by reducing its value during the hot season. In addition, evaporative emissions during the refuelling operation can be controlled in two different ways. One method is the so-called "Stage II" vapour recovery system. The fuel nozzle is designed to draw the air/petrol vapour mixture displaced by the liquid fuel entering the tank and to route it to the underground petrol storage tank of the service station. An alternative method is an "On-board Vapour Recovery System" (ORVR), which consists in specific design of the fuel system which forces the displaced vapours to be routed to the carbon canister instead of escaping from the refuelling port.

11. An unintended source of HC emissions may occur from leaks in the system. Leaks may occur in the vapour and/or the liquid system as a result of deterioration and/or faulty operations. Examples of deterioration are corrosion of metallic components (e.g. fuel lines, tanks), cracking of rubber hoses, hardening of seals, mechanical failures. On-board diagnostic systems have been developed to check the integrity of the fuel system and are required in some regions.

12. In the existing regional type approval procedures, the various situations that can lead to significant evaporative emissions have been addressed either by developing different tests or by adopting different measures. As an example, in certain regions refuelling emissions are controlled by mandating the use of the Stage II vapour recovery system while in other regions the ORVR approach has been chosen.

13. The need to represent real driving conditions as much as possible to make the performance of vehicles at certification and in real life comparable puts therefore some limitations on the level of harmonization to be achieved since, for instance, ambient temperatures vary widely on a global scale while other potential sources of evaporative

emissions are addressed in different ways across the regions (e.g. refuelling emissions or potential leaks).

14. At this time, the WLTP EVAP test procedure focuses only on the evaporative emissions that can occur during parking events. Running losses and refuelling emissions are out of the scope of the current WLTP EVAP procedure.

15. The purpose of a UN global technical regulation (gtr) is its implementation into regional legislation by as many Contracting Parties as possible. However, the scope of regional legislations in terms of vehicle categories concerned depends on regional conditions and cannot be predicted for the time being. On the other hand, according to the rules of the 1998 Agreement, Contracting Parties implementing a gtr must include all equipment falling into the formal gtr scope. Care must be taken so that an unduly large formal scope of the gtr does not prevent its regional implementation. Therefore the formal scope of this gtr is kept mainly for light duty vehicles. However, this limitation of the formal gtr scope does not indicate that it could not be applied to a larger group of vehicle categories by regional legislation. In fact, Contracting Parties are encouraged to extend the scope of regional implementations of this gtr if this is technically, economically and administratively appropriate.

## **B. Procedural background and future development of the WLTP EVAP**

16. In its November 2007 session, the World Forum for Harmonization of Vehicle Regulations (WP.29) decided to set up an Informal Working Group (IWG) under the Working Party on Pollution and Energy (GRPE) to prepare a road map for the development of WLTP. After various meetings and intense discussions, WLTP presented in June 2009 a first road map consisting of three phases, which was subsequently revised a number of times and contains the following main tasks:

(a) Phase 1 (2009–2014): Development of the worldwide harmonized light duty driving cycle and associated test procedure for the common measurement of criteria compounds, CO<sub>2</sub>, fuel and energy consumption;

(b) Phase 2 (2014–2018): Low temperature/high altitude test procedure, durability, in-service conformity, technical requirements for On-Board Diagnostics (OBD), Mobile Air-Conditioning (MAC) system energy efficiency, off-cycle/real driving emissions, and evaporative emission;

(c) Phase 3 (2018-...): Emission limit values and OBD threshold limits, definition of reference fuels, comparison with regional requirements.

17. It should be noted that since the beginning of the WLTP process, the European Union had a strong political objective set by its own legislation (Regulations (EC) 715/2007 and 692/2008) to review the test procedure for evaporative emissions to ensure that these are effectively limited throughout the normal life of the vehicles under normal conditions of use.

18. The IWG on WLTP presented at the GRPE January 2016 session an updated road map for the Phase 2 including a proposal for the development of the WLTP test procedure for evaporative emissions. A strong desire of the Contracting Parties to develop the gtr by January 2017 was announced.

19. The WLTP EVAP Task Force started its work in February 2016 with the first meeting and ended its work for the development of this gtr in September 2016 with the submission of the current text.

## C. Background on test procedures

20. For the development of the WLTP EVAP test procedure, the EVAP Task Force took into account existing legislation as well as the recent review and revision of the European evaporative emission test procedure.

21. The WLTP evaporative emission test procedure focuses only on evaporative emissions that can occur during parking events from both conventional petrol vehicles and hybrid vehicles combining an electric motor with a petrol fuelled engine.

22. The WLTP evaporative emission test procedure is designed to measure evaporative emissions from a parked vehicle using a sealed housing for evaporative emissions determination (SHED). Two specific situations are considered:

(a) Evaporative emissions occurring immediately after the end of a trip due to residual fuel tank heating and the high temperatures of the engine and fuel system (hot soak test);

(b) Evaporative emissions occurring during a simulated extended parking event (48 hours) while the vehicle is exposed to temperature fluctuations according to a specific profile. This is intended to represent the temperature profile of a hot day (diurnal test). The result of the diurnal test is represented by the total amount of VOCs released in the SHED over a 48 hour period.

23. The performance of the evaporative emission control system strongly depends on the initial condition of the carbon canister which is expected to adsorb the vapours generated in the tank. In order to simulate realistic conditions, prior to the starting of the hot soak and diurnal tests, the carbon canister is loaded to the breakthrough and then purged by driving the vehicle over a specific combination of WLTC sections (conditioning drive). The conditioning drive cycle was extensively assessed and discussed also on the basis of real world activity data to take into account that the most critical conditions are represented by short trips in urban areas. For this reason, the conditioning drive for Class 2 and 3 vehicles includes one low speed section, two medium speed sections and one high speed section. The extra-high section was excluded. The conditioning drive for Class 1 vehicles includes four low speed sections, two medium speed sections.

24. The test procedure includes also specific provisions to take into account the potential deterioration of the evaporative emission control system efficiency especially in the presence of ethanol in the fuel. The evaporative emission test is carried out with a carbon canister aged both mechanically and chemically according to a specific procedure. In addition, a permeation factor is used to take into account the potential increase over time of the full permeation rate through the tank walls.

25. As far as the fuel is concerned, its vapour pressure and composition (especially ethanol content) have a large effect on evaporative emissions and need therefore to be clearly specified. However, due to regional differences in the market specifications of fuels and in the measurement methods of their relevant properties, regionally different reference fuels need to be recognised. Contracting Parties may select their reference fuels either according to Annex 3 to gtr No. 15 or according to Annex 2 of this gtr.

## D. Technical feasibility, anticipated costs and benefits

26. In designing and validating the WLTP EVAP procedure, strong emphasis has been put on its practicability, which is ensured by a number of measures explained above.

27. In general, the WLTP EVAP test procedure has been defined taking into account the technology available for evaporative emission control as well as the existing test facilities.

28. The best available technology performance significantly exceeds the stricter requirements on evaporative emissions which will be introduced in some regions as a result of the adoption of the WLTP EVAP procedure. In general, compared to the technology needed to comply with the requirements based on the 24 hour diurnal test still in force in many regions, the additional cost per vehicle is considered quite limited and eventually compensated by the emission reduction and the fuel savings.

29. Performing a test according to the WLTP EVAP test procedure and complying with the emission limits should not represent a major issue in most cases. Since in many regions the current evaporative test procedure is based on the 24 hour diurnal test, limited upgrades to existing SHEDs might be required to run the 48 hour diurnal test. In other cases, additional SHEDs might be necessary to take into account the longer time needed to complete an evaporative emission tests. Nevertheless, 48 hour diurnal tests are already being performed by most of the car manufacturers since 48 hour and 72 hour diurnal test are already requested for some markets.

30. For a more accurate assessment, costs and benefits would have to be quantified on a regional level since they largely depend on the local conditions (climate, fleet composition, fuel quality, ...).

31. As pointed out in the technical rationale and justification, the principle of a globally harmonized light duty vehicle test procedure offers potential cost reductions for vehicle manufacturers. The design of vehicles can be better unified on a global scale and administrative procedures may be simplified. The monetary quantification of these benefits depends largely on the extent and timing of implementations of the WLTP in regional legislation.

## II. Text of the global technical regulation

### 1. Purpose

This global technical regulation (gtr) aims at providing a worldwide harmonized method to determine the levels of evaporative emission from light-duty vehicles in a repeatable and reproducible manner designed to be representative of real world vehicle operation. The results will provide the basis for the regulation of these vehicles within regional type approval and certification procedures.

### 2. Scope and application

This gtr applies to vehicles of categories 1-2 and 2, both having a technically permissible maximum laden mass not exceeding 3,500 kg with positive ignition engines with the exclusion of mono-fuel gas vehicles, and to all vehicles of category 1-1 with positive ignition engines with the exclusion of mono-fuel gas vehicles.<sup>1</sup>

### 3. Definitions

#### 3.1. Test equipment

3.1.1. "*Accuracy*" means the difference between a measured value and a reference value, traceable to a national standard and describes the correctness of a result;

3.1.2. "*Calibration*" means the process of setting a measurement system's response so that its output agrees with a range of reference signals.

#### 3.2. Pure electric, hybrid electric and fuel cell vehicles

3.2.1. "*Charge-depleting operating condition*" means an operating condition in which the energy stored in the Rechargeable Electric Energy Storage System (REESS) may fluctuate but decreases on average while the vehicle is driven until transition to charge-sustaining operation;

3.2.2. "*Charge-sustaining operating condition*" means an operating condition in which the energy stored in the REESS may fluctuate but, on average, is maintained at a neutral charging balance level while the vehicle is driven;

3.2.3. "*Off-Vehicle Charging Hybrid Electric Vehicle*" (OVC-HEV) means a hybrid electric vehicle that can be charged from an external source.

#### 3.3. Evaporative emission

3.3.1. "*Fuel tank system*" means the devices which allow storing the fuel, comprising the fuel tank, the fuel filler, the filler cap and the fuel pump when it is fitted in or on the fuel tank;

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<sup>1</sup> ECE/TRANS/WP.29/1045, as amended by Amends. 1 and 2 (Special Resolution No. 1, [www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html](http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html))

- 3.3.2. "*Fuel system*" means the components which store or transport fuel on board the vehicle and comprise the fuel tank system, all fuel and vapour lines, any non-tank mounted fuel pumps and the activated carbon canister;
- 3.3.3. "*Butane Working Capacity*" (BWC) means the measure of the ability of an activated carbon canister to adsorb and desorb butane from dry air or nitrogen under specified conditions;
- 3.3.4. "*BWC50*" means the butane working capacity after 50 cycles of fuel ageing cycles experienced;
- 3.3.5. "*BWC300*" means the butane working capacity after 300 cycles of fuel ageing cycles experienced;
- 3.3.6. "*Permeability Factor*" (PF) means the factor determined from hydrocarbon losses over a period of time and used to determine the final evaporative emissions.
- 3.3.7. "*Monolayer tank*" means a fuel tank constructed with a single layer of material, excluding metal tank, but including fluorinated/sulfonated materials;
- 3.3.8. "*Multilayer tank*" means a fuel tank constructed with at least two different layered materials, one of which is a hydrocarbon barrier material;
- 3.3.9. "*Sealed fuel tank system*" means a fuel tank system where the fuel vapours are stored under pressure over the 24 hour diurnal test;
- 3.3.10. "*Evaporative emissions*" means the hydrocarbon vapours lost from the fuel system of a motor vehicle other than those from exhaust emissions;
- 3.3.11. "*Mono-fuel gas vehicle*" means a mono-fuel vehicle that primarily runs on Liquefied Petroleum Gas, Natural Gas/biomethane, or hydrogen but may also have a petrol system for emergency purposes or starting only, where the petrol tank does not contain more than 15 litres of petrol.

## 4. Abbreviations

### General abbreviations

|         |  |
|---------|--|
| BWC     | Butane Working Capacity                      |
| PF      | Permeability Factor                          |
| APF     | Assigned Permeability Factor                 |
| OVC-HEV | Off-Vehicle Charging Hybrid Electric Vehicle |
| WLTC    | Worldwide Light-duty Test Cycle              |

## 5. General requirements

- 5.1. The vehicle and its components liable to affect the evaporative emissions shall be so designed, constructed and assembled as to enable the vehicle in normal use and under normal conditions of use such as humidity, rain, snow, heat, cold, sand, dirt, vibrations, wear, etc. to comply with the provisions of this gtr during its useful life determined by Contracting Parties.

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- 5.1.1. This shall include the security of all hoses, joints and connections used within the evaporative emission control systems.
  - 5.1.2. For vehicles with a sealed fuel tank system, this shall also include having a system which, just before the fuel cap is opened for refuelling, releases the tank pressure to a vapour storage unit which has the sole function of storing fuel vapour. This ventilation route shall also be the only one used in the situation that the tank pressure exceeds its safe working pressure.
  - 5.2. The test vehicle shall be representative in terms of its evaporative emissions-related components and functionality of the intended production series to be covered by the approval. The manufacturer and the responsible authority shall agree which vehicle test model is representative.
  - 5.3. Vehicle testing condition
    - 5.3.1. The types and amounts of lubricants and coolant for emissions testing shall be as specified for normal vehicle operation by the manufacturer.
    - 5.3.2. The type of fuel for testing shall be as specified in Annex 2 to this gtr.
    - 5.3.3. All evaporative emissions controlling systems shall be in working order.
    - 5.3.4. The use of any defeat device is prohibited.
  - 5.4. Provisions for electronic system security
    - 5.4.1. Any vehicle with an emission control computer shall include features to deter modification, except as authorised by the manufacturer. The manufacturer shall authorise modifications if these modifications are necessary for the diagnosis, servicing, inspection, retrofitting or repair of the vehicle. Any reprogrammable computer codes or operating parameters shall be resistant to tampering and afford a level of protection at least as good as the provisions in ISO 15031-7 (March 15, 2001). Any removable calibration memory chips shall be potted, encased in a sealed container or protected by electronic algorithms and shall not be changeable without the use of specialized tools and procedures.
    - 5.4.2. Computer-coded engine operating parameters shall not be changeable without the use of specialized tools and procedures (e.g. soldered or potted computer components or sealed (or soldered) enclosures).
    - 5.4.3. Manufacturers may seek approval from the responsible authority for an exemption to one of these requirements for those vehicles that are unlikely to require protection. The criteria that the responsible authority will evaluate in considering an exemption shall include, but are not limited to, the current availability of performance chips, the high-performance capability of the vehicle and the projected sales volume of the vehicle.
    - 5.4.4. Manufacturers using programmable computer code systems shall deter unauthorised reprogramming. Manufacturers shall include enhanced tamper protection strategies and write-protect features requiring electronic access to an off-site computer maintained by the manufacturer. Methods giving an adequate level of tamper protection will be approved by the responsible authority.
  - 5.5. Evaporative emission family

- 5.5.1. Only vehicles that are identical for the following parameters (a) to (d) and are similar or, where applicable, within the stated tolerance for the following parameters (e) and (f) may be part of the same evaporative emission family:
- (a) Fuel tank system material and construction;
  - (b) Vapour hose material, fuel line material and connection technique;
  - (c) Sealed tank or non-sealed tank system;
  - (d) Fuel tank relief valve setting (air ingestion and relief);
  - (e) Canister Butane Working Capacity (BWC300) within a 10 per cent range (for canisters with the same type of charcoal, the volume of charcoal shall be within 10 per cent of that for which the BWC300 was determined);
  - (f) Purge control system (for example, type of valve, purge control strategy).
- 5.5.2. The vehicle shall be considered to produce worst-case evaporative emissions and shall be used for testing if it has the largest ratio of fuel tank capacity to canister butane working capacity within the family. If the ratio is identical, the lowest purge volume over the single purge cycle described in paragraph 5.3.6. of Annex 1 shall be considered for the worst case selection. The vehicle selection shall be agreed in advance by the responsible authority.
- 5.5.3. The use of any innovative system calibration, configuration, or hardware related to the evaporative control system places the vehicle model in a different family.

## **6. Performance requirements**

- 6.1. Limit values
- The following limit values shall apply:
- (a) For Contracting Parties which adopt the calculation defined in paragraph 5.3.10.1. of Annex 1, the limit value shall be 2.0 g/test;
  - (b) For Contracting Parties which adopt the alternative calculation defined in paragraph 5.3.10.2. of Annex 1, the limit value shall be determined by the Contracting Party.
- 6.2. Testing
- Testing shall be performed according to the Type 4 test as described in Annex 1 using the appropriate fuel as described in Annex 2.

## Annex 1

### Type 4 test procedures and test conditions

1. Introduction

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
  - 2.1. Introduction
    - 2.1.1. The procedure includes the evaporative emissions test and two additional tests, one for the ageing of carbon canisters, as described in paragraph 5.1. of this annex, and one for the permeability of the fuel storage system, as described in paragraph 5.2. of this annex. The evaporative emissions test (Figure A1/1) determines hydrocarbon evaporative emissions as a consequence of diurnal temperature fluctuations, hot soaks during parking, and urban driving.
    - 2.1.2. In the case that the fuel system contains more than one carbon canister, all references to the term "canister" in this gtr will apply to each canister.
  - 2.2. The evaporative emissions test consists of:
    - (a) Test drive including a combination of phases of WLTC as specified in Annex 1 to gtr No. 15;
    - (b) Hot soak loss determination;
    - (c) Diurnal loss determination.

The mass emissions of hydrocarbons from the hot soak and the diurnal loss phase(s) shall be added together with the permeability factor 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 evaporative emissions, 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 during the run-in period. A carbon canister aged according to the procedure set out in paragraph 5.1. of this annex shall be used.
    - 3.1.2. The Type 4 test shall be performed with the vehicle which produces the worst evaporative emissions within the evaporative emission family according to paragraph 5.5.2. of this gtr.
  - 3.2. Fuel

The appropriate reference fuel as defined in Annex 2 shall be used for testing. For canister ageing, fuel specified in paragraph 5.1.3.1.1.1. of this annex shall be used.

Figure A1/1a  
**For non-sealed fuel tank system**

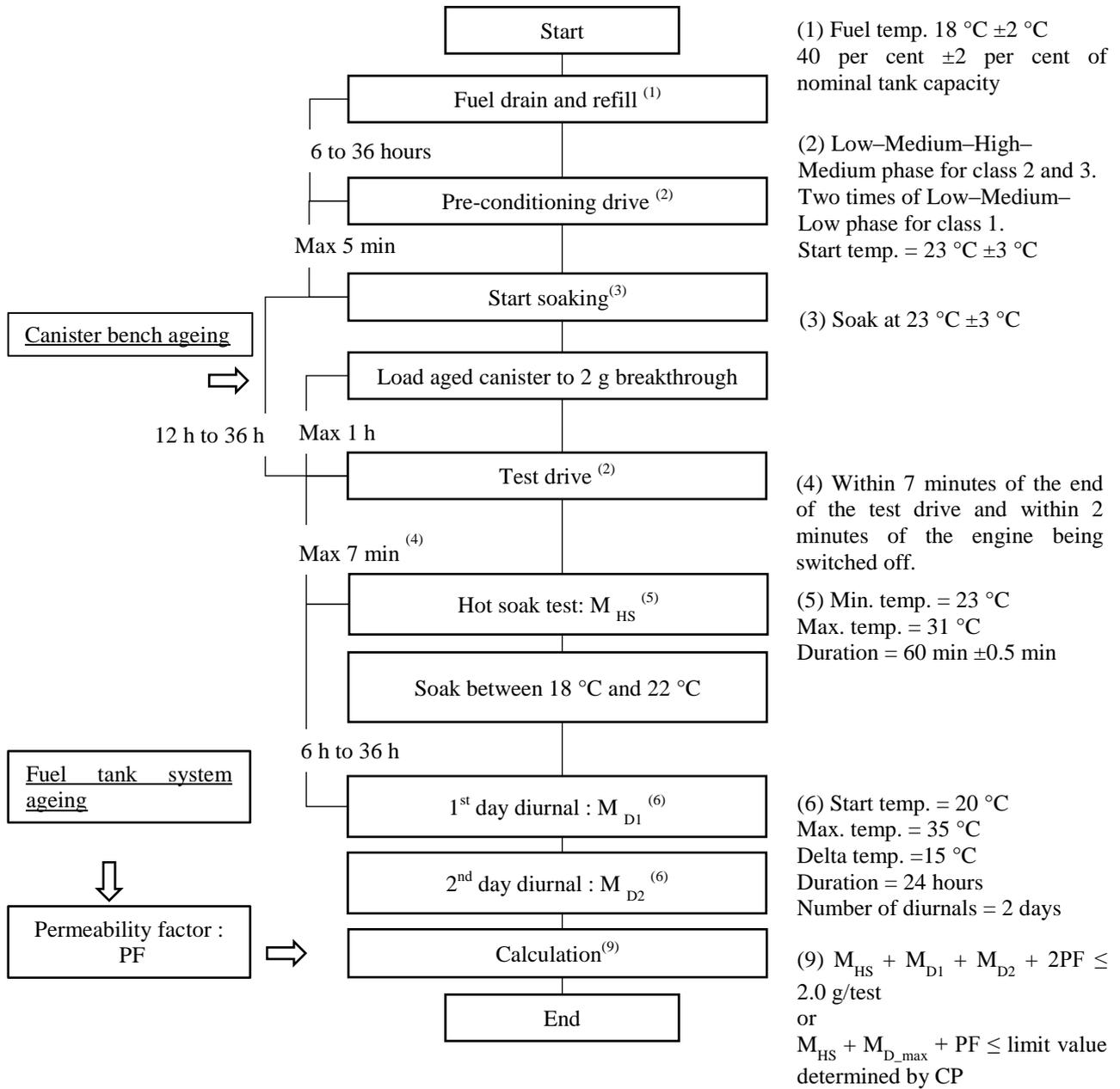


Figure A1/1b

**For sealed fuel tank system**

[Reserved]

4. Test equipment for the evaporative test
  - 4.1. Chassis dynamometer

The chassis dynamometer shall meet the requirements of paragraph 2. of Annex 5 to gtr No. 15.
  - 4.2. Evaporative emission measurement enclosure

The evaporative emission measurement enclosure shall meet the requirements of paragraph 4.2. of Annex 7 to the 07 series of amendments to Regulation No. 83 (Regulation No. 83-07).
  - 4.3. Analytical systems

The analytical systems shall meet the requirements of paragraph 4.3. of Annex 7 to Regulation No. 83-07. Continuous measuring of hydrocarbons is not mandatory unless the fixed volume type enclosure is used.
  - 4.4. Temperature recording

The temperature recording shall meet the requirements of paragraph 4.5. of Annex 7 to Regulation No. 83-07.
  - 4.5. Pressure recording

The pressure recording shall meet the requirements of paragraph 4.6. of Annex 7 to Regulation No. 83-07, except that the accuracy and resolution of the pressure recording system defined in paragraph 4.6.2. of that annex shall be:

    - (a) Accuracy:  $\pm 0.3$  kPa
    - (b) Resolution:  $\pm 0.025$  kPa
  - 4.6. Fans

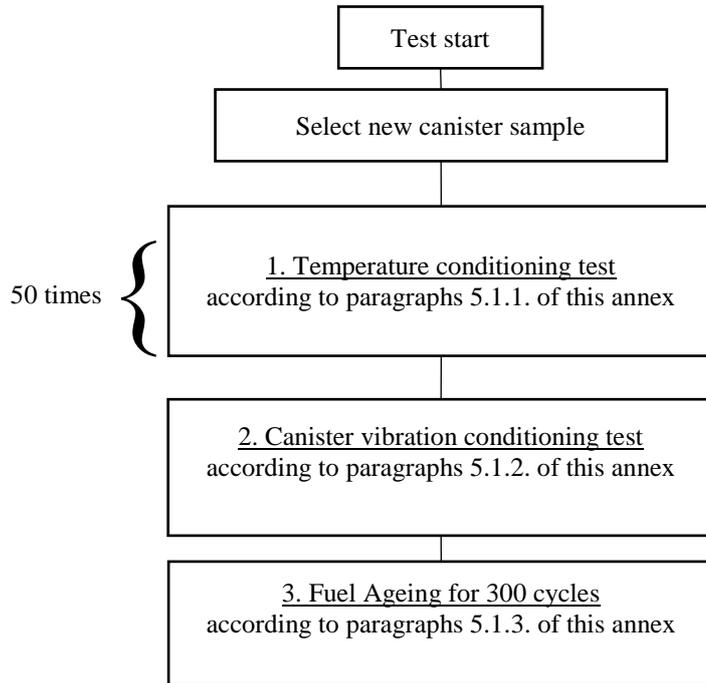
The fans shall meet the requirements of paragraph 4.7. of Annex 7 to Regulation No. 83-07, except that the capacity of the blowers shall be 0.1 to 0.5 m<sup>3</sup>/sec instead of 0.1 to 0.5 m<sup>3</sup>/min.
  - 4.7. Calibration gases

The gases shall meet the requirements of paragraph 4.8. of Annex 7 to Regulation No. 83-07.
  - 4.8. Additional Equipment

The additional equipment shall meet the requirements of paragraph 4.9. of Annex 7 to Regulation No. 83-07.
5. Test procedure
  - 5.1. Canister bench ageing

Before performing the hot soak and diurnal losses sequences, the canister shall be aged according to the procedure described in Figure A1/2.

Figure A1/2  
**Canister bench ageing procedure**



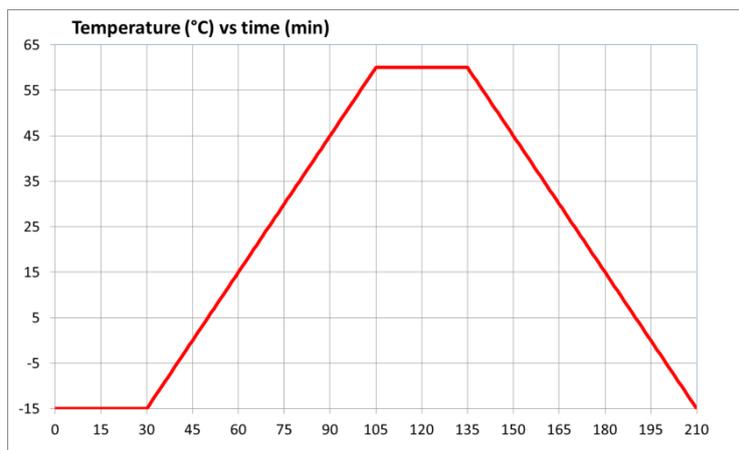
5.1.1. Temperature conditioning test

The canister shall be cycled between temperatures from -15 °C to 60 °C in a dedicated temperature enclosure with 30 minutes of stabilisation at -15 °C and 60 °C. Each cycle shall last 210 minutes (see Figure A1/3).

The temperature gradient shall be as close as possible to 1 °C/min. No forced air flow should pass through the canister.

The cycle shall be repeated 50 times consecutively. In total, this procedure lasts 175 hours.

Figure A1/3  
**Temperature conditioning cycle**



5.1.2. Canister vibration conditioning test

Following the temperature ageing procedure, the canister shall be shaken vertically with the canister mounted as per its orientation in the vehicle with overall Grms  $> 1.5 \text{ m/sec}^2$  with a frequency of  $30 \pm 10 \text{ Hz}$ . The test shall last 12 hours.

5.1.3. Canister fuel ageing test

5.1.3.1. Fuel ageing for 300 cycles

5.1.3.1.1. After the temperature conditioning test and vibration test, the canister shall be aged with a mixture of market fuel as specified in paragraph 5.1.3.1.1.1. of this annex and nitrogen or air with a  $50 \pm 15$  per cent fuel vapour volume. The fuel vapour fill rate shall be  $60 \pm 20 \text{ g/h}$ .

The canister shall be loaded to the corresponding breakthrough. Breakthrough shall be considered accomplished when the cumulative quantity of hydrocarbons emitted equals 2 grams. As an alternative, loading shall be deemed completed when the equivalent concentration level at the vent outlet reaches 3,000 ppm.

5.1.3.1.1.1. The market fuel used for this test shall fulfil the same requirements as a reference fuel with respect to:

- (a) Density at  $15 \text{ }^\circ\text{C}$ ;
- (b) Vapour pressure;
- (c) Distillation ( $70 \text{ }^\circ\text{C}$ ,  $100 \text{ }^\circ\text{C}$ ,  $150 \text{ }^\circ\text{C}$ );
- (d) Hydrocarbon analysis (olefins, aromatics, benzene only);
- (e) Oxygen content;
- (f) Ethanol content.

5.1.3.1.2. The canister shall be purged with  $25 \pm 5$  litres per minute with emission laboratory air until 300 bed volume exchanges are reached.

The canister shall be purged between 5 and 60 minutes after loading.

5.1.3.1.3. The procedures set out in paragraphs 5.1.3.1.1. and 5.1.3.1.2. of this annex shall be repeated 50 times, followed by a measurement of the Butane Working Capacity (BWC) in 5 butane cycles, as described in paragraph 5.1.3.1.4. of this annex. The fuel vapour ageing will continue until 300 cycles are reached. A measurement of the BWC in 5 butane cycles, as set out in paragraph 5.1.3.1.4. of this annex, shall be made after the 300 cycles.

5.1.3.1.4. After 50 and 300 fuel ageing cycles, BWC shall be measured. This consists of loading the canister according to paragraph 5.1.6.3. of Annex 7 to Regulation No. 83-07 until breakthrough. The BWC shall be recorded.

The canister shall be subsequently purged according the paragraph 5.1.3.1.2. of this annex.

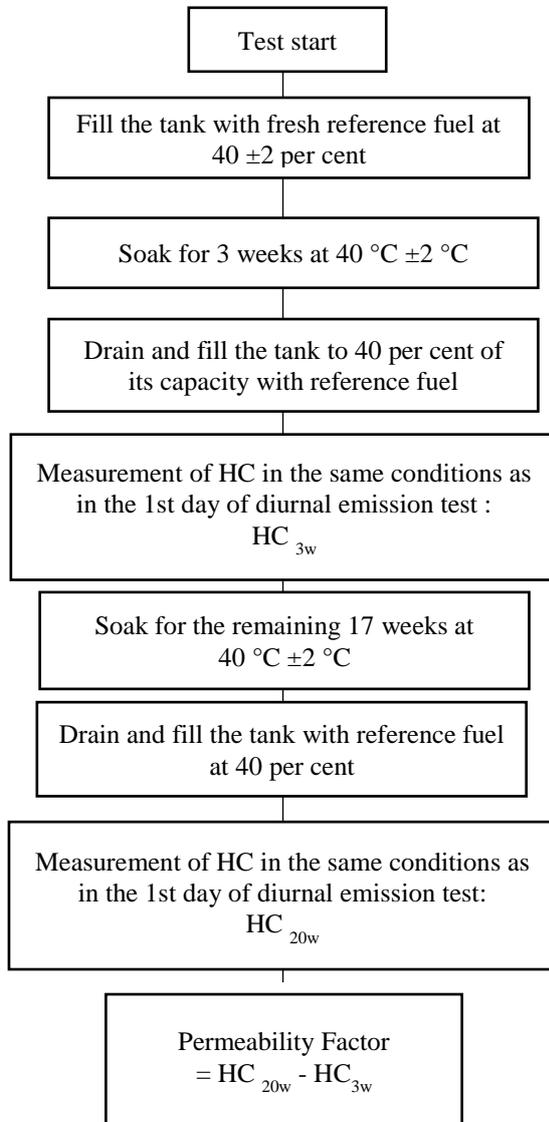
The operation of butane loading shall be repeated 5 times. The BWC shall be recorded after each butane loading step. The BWC<sub>50</sub> and BWC<sub>300</sub> shall be calculated as the average of the 5 BWCs and recorded.

In total, the canister shall be aged with 300 fuel ageing cycles + 10 butane cycles and shall be considered to be stabilised.

- 5.1.3.2. If an aged canister is provided by a supplier, the manufacturer shall inform the responsible authority in advance of the ageing process to enable witnessing any part of the ageing in the supplier’s facilities.
- 5.1.3.3. The manufacturer shall provide the responsible authority a test report including at least the following elements:
  - (a) Type of activated carbon;
  - (b) Loading rate;
  - (c) Fuel specifications;
  - (d) BWC measurements.
- 5.2. Determination of the Permeability Factor (PF) of the fuel tank system (Figure A1/4)

Figure A1/4

**Determination of the PF**



The fuel tank system representative of a family shall be selected and mounted on a rig, and subsequently soaked with reference fuel for 20 weeks at  $40\text{ °C} \pm 2\text{ °C}$ . The orientation of the fuel storage system on the rig shall be similar to that in the vehicle.

5.2.1. The tank shall be filled with fresh reference fuel at a temperature of  $18\text{ °C} \pm 2\text{ °C}$ . The tank shall be filled to  $40 \pm 2$  per cent of the nominal tank capacity. The rig with the fuel tank system shall be placed in a room with a controlled temperature of  $40\text{ °C} \pm 2\text{ °C}$  for 3 weeks.

5.2.2. At the end of the third week, the tank shall be drained and refilled with fresh reference fuel at a temperature of  $18\text{ °C} \pm 2\text{ °C}$  to  $40 \pm 2$  per cent of the nominal tank capacity.

Within 6 to 36 hours, the rig with the fuel tank system shall be placed in an enclosure. The last 6 hours of this period shall be at an ambient temperature of  $20\text{ °C} \pm 2\text{ °C}$ . In the enclosure, a diurnal procedure shall be performed over a first period of 24 hours of the procedure described in paragraph 5.3.9. of this annex. The fuel tank system shall be vented to the outside of the enclosure to eliminate the possibility of the tank venting emissions being counted as permeation. The HC emissions shall be measured and the value shall be recorded as  $\text{HC}_{3\text{W}}$ .

5.2.3. The rig with the fuel tank system shall be placed again in a room with a controlled temperature of  $40\text{ °C} \pm 2\text{ °C}$  for the remaining 17 weeks.

5.2.4. At the end of the seventeenth week, the tank shall be drained and refilled with fresh reference fuel at a temperature of  $18\text{ °C} \pm 2\text{ °C}$  at  $40 \pm 2$  per cent of the nominal tank capacity.

Within 6 to 36 hours, the rig with the fuel tank system shall be placed in an enclosure. The last 6 hours of this period shall be at an ambient temperature of  $20\text{ °C} \pm 2\text{ °C}$ . In the enclosure, a diurnal procedure shall be performed over a first period of 24 hours of the procedure described according to paragraph 5.3.9. of this annex. The fuel tank system shall be vented to the outside of the enclosure to eliminate the possibility of the tank venting emissions being counted as permeation. The HC emissions shall be measured and the value shall be recorded as  $\text{HC}_{20\text{W}}$ .

5.2.5. The PF is the difference between  $\text{HC}_{20\text{W}}$  and  $\text{HC}_{3\text{W}}$  in g/24h calculated to 3 significant digits using the following equation:

$$\text{PF} = \text{HC}_{20\text{W}} - \text{HC}_{3\text{W}}$$

5.2.6. If the PF is determined by a supplier, the vehicle manufacturer shall inform the responsible authority in advance of the determination to allow witness check in the supplier's facility.

5.2.7. The manufacturer shall provide the responsible authority a test report containing at least the following:

- (a) A full description of the fuel storage system tested, including information on the type of tank tested, whether the tank is monolayer or multilayer, and which types of materials are used for the tank and other parts of the fuel storage system;
- (b) The weekly mean temperatures at which the ageing was performed;
- (c) The HC measured at week 3 ( $\text{HC}_{3\text{W}}$ );

- (d) The HC measured at week 20 (HC<sub>20w</sub>);
  - (e) The resulting permeability factor (PF).
- 5.2.8. As an exception to paragraphs 5.2.1. to 5.2.7. inclusive of this annex, the manufacturer using multilayer tanks or metal tanks may choose to use the following Assigned Permeability Factor (APF) instead of the complete measurement procedure mentioned above:
- APF multilayer/metal tank = 120 mg /24 h
- 5.2.8.1. Where the manufacturer chooses to use APF, the manufacturer shall provide the responsible authority a declaration in which the type of tank is clearly specified as well as a declaration of the type of materials used.
- 5.3. Sequence of measurement of hot soak and diurnal losses
- 5.3.1. Vehicle preparation
- The vehicle shall be prepared in accordance to paragraphs 5.1.1. and 5.1.2. of Annex 7 to Regulation No. 83-07. At the request of the manufacturer and with the approval of the responsible authority, non-fuel background emission sources may be eliminated or reduced before testing (e.g. baking of tyres or vehicle, draining washer fluid).
- 5.3.2. Fuel drain and refill
- The fuel tank of the vehicle shall be emptied. This shall be done so as not to abnormally purge or abnormally load the evaporative control devices fitted to the vehicle. Removal of the fuel cap is normally sufficient to achieve this. The fuel tank shall be refilled with test fuel at a temperature of 18 °C ±2 °C to 40 ±2 per cent of the tank's normal capacity.
- 5.3.3. Preconditioning drive
- After completing the fuel drain and refilling following soaking for a minimum of 6 hours and a maximum of 36 hours at 23 °C ±3 °C, the vehicle shall be placed on a chassis dynamometer and driven over the following phases of the cycle described in Annex 1 of gtr No. 15:
- a) For Class1 vehicles:  
low, medium, low, low, medium, low
  - b) For vehicles of Classes 2 and 3:  
low, medium, high, medium
- Exhaust emissions need not be measured during this operation.
- 5.3.4. Soak and canister breakthrough for non-sealed tank system
- 5.3.4.1. Second soak
- Within five minutes of completing preconditioning, the vehicle shall be parked for a minimum of 12 hours and a maximum of 36 hours at 23 °C ±3 °C. The engine oil and coolant temperatures shall have reached a temperature within ±3 °C of the area before the canister breakthrough loading may begin.
- 5.3.4.2. Canister breakthrough
- The canister aged according to the sequence described in paragraph 5.1. of this annex shall be loaded to breakthrough according to the procedure described in paragraph 5.1.4. of Annex 7 to Regulation No. 83-07. Within

- one hour after completing canister loading, the vehicle shall be placed on the chassis dynamometer.
- 5.3.5. Soak and canister breakthrough for sealed tank system  
[Reserved]
- 5.3.6. Dynamometer test  
The vehicle shall be driven over the cycles as described in paragraph 5.3.3. of this annex. The engine shall be subsequently 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.
- 5.3.7. Hot soak evaporative emissions test  
After the dynamometer test, the hot soak evaporative emissions test shall be performed in accordance to paragraph 5.5. of Annex 7 to Regulation No. 83-07. The hot soak losses result shall be calculated according to paragraph 6. of Annex 7 to Regulation No. 83-07 and recorded as  $M_{HS}$ .
- 5.3.8. Third soak  
After the hot soak evaporative emissions test, the test vehicle shall be soaked for not less than 6 hours and not more than 36 hours between the end of the hot soak test and the start of the diurnal emission test. For at least 6 hours of this period the vehicle shall be soaked at  $20\text{ °C} \pm 2\text{ °C}$ .
- 5.3.9. Diurnal testing
- 5.3.9.1. The test vehicle shall be exposed to two cycles of ambient temperature according to the profile specified for the diurnal emission test in Appendix 2 to Annex 7 to Regulation No. 83-07 with a maximum deviation of  $\pm 2\text{ °C}$  at any time. The average temperature deviation from the profile, calculated using the absolute value of each measured deviation, shall not exceed  $\pm 1\text{ °C}$ . Ambient temperature shall be measured at least every minute. Temperature cycling begins when time  $T_{start} = 0$ , as specified in paragraph 5.3.9.6. of this annex.
- 5.3.9.2. The enclosure shall be purged for several minutes immediately before the test until a stable background is obtained. The chamber mixing fan(s) shall also be switched on at this time.
- 5.3.9.3. The test vehicle, with the engine shut off and the test vehicle windows and luggage compartment(s) opened, shall be moved into the measuring chamber. The mixing fan(s) shall be adjusted in such a way as to maintain a minimum air circulation speed of 8 km/h under the fuel tank of the test vehicle.
- 5.3.9.4. The hydrocarbon analyser shall be zeroed and spanned immediately before the test.
- 5.3.9.5. The enclosure doors shall be closed and gas-tight sealed.
- 5.3.9.6. Within 10 minutes of closing and sealing the doors, the hydrocarbon concentration, temperature and barometric pressure shall be measured to give initial readings of hydrocarbon concentration in the enclosure  $C_{HCi}$ , barometric pressure  $P_i$  and ambient chamber temperature  $T_i$  for the diurnal testing.  $T_{start} = 0$  starts at this time.
- 5.3.9.7. The hydrocarbon analyser shall be zeroed and spanned immediately before the end of each emission sampling period.

- 5.3.9.8. The end of the first and second emission sampling period shall occur 24 hours  $\pm$ 6 minutes and 48 hours  $\pm$ 6 minutes, respectively, after the beginning of the initial sampling, as specified in paragraph 5.3.9.6. of this annex. The elapsed time shall be recorded.

At the end of each emission sampling period, the hydrocarbon concentration, temperature and barometric pressure shall be measured to give the readings of hydrocarbon concentration in the enclosure  $C_{HCf}$ , barometric pressure  $P_f$  and ambient chamber temperature  $T_f$  for the diurnal testing used for the calculation in paragraph 6.1. of this gtr. The value obtained from the first 24 hours shall be recorded as  $M_{D1}$ . The value obtained from the second 24 hours shall be recorded as  $M_{D2}$ .

- 5.3.10. Calculation

- 5.3.10.1. The result of  $M_{HS} + M_{D1} + M_{D2} + PF + PF$  shall be below the limit defined paragraph 6.1.(a) of this gtr.

- 5.3.10.2. At the option of the Contracting Party, the following alternative calculation may be used.

The result of  $M_{HS} + M_{D_{max}} + PF$  shall be below the limit defined paragraph 6.1.(b) of this gtr. The  $M_{D_{max}}$  shall be either  $M_{D1}$  or  $M_{D2}$ , whichever generates the higher emission.

- 5.3.11. The manufacturer shall provide the responsible authority a test report containing at least the following:

- (a) Description of the soak periods, including time and mean temperatures;
- (b) Description to aged canister used and reference to exact ageing report;
- (c) Mean temperature during the hot soak test;
- (d) Measurement during hot soak test, HSL;
- (e) Measurement of first diurnal, DL1st day;
- (f) Measurement of second diurnal, DL2nd day;
- (g) Final evaporative test result, calculated according to paragraph 5.3.10. of this annex.

## Annex 2

### Reference fuels

1. As there are regional differences in the market specifications of fuels, regionally different reference fuels need to be recognised. Contracting Parties may select their reference fuels either according to Annex 3 to gtr No. 15. or according to paragraph 2. of this annex.
2. Specification of reference fuel for testing for mutual recognition  
The reference fuel listed in Table A2/1 is designed to be used as the reference fuel for mutual recognition under the rules of the 1998 Agreement.
3. Specification of reference fuel for regional testing  
The reference fuel listed in Annex 3 to gtr No. 15. may be used for this purpose.

Table A2/1

| <i>Parameter</i>            | <i>Unit</i>       | <i>Limits</i>  |                | <i>Test method</i>                                    |
|-----------------------------|-------------------|----------------|----------------|---|
|                             |                   | <i>Minimum</i> | <i>Maximum</i> |   |
| Research octane number, RON |                   | 95.0           | 98.0           | EN ISO 5164<br>JIS K2280                              |
| Density at 15 °C            | kg/m <sup>3</sup> | 743.0          | 756.0          | EN ISO 12185<br>JIS K2249-1,2,3                       |
| Vapour pressure             | kPa               | 56.0           | 60.0           | EN 13016-1<br>JIS K2258-1,2                           |
| Distillation:               |                   |                |                |   |
| – evaporated at 70 °C       | % v/v             | 34.0           | 46.0           | EN ISO 3405   |
| – evaporated at 100 °C      | % v/v             | 54.0           | 62.0           | EN ISO 3405   |
| – evaporated at 150 °C      | % v/v             | 86.0           | 94.0           | EN ISO 3405   |
| Hydrocarbon analysis:       |                   |                |                |   |
| – olefins                   | % v/v             | 6.0            | 13.0           | EN 22854  |
| – aromatics                 | % v/v             | 25.0           | 32.0           | EN 22854  |
| – benzene                   | % v/v             | -              | 1.00           | EN 22854<br>EN 238<br>JIS K2536-2,3,4                 |
| Oxygen content              | % m/m             | 3.3            | 3.7            | EN 22854<br>JIS K2536-2,4,6                           |
| Sulphur content             | mg/kg             | —              | 10             | EN ISO 20846<br>EN ISO 20884<br>JIS K2541-<br>1,2,6,7 |
| Lead content                | mg/l              | Not detected   |                | EN 237<br>JIS K2255                                   |
| Ethanol                     | % v/v             | 9.0            | 10.0           | EN 22854<br>JIS K2536-2,4,6                           |

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| <i>Parameter</i> | <i>Unit</i> | <i>Limits</i>  |                | <i>Test method</i>               |
|------------------|-------------|----------------|----------------|----------------------------------|
|                  |             | <i>Minimum</i> | <i>Maximum</i> |                                  |
| MTBE             |             | Not detected   |                | JIS K2536-2,4,5,6 <sup>(1)</sup> |
| Methanol         |             | Not detected   |                | JIS K2536-2,4,5,6 <sup>(1)</sup> |
| Kerosene         |             | Not detected   |                | JIS K2536-2,4 <sup>(1)</sup>     |

(1) Other method that is traceable to national or international standard may be used.

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