

Working paper EPPR informal group\_v7

## **GLOBAL REGISTRY**

Created on 18 November 2004, pursuant to Article 6 of the  
**AGREEMENT CONCERNING THE ESTABLISHING OF GLOBAL TECHNICAL  
REGULATIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE  
FITTED AND/OR BE USED ON WHEELED VEHICLES**

(ECE/TRANS/132 and Corr.1)

Done at Geneva on 25 June 1998.

### **Global technical regulation No. XX**

**MEASUREMENT PROCEDURE FOR TWO- OR THREE-WHEELED MOTOR VEHICLES  
EQUIPPED WITH A COMBUSTION ENGINE WITH REGARD TO THE CRANKCASE AND  
EVAPORATIVE EMISSIONS**

(Established in the Global Registry on dd.mm.yy)



**UNITED NATIONS**

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## [ A. STATEMENT OF TECHNICAL RATIONALE AND JUSTIFICATION

### A.1. Introduction

The industry producing two-, three and four-wheeled vehicles is a global one, with companies selling their products in many different countries. The Contracting Parties to the 1998 Agreement have determined that work should be undertaken to address the environmental performance requirements from two- and three-wheeled vehicles as a way to help improve air quality internationally. The aim of this Global Technical Regulation (GTR) is to provide measures to strengthen the world-harmonisation of vehicle approval and certification legislation, in order to improve the cost effectiveness of environmental performance testing, remove trade barriers, reduce the overall complexity of global legislation, remove potential areas of conflict or opposing requirements and improve the air quality.

This GTR establishes harmonised test procedures to determine the crankcase emissions and evaporative emissions of [two- and [three wheeled] / [3-1, 3-3 and 3-2, 3-4, 3-5] vehicles as part of the environmental performance tests for [approval] / [certification] of such vehicles. The test procedures were developed so that they would be:

- able to provide an internationally harmonised set of tests to ensure efficient, cost-effective and practicable testing;
- corresponding to state-of-the-art testing, sampling and measurement technology in the area of performance testing of vehicles; and
- applicable in practice to existing and foreseeable future powertrain technologies.

The technical and economic feasibility of the measures contained within this GTR have been considered and are discussed further in Section A.5.

This GTR covers the following test types:

- test type III, emissions of crankcase gasses;

The section on emissions from crankcase gasses includes two alternative tests which were set out to demonstrate, where required, that no emissions are released from the crankcase gas ventilation system and hence to ensure that no crankcase emissions can escape to the atmosphere from the crankcase ventilation system.

- test type IV, evaporative emissions.

The section on evaporative emissions includes a cascade of three tests to determine the evaporative emissions, from either a fuel tank permeability test for non-metallic fuel storage tanks, a fuel storage and delivery system permeation test, or a SHED based test to determine the evaporative emissions from the entire vehicle in a sealed house test.

This GTR is based on the work of the Informal Working Group (IWG) on Environmental and Propulsion unit Performance Requirements of vehicles, from now on referred to as L-EPPR, which held its first meeting during the 65<sup>th</sup> GRPE in January 2013 and on the initial proposal by the European Commission (EC). Specific issues and options raised and resolved in their development are discussed in Section 0. "Introduction issues and proposed options for harmonisation" of this document, which will be transferred into the report that accompanies this new

draft GTR.

## **A.2. Procedural background**

The EU put forward and announced their intention of setting up a group during the 63<sup>rd</sup> and 64<sup>th</sup> meetings of the GRPE in January and June 2012 and in the 157<sup>th</sup> session of the WP.29 in June 2012.

With the mandate (informal document: WP.29-158-15) accepted at the 158<sup>th</sup> session of the WP.29 (13-16<sup>th</sup> November 2012) to establish the L-EPPR IWG under the GRPE.

At the [72]<sup>th</sup> GRPE session in [January 2016],[tv1] a formal proposal for this new GTR was tabled for adoption by the Executive Committee for the 1998 Agreement (AC.3).

On-going developments of test types and procedures and global discussion on harmonisation have resulted in the technical requirements contained within this GTR. The final text of the GTR is presented in Part B of this document.

## **A.3. Existing regulations, directives and international voluntary standards**

### **A.3.1. Technical references in the development of the GTR**

For the development of the GTR, the following legislation and technical standards contained relevant applications of requirements for motorcycles and other [category 3] / [two- [and three-]wheeled] vehicles or transferable provisions for passenger cars:

- crankcase emissions:

UN Regulation No 83 (applicable to cars and vans) custom tailored for combustion engines fitted to [category 3] / [two- [and three-]wheeled] vehicles;

- evaporative emissions, permeability tests;

Annex 1 to chapter 6 of Directive 97/24/EC;

- evaporative emissions, permeation tests;

US Federal test procedures (86.410-2006 Emission standards for 2006 and later model year motorcycles);

- evaporative emissions: SHED test;

California Air Resources board test procedure (based on the 1978 test procedure for light-duty vehicles); California evaporative emission standards and test procedures; for 2001 and subsequent model motor vehicles, as amended on 22 March 2012)

### **A.3.2. Methodology for deriving harmonised test procedures for the GTR**

The European Commission launched an L-EPPR study in January 2012 with the objective to develop proposals to update GTR No 2 for technical progress and to develop proposals for GTRs and UN Regulations with respect to harmonised EPPR legislation not yet covered at the international level for [category 3] / [two- [and three-] wheeled] vehicles, e.g. crankcase and evaporative emission test requirements, on-board diagnostic requirements, propulsion unit performance requirements etc. The output of this comprehensive study was submitted for the

assessment and approval of the L-EPPR group.

The methodology used in this study to develop the test procedures contained within the GTR involved an iterative process of review. The process was initially based on an assessment of existing literature and new evidence, which was gathered from a wide range of pertinent stakeholders, to provide more insight with regards to the future requirements of the GTR.

The first phase comprised a stocktake of appropriate literature, international legislation and proposals. The aim was to ensure that all current and proposed test types and the specific requirements of different regions were captured.

The second phase of the evidence gathering consisted of a stakeholder consultation. An important part of this was a questionnaire, which asked stakeholders to provide information and at times their views on current practices in different regions and the way forward.

The third and final phase of the study, the derivation of the test procedures contained within the GTR, consisted of a technical evaluation of the information collected in phases one and two. Specifically, each test type was assessed and the following aspects considered:

- common international practices (existing harmonised practices);
- significant differences with respect to testing methods and procedures;
- the global technical feasibility;
- the likely cost and economic impact;
- the likely acceptability for all Contracting Parties;
- the effectiveness of each proposal at improving vehicle emission performance;
- the suitability of the testing procedures with regard to current and future powertrains and technologies.

The order of the aspects presented above does not represent any ranking, the priority was dependent on, each of the specific areas analysed during the development of the GTR. This is shown where applicable in the accompanying options section 0. Where multiple options were left after the assessment of the factors listed above, further iterative evaluation was undertaken by the L-EPPR IWG.

The outcome of this work was among others the development of a new proposal based on the consolidation of existing global legislation and up-to-date technical provisions.

Subsequently the L-EPPR group assessed the study output and decided as follows:<sup>[g2]</sup>

#### **A.4. Discussion of the issues addressed by the GTR**

This GTR brings together the test procedures to determine the crankcase emissions and evaporative emissions of [category 3] vehicles. The process to develop this GTR followed the methodology discussed in Section A.3.2, where important issues addressed during the development were:

- Adapt provisions to two- and three-wheeled vehicles where necessary;

- Provide a series of options to allow testing to be carried out involving varying degree of complexity and equipment (i.e. from a simple mass based permeability test to a full SHED test).

#### A.4.1. Applicability

The IWG followed the agreed terms of reference and has prepared a GTR for two- and three-wheeled vehicles under the 1998 Agreement as well as two-, three- and four-wheeled vehicles under the 1958 Agreement. In accordance with the agreed terms of reference UN GTRs and UN Regulations in the area of EPPR will be developed as much as possible in a coherent way.

#### A.4.2. Definitions

The definitions used in the GTR are taken from definitions in international legislation and from the work of the VPSD group operating under GRPE with the goal to harmonise high level powertrain definitions as well as from other regional legislation as listed in A.3.1.

#### A.4.3. Requirements

For the general requirements are:

For crankcase emissions:

- if there is any doubt that crankcase gases might escape to the atmosphere, the manufacturer is required to conduct a type III test:
- the engine is run at a three specified steady state conditions;
- the crankcase vacuum is measured at an appropriate location;
- the vehicle is deemed satisfactory if, at each condition, the pressure does not exceed the atmospheric pressure;
- if the vehicle fails the initial test, then one of two additional tests can be performed at the choice of the manufacturer:
- the initial test is repeated but with a flexible bag connected to a suitable location. The vehicle is satisfactory if there is no visible inflation of the bag at each test condition;
- the crankcase of the stopped engine is pressurised to at least 5 kPa above atmospheric pressure. If the crankcase can maintain over 95% of this overpressure for 300 seconds after the air source is closed, then the engine is deemed satisfactory.

For evaporative emissions, there are a choice of three different test procedures:

- fuel tank permeability test – the fuel tank is half filled and weighed daily over an 8 week period to determine the mass of fuel lost over that period;
- fuel storage and supply system permeation test – a similar test to the fuel tank permeability test but with additional preconditioning treatment to simulate partial deterioration of the system as would occur in normal use and determination of the evaporative losses of the fuel lines;
- SHED test, comprising of a diurnal test (emissions due to an increase in the temperature of the fuel and vapour in the fuel tank) and a hot soak test (evaporative emissions occurring after getting the engine up to temperature by

driving over a Type I test cycle on a chassis dynamometer) of the complete vehicle.

A.4.5. Performance requirements

With respect to crankcase gas emissions these shall be entirely combusted by the engine and therefore zero emissions shall be evacuated directly from the crankcase system to the atmosphere.

The performance requirements for the three evaporative emissions have been derived from a mix of USA and EU requirements, which are proposed to be adopted for the evaporative emission performance of [category 3] / [two- [and three-]wheeled] vehicles world-wide. Test limits for a first stage ('UN 1') were agreed. It should be considered in the future to update these test limits, (i.e. establish a 'UN 2' stage).<sup>[iv3]</sup>

A.4.6. Reference fuel

For the crankcase emissions and the evaporative emissions test, the same reference fuel as specified for the Type I (exhaust emissions after cold start) test should be used as referenced in Annex B.6.2. of Revision 1 of GTR No 2.

**A.5. Regulatory impact and economic effectiveness**

A.5.1. Increasingly, mopeds, motorcycles and other [category 3] / [two- [and three-]wheeled] vehicles are being designed for the world market. To the extent that manufacturers are preparing substantially different models in order to meet different emission regulations and methods of measuring CO<sub>2</sub> emission and fuel or energy consumption, testing costs and other production values are increased. It would be more economically efficient to have manufacturers using a similar test procedure worldwide wherever possible to prove satisfactory environmental performance before being placed on the market. A prerequisite for that is a harmonised definition of the test procedures for measuring crankcase emissions and evaporative emissions. It is anticipated that the test procedures in this GTR will provide a common test programme for manufacturers to use in countries worldwide and thus reduce the amount of resources utilised to test [category 3] / [two- [and three-]wheeled] vehicles. These savings will accrue not only to the manufacturers, but more importantly, to the consumers and the authorities as well. However, developing a test programme just to address the economic question does not address the mandate given when work on this GTR was first started, which is to reduce hydrocarbon emissions from crankcase gas and evaporative emissions. The test programme also improves the state of testing [category 3] / [two- [and three-]wheeled] vehicles and covers recent and near-future powertrain technologies.

A.5.2. Potential cost effectiveness

At the time of writing this revision of the GTR, the data is not available to undertake a full impact assessment of the test procedures contained. Specific cost effectiveness values in markets around the globe can be quite different, depending on the national or regional market situation. While there are no calculated values here, the belief of the technical group is that there are clear and significant benefits comparing to low anticipated cost increases associated with this GTR. ]

**B.1. TEXT OF THE REGULATION, GENERAL PART**

**1. Purpose**

1.1. This Global Technical Regulation provides worldwide-harmonized test methods for the determination of crankcase gas emissions (Test Type III).

1.2. This Global Technical Regulation also provides world-harmonised test procedures to determine evaporative emissions (Test Type IV) owing to evaporation of fuel through the vehicle's fuel storage and fuel delivery system

**2. [ Scope**

Two- [and three-]wheeled vehicles [ig4]of category 3-1, 3-3 and 3-2, 3-4, 3-5[TV5] as defined in S.R. 1, concerning the common definitions of vehicle categories, masses and dimensions document TRANS/WP29/1045e, as amended by ECE/TRANS/WP29/1045/Amend.1, ]equipped with a PI engine in accordance with table B.1.-1.]



	Vehicle with PI engines							Vehicles with CI engines			Pure electric vehicle or vehicle propelled with compressed air (CA)	Hydrogen Fuel cell vehicle	
	Mono-fuel*				Bi-fuel			Flex-fuel		Flex-fuel			Mono-fuel
	Petrol	LPG	NG/Biomethane	H <sub>2</sub>	Petrol	Petrol	Petrol	Petrol	NG/Biomethane	Diesel			Diesel
LPG					NG/Biomethane	H <sub>2</sub>	Ethanol (E85)	H <sub>2</sub> NG	Biodiesel				
Type III test	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Type IV test	Yes*	No	No	No	Yes (petrol only)*	Yes (petrol only)*	Yes (petrol only)*	Yes (petrol only)*	No	No	No	No	No

\* Type IV test is not applicable for motor vehicle that is designed primarily for permanent running on LPG or NG / bio-methane or hydrogen, having a petrol system, with petrol tank capacity not exceeding 2 litres in the case of a 3-1, 3-3 and 3-4 category vehicle and not exceeding 3 litres in the case of a 3-2 and 3-5 category vehicles, intended for emergency purposes or starting only.

Table B.1.-1: Scope with regard to the propulsion unit

### 3. **Definitions**<sup>[TV6]</sup>

The definitions set out in GTR No 2 shall apply. In addition the the following definitions shall apply in this UN GTR:

- 3.1. ‘crankcase emissions’ means emissions from spaces in or external to an engine which are connected to the oil sump crankcase by internal or external ducts through which gases and vapour can escape;
- 3.2. ‘engine crankcase’ means the spaces in or external to an engine which are connected to the oil sump by internal or external ducts through which gases and vapour can escape;
- 3.3. ‘evaporative emissions’ means the hydrocarbon vapours lost from the fuel system of a vehicle other than those from exhaust emissions means the hydrocarbon vapours lost from the fuel storage and fuel supply system of a motor vehicle and not those from tailpipe emissions;
- 3.4. ‘fuel storage breathing losses’ are hydrocarbon emissions caused by temperature changes in the fuel storage;
- 3.5. [‘fuel storage<sup>[g7]</sup> tank’] means a type of energy storage system that stores <sup>[g8]</sup>the liquid fuel [and which is refillable];
- 3.6. ‘hot soak losses’ are hydrocarbon emissions arising from the fuel system of a stationary vehicle after a period of driving (assuming a ratio of C1H2.20);
- 3.7. ‘non-exposed’ type of fuel storage tank and delivery system means that the fuel storage and fuel delivery system, except the fuel tank cap, are not directly exposed to radiation of sunlight;
- 3.8. ‘permeability test’ means testing of the hydrocarbon losses through the walls of the non-metallic fuel storage;
- 3.9. ‘permeation’ means the hydrocarbon losses through the walls of the fuel storage and delivery systems, generally tested by weight loss;
- 3.10. ‘positive ignition engine’ or ‘PI engine’ means a combustion engine working according to the principles of the ‘Otto’ cycle;
- 3.11. ‘SHED test’ means a vehicle test in a sealed house for evaporation determination, in which a special evaporative emission test is conducted;
- 3.12. ‘Useful life’ means the relevant period of distance and/or time over which compliance with the relevant gaseous and particulate emission limits has to be assured.

### 4. **List of acronyms and symbols**

[To be established]<sup>[tv9]</sup>

5. [T<sub>g10</sub>]he manufacturer shall equip vehicles in the scope of this GTR with systems, components and separate technical units affecting the environmental performance of a vehicle that are designed, constructed and assembled so as to enable the vehicle in normal use and maintained according to the prescriptions of the manufacturer to comply with the detailed technical requirements and testing procedures of this GTR during its useful life, as defined by the Contracting Party, including when installed in the vehicle. [tv11]

**B.2. TEXT OF THE REGULATION, TEST TYPE III, EMISSIONS OF CRANKCASE GASSES**

**1. Introduction**

- 1.1. Test type III shall be conducted in order to demonstrate that zero emissions from the crankcase and/or if applicable the crankcase ventilation system can escape directly into the atmosphere.

**2. General provisions**

- 2.1 Zero emissions from the crankcase and/or if applicable the crankcase ventilation system may escape directly into the atmosphere from any vehicle throughout its useful life. For this purpose Contracting Parties may require:

A written declaration from the vehicle manufacturer that the propulsion unit is equipped with a closed crankcase system preventing crankcase gas to be discharged directly into the ambient atmosphere. In this case the Type III test<sup>1</sup> requirements may be waived.

- 2.2. The manufacturer shall provide the approval authority of the Contracting party or its designated agency with technical details and drawings to prove that the engine or engines are so constructed as to prevent vapour of any fuel, lubrication oil or crankcase gases from escaping to the atmosphere from the crankcase gas ventilation system.

A Physical verification may be conducted that the crankcase breather is not let out into atmosphere.

- 2.3 Type III test is not applicable for vehicles equipped with a two-stroke engine containing a scavenging port between the crank case and the cylinder(s).

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<sup>1</sup> The Type III test procedure to be conducted in accordance with the requirements to be agreed upon by the UN EPPR informal working group and to be supplemented in a subsequent amendment No to this GTR.

### **B.3. Test type IV requirements: evaporative emissions**

#### **1. Introduction – evaporative and permeation emissions**

- 1.1. To allow for the large variation of vehicle types and sizes and also to allow for the differing requirements from various regions, the evaporative emission test procedures shall be available as different classes. This ranges from the basic permeability test for a non-metallic fuel storage tank, requiring minimum test equipment and effort, to a more complex fuel storage and delivery system evaporative emission test procedure, and finally to the most comprehensive whole vehicle evaporative emission test procedure requiring a chassis dynamometer and a SHED.
- 1.2. The test procedure in Annex B.3.1. sets out the procedure for testing the permeability of a non-metallic fuel storage tank.
- 1.3. The evaporative emission test procedure laid down in Annexes B.3.2. sets out the test method for the determination of the loss of hydrocarbons by permeation from the fuel storage and supply system of a vehicle equipped with a propulsion unit type that uses volatile, liquid fuel.
- 1.4. The procedure laid down in Annex B.3.3. sets out the evaporative hydrocarbon emission determination requirements of the whole vehicle and it is therefore the most comprehensive test methodology.

#### **2. General requirements**

- 2.1. The vehicle manufacturer shall prove to the approval authority of the Contracting party or its designated agency that the fuel storage and supply system are leak-tight in accordance with point 2.2.
- 2.2. Hydraulic test
  - 2.2.1. Fuel tanks shall pass the leak-tightness tests carried out with an internal pressure equal to twice the relative service pressure (design pressure) or an overpressure of 30 kPa, whichever is higher. Any orifices may be blocked for the purpose of this test. The fuel tank shall not crack or leak during the test, but may remain permanently deformed.
  - 2.2.2. The tank shall be subjected to a hydraulic internal pressure test which shall be carried out on an isolated unit complete with all its accessories. The tank shall be completely filled with a non-flammable liquid having a density and a viscosity close to those of the fuel normally used, or with water. After all communication with the outside has been cut off, the pressure shall be gradually increased, through the pipe connection through which fuel is fed to the engine, to the internal pressure specified in point 2.2.1. and this pressure shall be maintained for at least 60 seconds. The fuel tank shall not crack or leak during the test, but may remain permanently deformed.
- 2.3. The following three classes of type IV testing are listed in hierarchical order as follows:

2.3.1. Class A; the test procedure in Annex B.3.1 sets out the permeability test procedure of a non-metallic fuel storage; as a component

2.3.2. Class B; the test procedure in Annex B.3.2 sets out the permeation test procedures of the fuel storage and supply systems.

2.3.3. Class C;  
The SHED test is described in Annex B.3.3. and sets out the evaporative emission test procedure for a whole vehicle:

2.4. Test hierarchy and obligations of contracting parties  
Each class shall consist of one or more tests, which are listed in Table B.3.-1, together with the SHED type required for the tests, if any.

2.4.1.

Test	Evaporative emissions class			SHED type
	A	B	C	
Permeability test of a non-metallic fuel storage tank as component	✓			-
Permeation test of the fuel storage and supply system		✓		-
SHED test of the whole vehicle, short diurnal test (fuel temp. change)			✓	$S_{fv}^{(1)}$
SHED test of the whole vehicle, hot soak loss test			✓	$S_{fv}^{(1)}$
Comments: (1) $S_{fv}$ Fixed volume SHED SHED Sealed Housing for Evaporative Determination The fixed volume SHED is the minimum requirement. The tests may be carried out in a variable volume SHED.				

Table B.3.-1 Evaporative emission test classes

- 2.4.2. A two-wheeled motorcycle, [a motorcycle with sidecar and a tricycle] [of Category 3-3, 3-4 and 3-5] shall be tested according to the class C evaporative emission test procedure.
- 2.4.3. For other type of a two- [g12]or three-]wheeled [g13] vehicle, [including the category or subcategory as per the classification followed by the Contracting Party,] the Contracting Party may decide to apply one test procedure only from the three listed evaporative emission test procedure classes for the [approval] / [certification] of a vehicle laid down in point 2.3.
- 2.4.4. The Contracting Parties shall accept test reports for the approval of a vehicle according to table B.3-2:

<b>Type IV test class mandated by the Contracting Party for the whole vehicle in its territory:</b>	<b>Compliance to type IV test class to be accepted by the Contracting Party for the whole vehicle:</b>
A	A / B / C
B	B / C
C	C

Table B.3-2 Hierarchy of evaporative emission tests.

- 2.5. Test fuel
- The appropriate test fuel, as defined in Annex 2 of GTR No 2 (type: Petrol E0) and Annex 3.8. of this GTR (types: [Petrol E5 and Petrol E10]), shall be used, as decided by the Contracting Party.
- 2.5.1. If the combustion engine uses a petrol-lubrication oil mixture, the lubrication oil added to the reference fuel shall comply with the grade and quantity recommended by the manufacturer.
- 2.5.2. [Tg14]he Contracting Parties shall accept test reports for the approval of a vehicle according to the test fuel used given in Table – B.3.3

Test fuel mandated by the Contracting Party	Compliance to type IV test using
E10	E10
E5	E5 / E10
E0	E10 /E5 / E0

Table B.3-3 Hierarchy of acceptance of test reports with different test fuel blends.]

### 3. Durability

The manufacturer shall demonstrate the durability of the evaporative emission control system using the applicable durability test procedure as follows:

<b>Type IV test class mandated by the Contracting Party for the whole vehicle in its territory</b>	<b>Durability test procedure</b>
A	Points 2.1.2.to 2.1.4 of Annex B.3.1. (pre-storage period)
B	Point 6 of Annex B.3.2.
C	point 2.1 of B.3.3

Table B3-4: overview durability test procedure

4. Test limits

<b>Type IV test class mandated by the Contracting Party for the whole vehicle in its territory</b>	<b>Test conditions / Test subject</b>	<b>Test limits stage UN 1</b>
A	40 °C± 2 °C:	20000 mg <sub>[tv15]</sub> /24h
	23 °C ± 2 °C:	10000 mg /24h
B	Fuel storage	1500 mg/m <sup>2</sup> /24h
	Fuel tubing	15000 mg/m <sup>2</sup> /24h
C	-	2000 mg/test

Table B.3.-5 : Test type IV limits

5. **Propulsion family definition with regard to test type IV**

A representative parent vehicle shall be selected to test and demonstrate to the approval authority of the Contracting party or its designated agency the test type IV requirements based on the propulsion family definition in accordance with Annex B.3.6.

6. **Documentation**

The vehicle manufacturer shall fill out the information document in accordance with the template laid down in Annex B.3.7. and submit it to the approval authority of the Contracting party or its designated agency.



**Annex B.3.1.**  
**Fuel storage permeability test procedure**

**1 Scope**

- 1.1. This requirement shall apply to all [two- [and three-]wheeled] vehicles equipped with a non-metallic fuel tank to store liquid, volatile fuel, as applicable for vehicles equipped with a positive ignition combustion engine.

**2. Fuel tank permeability test**

2.1. Test method

2.1.1. Test temperature

The fuel storage tank shall be tested at a temperature of  $40\text{ °C} \pm 2\text{ °C}$ .

- 2.1.2. The tank is filled with the test fuel up to 50 % of its total rated capacity and allowed to rest in the ambient air at a temperature of  $40\text{ °C} \pm 2\text{ °C}$  until there is a constant weight loss. That period shall be at least four weeks (pre-storage period). The tank is emptied and then refilled with test fuel to 50 % of its rated capacity.

- 2.1.3. The tank is stored under the stabilising conditions at a temperature of  $40\text{ °C} \pm 2\text{ °C}$  until its contents are at the test temperature. The tank is then sealed. The pressure rise in the tank during the test may be compensated.

- 2.1.4. The weight loss due to diffusion shall be measured during the eight-week test. During that period, a maximum quantity of [20000<sub>[tv16]</sub>] mg may escape from the fuel storage, on average, every 24 hours.

- 2.1.5. If the diffusion losses are greater, the fuel loss shall also be determined at a test temperature of  $23\text{ °C} \pm 2\text{ °C}$ , all other conditions being maintained (pre-storage at  $40\text{ °C} \pm 2\text{ °C}$ ). The loss determined under those conditions shall not exceed [10000] mg per 24 hours.

- 2.2. The permeability evaporation test results shall not be averaged between the different tested fuel storage tanks, but the worst-case diffusion loss rate observed of any one of those fuel storage tanks shall be taken and compared against the maximum permitted loss rate set out in point 2.1.5 and, if applicable, in point 2.1.6.

2.3. Fuel tank permeability test conducted with internal pressure compensation

If the fuel storage tank permeability test is conducted with internal pressure compensation, which shall be noted in the test report, the fuel loss resulting from the pressure compensation shall be taken into account when the diffusion loss is calculated.

## Annex B.3.2.

### Fuel storage and delivery system permeation test procedure

#### 1. Introduction

- 1.1. For the purposes of the requirements of this Annex, the minimum fuel system components falling within the scope of this Annex consist of a fuel storage tank and fuel line sub-assembly. Other components that form part of the fuel delivery system, fuel metering and control system are not subject to the requirements of this Annex.

#### 2. Description of the fuel storage and delivery system permeation test

- 2.1 Measure permeation emissions by weighing a sealed fuel storage tank before and after a temperature-controlled soak according to the flow charts shown in Figure B.3.2-1

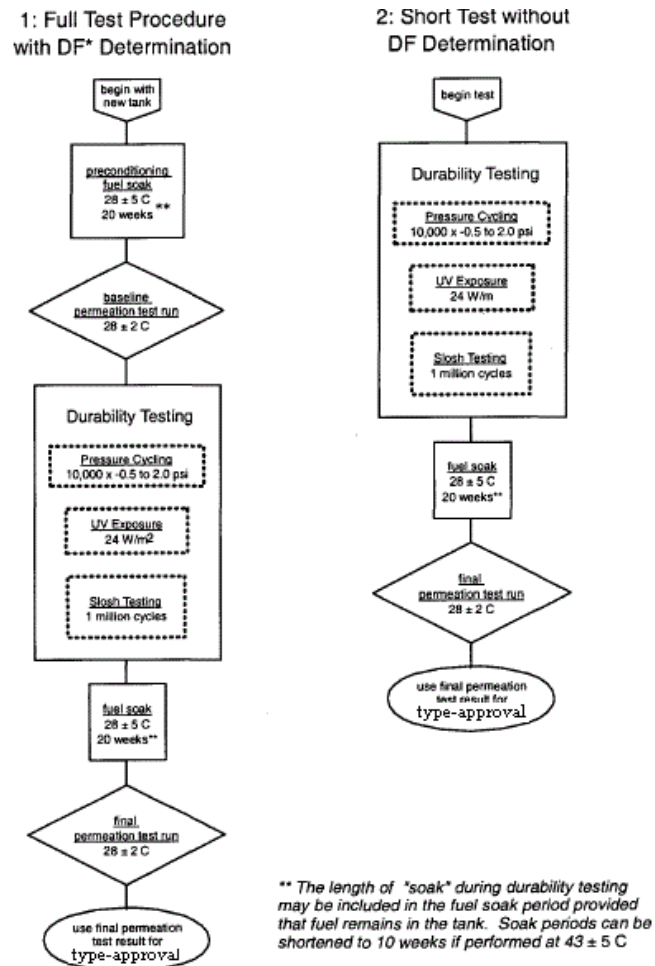


Figure B.3.2-1<sup>[iv17]</sup>: Fuel storage tank permeation full and short tests

- 2.2. Metallic fuel storage tanks are exempted from durability testing.

#### 3. Preconditioning fuel soak for the fuel storage and supply system permeation

## **test**

To precondition the fuel storage tank in the fuel storage and supply system permeation test, the following five steps shall be followed:

- 3.1. The fuel storage tank shall be filled with reference fuel and sealed. The filled tank shall be soaked at an ambient temperature of  $28\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  for 20 weeks or at  $43\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  for ten weeks. Alternatively, a shorter period of time at a higher - temperature may be used as soak time if the manufacturer can prove to the approval authority of the Contracting party or its designated agency that the hydrocarbon permeation rate has stabilised.
- 3.2. The fuel storage tank's internal surface area shall be determined in square metres accurate to at least three significant figures. The manufacturer may use less accurate estimates of the surface area if it is ensured that the surface area will not be overestimated.
- 3.3. The fuel storage tank shall be filled with the reference fuel to its nominal capacity.
- 3.4. The fuel storage tank and fuel shall equilibrate to  $28\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  or  $43\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  in the case of the alternative short test.
- 3.5. The fuel storage tank shall be sealed using fuel caps and other fittings (excluding petcocks) that can be used to seal openings in a production fuel storage tank. In cases where openings are not normally sealed on the fuel storage tank (such as hose-connection fittings and vents in fuel caps), these openings may be sealed using non-permeable fittings such as metal or fluoropolymer plugs.

## **4. Fuel storage tank permeation test procedure**

To run the test, the following steps shall be taken for a fuel storage tank preconditioned as specified in point 3.

- 4.1. Weigh the sealed fuel storage tank and record the weight in mg. This measurement shall be taken within eight hours of filling of the fuel storage tank with test fuel.
- 4.2. The fuel storage tank shall be placed in a ventilated, temperature-controlled room or enclosure.
- 4.3. The test room or enclosure shall be closed and sealed and the test time shall be recorded.
- 4.4. The test room or enclosure temperature shall be continuously maintained at  $28\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$  for 14 days. This temperature shall be continuously monitored and recorded.

## **5. Fuel storage tank permeation test result calculation**

- 5.1. At the end of the soak period, the weight in mg of the sealed fuel storage tank shall be recorded. Unless the same fuel is used in the preconditioning fuel soak and the permeation test run, weight measurements shall be recorded on five separate days per week of testing. The test is void if a linear plot of tank weight

vs. test days for the full soak period for permeation testing yields a linear regression correlation coefficient  $r^2 < 0.8$ .

- 5.2. The weight of the filled fuel storage tank at the end of the test shall be subtracted from the weight of the filled fuel storage tank at the beginning of the test.
- 5.3. The difference in mass shall be divided by the internal surface area of the fuel storage tank.
- 5.4. The result of the calculation under point 5.3., expressed in  $\text{mg}/\text{m}^2$ , shall be divided by the number of test days to calculate the  $\text{mg}/\text{m}^2/\text{day}$  emission rate and rounded to the same number of decimal places as the applicable emission standard laid down in point 4 of Chapter B.3.
- 5.5. In cases where permeation rates during a soak period of 14 days are such that the manufacturer considers that period not long enough to be able to measure significant weight changes, the period may be extended by a maximum of 14 additional days. In this case, the test steps in points 5.2. to 5.4. shall be repeated to determine the weight change for the full 28 days.
- 5.6. Determination of the deterioration factor when applying the full permeation test procedure  
The deterioration factor (DF) shall be determined from the following alternatives at the choice of the manufacturer:
  - 5.6.1. the ratio between the final permeation and baseline test runs;
  - 5.6.2. the fixed additive  $\text{DF} = 300 \text{ mg}/\text{m}^2/\text{day}$  for total hydrocarbons.
- 5.7. Determination of the final tank permeation test results
  - 5.7.1. Full test procedure  
To determine the permeation test results:
    - 5.7.1.1. the deterioration factor determined in point 5.6.1. shall be multiplied with the measured permeation test result determined in point 5.4.; or
    - 5.7.1.2. the fixed additive deterioration factor set out in point 5.6.2. shall be added to the measured permeation test result determined in point 5.4;
    - 5.7.1.3. The calculation results determined in points 5.7.1.1. or 5.7.1.2. shall be no greater than the applicable permeation test limits set out in point 4 of Chapter B.3.
  - 5.7.2. Accelerated (short) test procedure  
The measured permeation test result determined in points 5.4 or 5.5. if applicable, shall be no greater than the applicable permeation test limit set out in point 4 of Chapter B.3.
- 6. Fuel tank durability testing**
  - 6.1. A separate durability demonstration for each substantially different combination

of treatment approaches and non-metallic tank materials shall be performed by taking the following steps:

6.1.1. Pressure cycling

A pressure test shall be conducted by sealing the tank and cycling it between 115.1 kPa absolute pressure (+2.0 psig) and 97.9 kPa absolute pressure (−0.5 psig) and back to 115.1 kPa absolute pressure (+2.0 psig) for 10000 cycles at a rate of 60 seconds per cycle.

6.1.2. UV exposure

A sunlight exposure test shall be conducted by exposing the fuel storage tank to an ultraviolet light of at least 24 W/m<sup>2</sup> (0.40 W-hr/m<sup>2</sup>/min) on the tank surface for at least 450 hours. Alternatively, the non-metallic fuel storage tank may be exposed to direct natural sunlight for an equivalent period of time, as long as it is ensured that it is exposed to at least 450 daylight hours.

6.1.3. Slosh testing

A slosh test shall be conducted by filling the non-metallic fuel storage tank to 40 percent of its capacity with the reference fuel or with a commercial premium-grade fuel at the choice of the manufacturer and to the satisfaction of the approval authority the Contracting party or its designated agency. The fuel storage tank assembly shall be rocked at a rate of 15 cycles per minute until one million total cycles are reached. An angle deviation of +15° to −15° from level shall be used and the slosh test shall be conducted at an ambient temperature of 28 °C ± 5 °C.

6.2. Final fuel storage tank durability test results

Following the durability testing, the fuel storage tank shall be soaked according to the requirements of point 3 to ensure that the permeation rate is stable. The period of slosh testing and the period of ultraviolet testing may be considered to be part of this soak, provided that the soak begins immediately after the slosh testing. To determine the final permeation rate, the fuel storage tank shall be drained and refilled with fresh reference fuel. The permeation test run laid down in point 4 shall be repeated immediately after this soak period. The same test fuel requirement shall be used for this permeation test run as for the permeation test run conducted prior to the durability testing. The final test results shall be calculated in accordance with point 5.

6.3. The manufacturer may request that any of the durability tests be excluded if it can be clearly demonstrated to the approval authority of the Contracting party or its designated agency that this does not affect the emissions from the fuel storage tank.

6.4. The length of ‘soak’ during durability testing may be included in the fuel soak period provided that fuel remains in the tank. Soak periods may be shortened to ten weeks if performed at 43 °C ± 5 °C.

**7. Fuel line assembly test requirements**

7.1. Fuel line assembly permeation physical testing procedure

The manufacturer shall conduct a fuel line assembly test, including the fuel hose clamps and the material to which the fuel lines are connected on both sides, by performing a physical test as follows:

(a) in accordance with the requirements of points 6.2 to 6.4. The piping material to which the fuel lines are connected at both sides of the fuel line shall be plugged with impermeable material. The words 'fuel storage tank' in points 6.2 to 6.4 shall be replaced with 'fuel-line assembly'. The fuel hose clamps shall be tightened with the torque specified for series production; or

(b) the manufacturer may use a proprietary test procedure if it can be demonstrated to the approval authority of the Contracting party or its designated agency that this test is just as severe as test method (a).

7.2. Fuel line assembly permeation test limits in the case of physical testing

The applicable test limits for fuel tubing in point 6 of Chapter B2 shall be met when conducting the test procedures laid down in point 7.1.

7.3. Physical testing of fuel-line assembly permeation is not required if:

(a) the fuel lines meet the R11-A or R12 permeation specifications in SAE J30:2008 or

(b) non-metallic fuel lines meet the Category 1 specifications for permeation in SAE J2260:2004, and

(c) the manufacturer can demonstrate [to the approval authority] that the connections between the fuel storage tank and other fuel system components are leak-tight thanks to robust design.

If the fuel hoses fitted on the vehicle meet all three specifications, the applicable fuel tubing test limit requirements in point 5.1 and 5.2 of Chapter B.3 shall be considered as fulfilled.

### Annex B.3.3.

## Sealed Housing for Evaporation Determination (SHED) test procedure

### 1. Description of SHED test

The evaporative emission SHED test (Figure B.3.3.-1) consists of a conditioning phase and a test phase, as follows:

(a) conditioning phase:

- driving cycle;
- vehicle soak;

(b) test phase:

- diurnal (breathing loss) test;
- driving cycle;
- hot soak loss test.

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

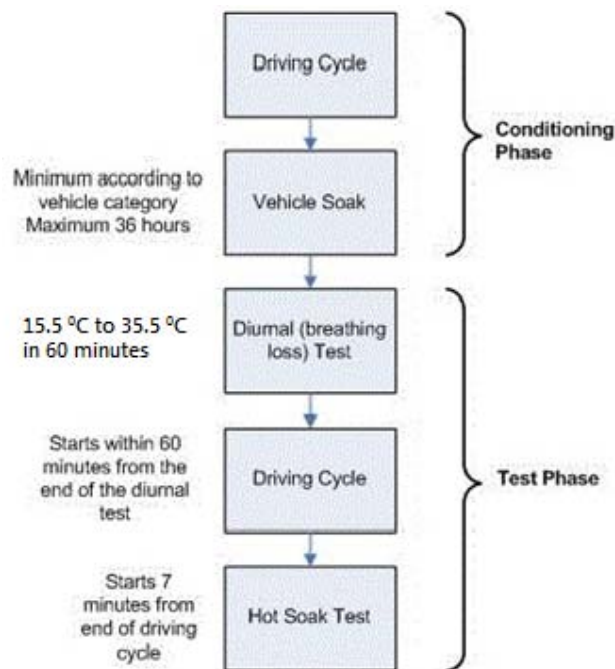


Figure B.3.3.-1: Flow chart – evaporative emission SHED test

### 2. Test vehicles requirement

#### 2.1. [Durability]<sub>[tv18]</sub>

The SHED test shall be conducted at the choice of the manufacturer with one or more degreened test vehicle(s) equipped with:

2.1.1. degreened emission control devices. A fixed deterioration factor of 300 mg/test shall be added to the SHED test result, or

2.1.2. aged evaporative emission control devices. The ageing test procedure set-out in Annex B.3.4. shall apply.

2.2. Test vehicles

The degreened test vehicle, which shall be representative of the vehicle type with regard to environmental performance to be approved, shall be in good mechanical condition and, before the evaporative test, have been run in and driven at least 1000 km after first start on the production line. The evaporative emission-control system shall be connected and functioning correctly over this period and the carbon canister<sup>[2]</sup> and evaporative emission control valve subjected to normal use, undergoing neither abnormal purging nor abnormal loading.

### 3. Chassis dynamometer and evaporative emissions enclosure

3.1. The chassis dynamometer shall meet the requirements of Annex 6 of GTR No 2 [provided that in the case of 3 wheeled vehicles the chassis dynamometer shall be capable of accommodating 3 wheeled vehicles (e.g. 2 rollers, long single roller)].

3.2. Evaporative emission measurement enclosure (SHED)

The evaporative emission measurement enclosure shall be a gas-tight rectangular measuring chamber able to contain the vehicle under test. The vehicle shall be accessible from all sides when inside and the enclosure when sealed shall be gas-tight. The inner surface of the enclosure shall be impermeable to hydrocarbons. At least one of the surfaces shall incorporate a flexible impermeable material or other device to allow the equilibration of pressure changes resulting from small changes in temperature. Wall design shall be such as to promote good dissipation of heat.

3.3. Analytical systems

3.3.1. Hydrocarbon analyser

3.3.1.1. The atmosphere within the chamber is monitored using a hydrocarbon detector of the flame ionisation detector (FID) type. Sample gas shall be drawn from the midpoint of one side wall or the roof of the chamber and any bypass flow shall be returned to the enclosure, preferably to a point immediately downstream of the mixing fan.

3.3.1.2. The hydrocarbon analyser shall have a response time to 90 % of final reading of less than 1.5 seconds. Its stability shall be better than 2 % of full scale at zero and at  $80 \pm 20$  % of full scale over a 15-minute period for all operational ranges.

3.3.1.3. The repeatability of the analyser expressed as one standard deviation shall be better than 1 % of full scale deflection at zero and at  $80 \pm 20$  % of full scale on all ranges used.

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[<sup>2</sup> or the canister with HC adsorbent material or other equivalent.]



- 3.3.1.4. The operational ranges of the analyser shall be chosen to give best resolution over the measurement, calibration and leak-checking procedures.
- 3.3.2. Hydrocarbon analyser data recording system
- 3.3.2.1. The hydrocarbon analyser shall be fitted with a device to record electrical signal output either by strip chart recorder or other data-processing system at a frequency of at least once per minute. The recording system shall have operating characteristics at least equivalent to the signal being recorded and shall provide a permanent record of results. The record shall show a positive indication of the beginning and end of the fuel storage tank heating and hot soak periods together with the time elapsed between start and completion of each test.
- 3.4. Fuel tank heating
- 3.4.1. The fuel storage tank heating system shall consist of at least two separate heat sources with two temperature controllers. A typical heat source shall be a pair of heating pads. Other heat sources may be used as required by the circumstances at the request of the manufacturer to the satisfaction of the approval authority of the Contracting party or its designated agency. Temperature controllers may be manual, such as variable transformers, or they may be automated. Since vapour and fuel temperature are to be controlled separately, an automatic controller is recommended both for the fuel and the vapour.
- 3.4.2. The heating system shall not cause hot-spots on the wetted surface of the tank which would cause local overheating of the fuel. Heating pads, for the fuel if used, shall be located as low as practicable on the fuel storage tank and shall cover at least 10 % of the wetted surface. The centre line of the fuel heating strips if used, shall be below 30 % of the fuel depth as measured from the bottom of the fuel storage tank, and approximately parallel to the fuel level in the tank. The centre line of the vapour heating strips, if used, shall be located at the approximate height of the centre of the vapour volume. The temperature controllers shall be capable of controlling the fuel and vapour temperatures to the heating function laid down in point 4.3.1.6.
- 3.4.3. In order to ensure uniform and appropriate heating and measurement of temperature for fuel and vapour the following precautions or the manufacturer recommendations shall be followed:
- (a) Separate heating pads for fuel and vapour shall cover as much area as possible;
  - (b) The pasting of heating pads on either side of fuel tank shall be symmetric for fuel and vapour heating;
  - (c) The position of fuel and vapour temperature sensors shall be as close to the area covered by heating pads respectively;
  - (d) No fuel heating pad shall be located above a 40% volume fill line from bottom. Likewise no vapour heating pad for the tank evaporative test shall be below the 60% volume fill line from bottom.

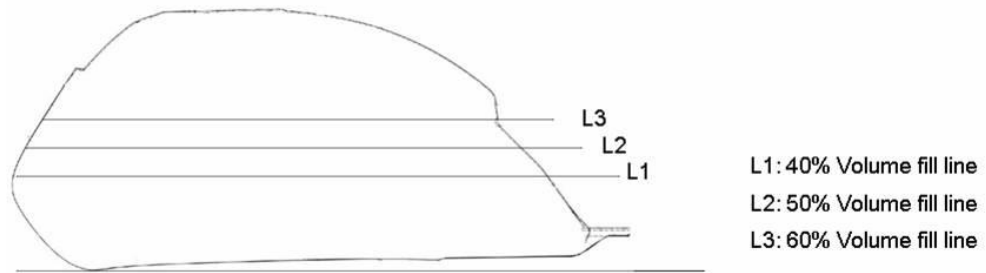


Figure B.3.3.-2: Example fuel storage tank with appropriate positioning of fuel tank heating pads to control fuel and vapour temperatures.

- 3.4.4. With temperature sensors positioned as in point 3.5.2., the fuel heating device shall make it possible to evenly heat the fuel and fuel vapour in the tank in accordance with the heating function described in 4.3.1.6. The heating system shall be capable of controlling the fuel and vapour temperatures to  $\pm 1.7$  °C of the required temperature during the tank heating process.
- 3.4.5. Notwithstanding the requirements of point 3.4.2., if a manufacturer is unable to meet the heating requirement specified, due to use of thick-walled plastic fuel storage tanks for example, then the closest possible alternative heat slope shall be used. Prior to the commencement of any test, manufacturers shall submit engineering data to the technical service to support the use of an alternative heat slope.
- 3.5. Temperature recording
- 3.5.1. The temperature in the chamber is recorded at two points by temperature sensors which are connected so as to show a mean value. The measuring points are extended approximately 0.1 m into the enclosure from the vertical centre line of each side wall at a height of  $0.9 \pm 0.2$  m.
- 3.5.2. The temperatures of the fuel and fuel vapour shall be recorded by means of sensors positioned in the fuel storage tank so as to measure the temperature of the prescribed test fuel at the approximate mid-volume of the fuel. In addition, the vapour temperature in the fuel storage tank shall be measured at the approximate mid-volume of the vapour
- 3.5.3. When the fuel or vapour temperature sensors cannot be located in the fuel storage tank to measure the temperature of the prescribed test fuel or vapour at the approximate mid-volume, sensors shall be located at the approximate mid-volume of each fuel or vapour containing cavity. The average of the readings from these sensors shall constitute the fuel or vapour temperature. The fuel and vapour temperature sensors shall be located at least one inch away from any heated tank surface. The approval authority may approve alternate sensor locations where the specifications above cannot be met or where tank symmetry provides redundant measurements.
- 3.5.4. Throughout the evaporative emission measurements, temperatures shall be recorded or entered into a data processing system at a frequency of at least once per minute.
- 3.5.5. The accuracy of the temperature recording system shall be within  $\pm 1.7$  °C and capable of resolving temperatures to 0.5 °C.
- 3.5.6. The recording or data processing system shall be capable of resolving time to  $\pm 15$  seconds.
- 3.6. Fans
- 3.6.1. It shall be possible to reduce the hydrocarbon concentration in the chamber to the ambient hydrocarbon level by using one or more fans or blowers with the SHED door(s) open.

3.6.2. The chamber shall have one or more fans or blowers of likely capacity 0.1 to 0.5 m<sup>3</sup>/s with which to thoroughly mix the atmosphere in the enclosure. It shall be possible to attain an even temperature and hydrocarbon concentration in the chamber during measurements. The vehicle in the enclosure shall not be subjected to a direct stream of air from the fans or blowers.

3.7. Gases

3.7.1.<sup>[v20]</sup> The following pure gases shall be available for calibration and operation:

(a) purified synthetic air (purity: < 1 ppm C<sub>1</sub> equivalent <1 ppm CO, < 400 ppm CO<sub>2</sub>, 0.1 ppm NO); oxygen content between 18 and 21 % by volume;

(b) hydrocarbon analyser fuel gas (40 ± 2 % hydrogen, and balance helium with less than 1 ppm C<sub>1</sub> equivalent hydrocarbon, less than 400 ppm CO<sub>2</sub>);

(c) propane (C<sub>3</sub>H<sub>8</sub>), 99.5 % minimum purity.

3.7.2. Calibration and span gases shall be available containing mixtures of propane (C<sub>3</sub>H<sub>8</sub>) and purified synthetic air. The true concentrations of a calibration gas shall be within ± 2 % of the stated figures. The accuracy of the diluted gases obtained when using a gas divider shall be to within ± 2 % of the true value. The concentrations specified in point 3.7.1. may also be obtained by the use of a gas divider using synthetic air as the diluting gas. The FID analyser shall be calibrated using air/propane or air/hexane mixtures with nominal hydrocarbon concentrations equal to 50 per cent and 90 percent of full scale.

3.8. Additional equipment

3.8.1. The relative humidity in the test area shall be measurable to within ± 5 %.

3.8.2. The pressure within the test area shall be measurable to within ± 0.1 kPa.

3.9. Alternative equipment

3.9.1. At the request of the manufacturer and with the agreement of the approval authority of the Contracting party or its designated agency, the technical service may authorise the use of alternative equipment provided that it can be demonstrated that it gives equivalent results.

## 4. Test procedure

4.1. Test preparation

4.1.1. The vehicle is mechanically prepared before the test as follows:

(a) the exhaust system of the vehicle shall not exhibit any leaks;

(b) the vehicle may be steam-cleaned before the test;

(c) the fuel storage tank of the vehicle shall be equipped with temperature sensors so that the temperature of the fuel and fuel vapour in the fuel storage tank can be measured when it is filled to 50 % ± 2 % of its capacity declared by the manufacturer;

(d) additional fittings, adaptors or devices may optionally be fitted to allow a complete draining of the fuel storage tank. Alternatively, the fuel storage tank may be evacuated by means of a pump or siphon that prevents fuel spillage.

4.2. Conditioning phase

4.2.1. The vehicle shall be taken into the test area where the ambient temperature is between 20 °C and 30 °C.

4.2.2. The vehicle is placed on a chassis dynamometer and driven a single time through the test cycle specified in Annex 5 of GTR No 2 as appropriate for the class of vehicle being tested [, in the case of category 3-3 vehicles.

The cycles used for the Type I test prescribed in the national regulation of the Contracting Party in the case of other categories of vehicles]

4.2.3. The vehicle is parked in the test area for the minimum period stated in Table B.3.3-1.

Engine capacity	Minimum (hours)	Maximum (hours)
< 170 cm <sup>3</sup>	6	36
170 cm <sup>3</sup> ≤ engine capacity < 280 cm <sup>3</sup>	8	36
≥ 280 cm <sup>3</sup>	12	36

Table B.3.3-1.: SHED test – minimum and maximum soak periods

4.3. Test phases

4.3.1 Tank breathing (diurnal) evaporative emission test

4.3.1.1. The measuring chamber shall be vented/purged for several minutes immediately before the test until a stable background is obtainable. The chamber mixing fan(s) shall be switched on at this time also.

4.3.1.2. The hydrocarbon analyser shall be set to zero and spanned immediately before the test.

4.3.1.3. The fuel storage tank(s) shall be emptied as described in point 4.1.1 and refilled with test fuel at a temperature of between 10 °C and 14 °C to 50 % ± 2 % of the capacity declared by the manufacturer.

4.3.1.4. The test vehicle shall be brought into the test enclosure with the engine switched off and parked in an upright position. The fuel storage tank sensors and heating device shall be connected, if necessary. Immediately begin recording the fuel temperature and the air temperature in the enclosure. If a venting/purging fan is still operating, it shall be switched off at this time.

4.3.1.5. The fuel and vapour may be artificially heated to the starting temperatures of 15.5 °C and 21.0 °C ± 1 °C respectively. An initial vapor temperature up to 5 °C above

21.0 °C may be used. For this condition, the vapor shall not be heated at the beginning of the diurnal test. When the fuel temperature has been raised to 5.5 °C below the vapor temperature by following the  $T_f$  function, the remainder of the vapor heating profile shall be followed.

4.3.1.6. As soon as the fuel temperature reaches 14.0 °C:

- (1) Install the fuel filler cap(s);
- (2) Turn off the purge blowers, if not already off at that time;
- (3) Close and seal enclosure doors.

As soon as the fuel reaches a temperature of  $15.5\text{ °C} \pm 1\text{ °C}$  the test procedure shall continue as follows:

(a) the hydrocarbon concentration, barometric pressure and the temperature shall be measured to give the initial readings  $C_{HC}$ ,  $i$ ,  $p_i$  and  $T_i$  for the tank heat build test;

(b) a linear heat build of  $13.3\text{ °C}$  or  $20\text{ °C} \pm 0.5\text{ °C}$  over a period of  $60 \pm 2$  minutes shall begin. The temperature of the fuel and fuel vapour during the heating shall conform to the function below to within  $\pm 1.7\text{ °C}$ , or the closest possible function as described in 3.4.3:

For exposed type of fuel storage tanks:

Equations B.3.3-1

$$T_f = 0.3333 \cdot t + 15.5\text{ °C}$$

$$T_v = 0.3333 \cdot t + 21.0\text{ °C}$$

For non-exposed type of fuel storage tanks:

Equations B.3.3-2

$$T_f = 0.2222 \cdot t + 15.5\text{ °C}$$

$$T_v = 0.2222 \cdot t + 21.0\text{ °C}$$

where:

$T_f$  = required temperature of fuel (°C);

$T_v$  = required temperature of vapour (°C);

$t$  = time from start of the tank heat build in minutes.

4.3.1.7. The hydrocarbon analyser is set to zero and spanned immediately before the end of the test.

4.3.1.8. If the heating requirements in point 4.3.1.6. have been met over the  $60 \pm 2$  minute period of the test, the final hydrocarbon concentration in the enclosure is measured ( $CHC_f$ ). The time or elapsed time of this measurement is recorded, together with the final temperature and barometric pressure  $T_f$  and  $p_f$ .

4.3.1.9. The heat source is turned off and the enclosure door unsealed and opened. The heating device and temperature sensor are disconnected from the enclosure apparatus. The vehicle is now removed from the enclosure with the engine

switched off.

- 4.3.1.10. To prevent abnormal loading of the [C<sub>g21</sub>] carbon canister, fuel storage tank caps may be removed from the vehicle during the period between the end of the diurnal test phase and the start of the driving cycle. The driving cycle shall begin within 60 minutes of the completion of the breathing loss test.
- 4.3.2. Driving cycle
  - 4.3.2.1. Following the tank breathing losses test, the vehicle is pushed or otherwise manoeuvred onto the chassis dynamometer with the engine switched off. It is then driven through the driving cycle specified for the class of vehicle on test.
  - 4.3.3. Hot soak evaporative emissions test
    - The level of evaporative emissions is determined by the measurement of hydrocarbon emissions over a 60-minute hot soak period. The hot soak test shall begin within seven minutes of the completion of the driving cycle specified in point 4.3.2.1.
    - 4.3.3.1. Before the completion of the test run, the measuring chamber shall be purged for several minutes until a stable hydrocarbon background is obtained. The enclosure mixing fan(s) shall also be turned on at this time.
    - 4.3.3.2. The hydrocarbon analyser shall be set to zero and spanned immediately prior to the test.
    - 4.3.3.3. The vehicle shall be pushed or otherwise moved into the measuring chamber with the engine switched off.
    - 4.3.3.4. The enclosure doors are closed and sealed gas-tight within seven minutes of the end of the driving cycle.
    - 4.3.3.5. A  $60 \pm 0.5$  minute hot soak period begins when the chamber is sealed. The hydrocarbon concentration, temperature and barometric pressure are measured to give the initial readings  $C_{HC, i}$ ,  $P_i$  and  $T_i$  for the hot soak test. These figures are used in the evaporative emission calculation shown in chapter 6.
    - 4.3.3.6. The hydrocarbon analyser shall be zeroed and spanned immediately before the end of the  $60 \pm 0.5$  minute test period.
    - 4.3.3.7. At the end of the  $60 \pm 0.5$  minute test period, measure the hydrocarbon concentration in the chamber. The temperature and the barometric pressure are also measured. These are the final readings  $C_{HC, f}$ ,  $p_f$  and  $T_f$  for the hot soak test used for the calculation in point 6. This completes the evaporative emission test procedure.
- 4.4. Alternative test procedures
  - 4.4.1. At the request of the manufacturer to the satisfaction of the approval authority of the Contracting party or its designated agency, alternative methods may be used to demonstrate compliance with the requirements of this Annex. In such cases, the manufacturer shall satisfy the technical service that the results from the alternative

test can be correlated with those resulting from the procedure described in this Annex. This correlation shall be documented and added to the information folder.

## 5. Calculation of results

- 5.1. The evaporative emission tests described in point 4 allow the hydrocarbon emissions from the tank breathing and hot soak phases to be calculated. Evaporative losses from each of these phases is calculated using the initial and final hydrocarbon concentrations, temperatures and pressures in the enclosure, together with the net enclosure volume.

The formula below is used:

Equation B.3.3-3:

$$M_{HC} = k.V.10^{-4} \cdot \left( \frac{C_{HCf} \cdot P_f}{T_f} - \frac{C_{HCi} \cdot P_i}{T_i} \right)$$

where:

$M_{HC}$  = mass of hydrocarbon emitted over the test phase (grams);

$C_{HC}$  = hydrocarbon concentration measured in the enclosure (ppm (volume) Ci equivalent);

$V$  = net enclosure volume in cubic metres corrected for the volume of the vehicle. If the volume of the vehicle is not determined, a volume of 0.14 m<sup>3</sup> [in the case of two wheeled vehicles and 0.25 m<sup>3</sup> for three wheeled vehicle] shall be subtracted;

$T$  = ambient chamber temperature, K;

$p$  = barometric pressure in kPa;

H/C = hydrogen to carbon ratio;

$k = 1.2 (12 + H/C)$ ;

where:

$i$  is the initial reading;

$f$  is the final reading;

H/C is taken to be 2.33 for tank breathing losses;

H/C is taken to be 2.20 for hot soak losses.

- 5.2. Overall results of test

The overall evaporative hydrocarbon mass emission for the vehicle is taken to be:

Equation B.3.3-4

$$m_{\text{total}} = m_{\text{TH}} + m_{\text{HS}}$$

where:

$m_{\text{total}}$  = overall evaporative mass emissions of the vehicle (grams);

$m_{\text{TH}}$  = evaporative hydrocarbon mass emission for the tank heat build (grams);

$m_{\text{HS}}$  = evaporative hydrocarbon mass emission for the hot soak (grams).



**6.**

**Limit values**

When tested according to this Annex, overall evaporative hydrocarbon mass emission for the vehicle ( $m_{\text{total}}$ ) shall be as specified in point 4 of section B.3.

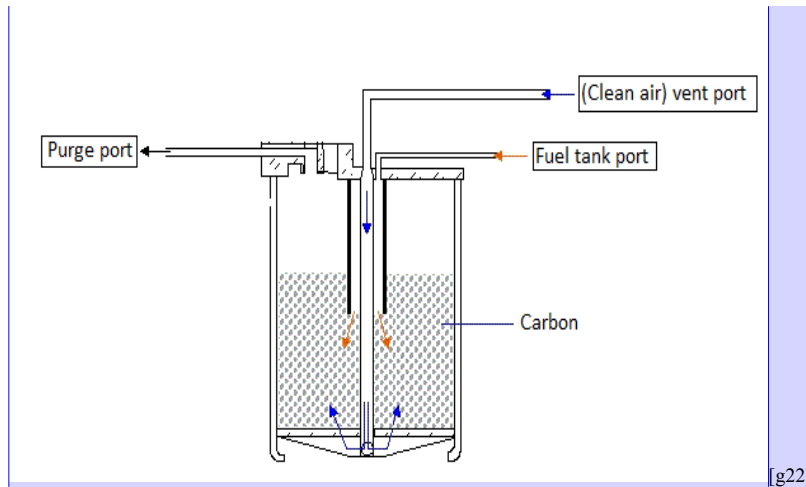
### Annex B.3.4.:

#### ageing test procedure for evaporative emission control devices

#### 1. Test methods for ageing of evaporative emission control devices

The SHED test shall be conducted with aged evaporative emission control devices fitted. The ageing tests for those devices shall be conducted according to the procedures in this Sub-appendix.

#### 2. Carbon canister ageing



[Figure B.3.4-1: carbon canister gas flow diagram and ports]

A carbon canister representative of the propulsion family of the two- [and three-] wheeled vehicle as set out in Annex B.3.6. shall be selected as test canister. Canister aging shall be conducted at the choice of manufacturer by the [c<sub>g23</sub>]arbon] canister aging procedure A or B.

#### 2.1. Canister ageing test procedure A

In the case of a multiple [c<sub>g24</sub>]arbon] canister system, each [c<sub>g25</sub>]arbon] canister shall undergo the procedure separately. The [c<sub>g26</sub>]umber of test cycles of [c<sub>g27</sub>]arbon] canister loading and discharging shall correspond to the number set out in Table B.3.4-1:

Vehicle classification	Number of cycles
$v_{\max} \leq 50 \text{ km/h}$	90
$50\text{km/h} < v_{\max} < 130 \text{ km/h}$	170
$v_{\max} \geq 130 \text{ km/h}$	300

Table B.3.4-1: vehicle classification and the required number of loading and discharging of the carbon canister for rapid ageing.

The dwell time and subsequent purging of fuel vapour shall be run to age the test [c<sub>g28</sub>]arbon] canister at an ambient temperature of  $24 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$  as follows:

#### 2.1.1. Canister loading part of the test cycle

- 2.1.1.1. Loading of the [c<sub>g29</sub>]arbon] canister shall start within one minute of completing the purge portion of the test cycle.
- 2.1.1.2. The (clean air) vent port of the [c<sub>g30</sub>]arbon] canister shall be open and the purge port shall be capped. A mix by volume of 50 % air and 50 % commercially available petrol or reference fuel shall enter through the tank port of the test [c<sub>g31</sub>]arbon] canister at a flow rate of 40 grams/hour. The petrol vapour shall be generated at a petrol temperature of  $40 \pm 2$  °C.
- 2.1.1.3. The test [c<sub>g32</sub>]arbon] canister shall be loaded each time to 2000 mg or more breakthrough detected by:
  - 2.1.1.3.1. FID analyser reading (using a mini-SHED or similar) or 5000 ppm instantaneous reading on the FID occurring at the (clean air) vent port; or
  - 2.1.1.3.2. Gravimetric test method using the difference in mass of the test [c<sub>g33</sub>]arbon] canister charged to 2000 mg or more breakthrough and the purged [c<sub>g34</sub>]arbon] canister. In this case the test equipment shall be capable of measuring the mass with a minimum accuracy in the range between 0 and +100 mg.
- 2.1.2. Dwell time
  - A five minute dwell period between [c<sub>g35</sub>]arbon] canister loading and purging as part of the test cycle shall be applied.
- 2.1.3 Canister purging part of the test cycle
  - 2.1.3.1. The test [c<sub>g36</sub>]arbon] canister shall be purged through the purge port and the tank port shall be capped.
  - 2.1.3.2. Four hundred [c<sub>g37</sub>]arbon] canister bed volumes shall be purged at a rate of 24 l/min into the vent port.
- 2.2. Canister ageing test procedure B
  - 2.2.1. A test cycle will include loading the HC storing components with gasoline vapours up to 80% by weight of its maximum storing capacity followed by 10 minutes waiting with the system intake port sealed. Then purge shall start using a flow rate of  $28.3 \pm 5.5$  l/min at  $20 \text{ °C} \pm 5 \text{ °C}$  for 7.5 minutes.
  - 2.2.2. The method to be used to load the storing components consists of heating a container filled with a pre-measured quantity of petrol up to 80 °C. At 80 °C approximately one third of the petrol will evaporate. The evaporated petrol should be equivalent to 80% (by weight) of the HC storing capacity of the HC storing components. The petrol vapours are allowed to enter through the intake of the storing components.
  - 2.2.3. The number of test cycles of carbon canister loading and purging shall correspond to the number set out in Table B.3.4-1.

**3. Ageing test procedure of evaporative emission control valves, cables and linkages**

[3.1.[TV38]] [[g39]The durability test shall actuate control valves, cables, and linkages, where applicable [g40] and be representative for the operation conditions of these parts during the useful life of the vehicle if used under normal conditions and serviced in accordance with the manufacturer's recommendations. The accumulated distance and operation conditions of the type V durability test may be regarded as representative for the useful life of the vehicle.]

**4. Reporting**

The manufacturer shall report the results of the tests referred to in points 2 and 3 of this Annex in the information document according to the template set out in Annex B.3.7.

**Annex B.3.5.:**  
**calibration of equipment for evaporative emission testing**

**1. Calibration frequency and methods**

1.1. All equipment shall be calibrated before its initial use and then as often as necessary, and in any case [in the month before type-approval testing]. The calibration methods to be used are described in this Annex.

**2. Calibration of the enclosure**

2.1. Initial determination of enclosure internal volume

2.1.1. Before its initial use, the internal volume of the chamber shall be determined as follows. The internal dimensions of the chamber are carefully measured, allowing for any irregularities such as bracing struts. The internal volume of the chamber is determined from these measurements.

2.1.2. The net internal volume is determined by subtracting  $0.14 \text{ m}^3$  [in the case of two wheeled vehicles and  $0.25 \text{ m}^3$  for three wheeled vehicle] from the internal volume of the chamber. Alternatively, the actual volume of the test vehicle may be subtracted.

2.1.3. The chamber shall be checked as in point 2.3. If the propane mass does not tally to within  $\pm 2 \%$  with the injected mass, corrective action is required.

2.2. Determination of chamber background emissions

This operation determines that the chamber contains no materials that emit significant amounts of hydrocarbons. The check shall be carried out when the enclosure is brought into service, after any operations in it which may affect background emissions and at least once per year.

2.2.1. Calibrate the analyser (if required). The hydrocarbon analyser shall be set to zero and spanned immediately before the test.

2.2.2. Purge the enclosure until a stable hydrocarbon reading is obtained. The mixing fan is turned on, if not already on.

2.2.3. Seal the chamber and measure the background hydrocarbon concentration, temperature and barometric pressure. These are the initial readings  $C_{\text{HCi}}$ ,  $p_i$  and  $T_i$  used in the enclosure background calculation.

2.2.4. The enclosure is allowed to stand undisturbed with the mixing fan on for four hours.

2.2.5. The hydrocarbon analyser shall be set to zero and spanned immediately before the end of the test.

2.2.6. At the end of this time, use the same analyser to measure the hydrocarbon concentration in the chamber. The temperature and the barometric pressure are also measured. These are the final readings  $C_{\text{HCF}}$ ,  $p_f$  and  $T_f$ .

2.2.7. Calculate the change in mass of hydrocarbons in the enclosure over the time of the

test in accordance with the equation in point 2.4. The background emission of the enclosure shall not exceed 400 mg.

### 2.3. Calibration and hydrocarbon retention test of the chamber

The calibration and hydrocarbon retention test in the chamber provides a check on the calculated volume in point 2.1.1. and also measures any leak rate.

2.3.1. Purge the enclosure until a stable hydrocarbon concentration is reached. Turn on the mixing fan, if it is not already on. The hydrocarbon analyser shall be calibrated (if necessary) then set to zero and spanned immediately before the test.

2.3.2. Seal the enclosure and measure the background concentration, temperature and barometric pressure. These are the initial readings  $C_{HCi}$ ,  $p_i$  and  $T_i$  used in the enclosure calibration.

2.3.3. Inject approximately 4 grams of propane into the enclosure. The mass of propane shall be measured to an accuracy of  $\pm 2\%$  of the measured value.

2.3.4. Allow the contents of the chamber to mix for five minutes. The hydrocarbon analyser shall be set to zero and spanned immediately before the following test. Measure the hydrocarbon concentration, temperature and barometric pressure. These are the final readings  $C_{HCf}$ ,  $p_f$  and  $T_f$  for the calibration of the enclosure.

2.3.5. Using the readings taken in accordance with points 2.3.2 and 2.3.4 and the formula in point 2.4, calculate the mass of propane in the enclosure. This shall be within  $\pm 2\%$  of the mass of propane measured in accordance with point 2.3.3.

2.3.6. Allow the contents of the chamber to mix for a minimum of four hours. Then measure and record the final hydrocarbon concentration, temperature and barometric pressure. The hydrocarbon analyser shall be set to zero and spanned immediately before the end of the test.

2.3.7. Using the formula in 2.4, calculate the hydrocarbon mass from the readings taken in points 2.3.6 and 2.3.2. The mass may not differ by more than 4% from the hydrocarbon mass calculated in accordance with point 2.3.5.

### 2.4. Calculations

The calculation of net hydrocarbon mass change within the enclosure is used to determine the chamber's hydrocarbon background and leak rate. Initial and final readings of hydrocarbon concentration, temperature and barometric pressure are used in the following formula to calculate the mass change:

Equation B.3.5-1

$$M_{HC} = k.V.10^{-4} \cdot \left( \frac{C_{HCf} \cdot P_f}{T_f} - \frac{C_{HCi} \cdot P_i}{T_i} \right)$$

where:

$M_{HC}$  = mass of hydrocarbon in grams;

$C_{HC}$  = hydrocarbon concentration in the enclosure (ppm carbon (NB: ppm carbon = ppm propane x 3));

V = enclosure volume in cubic metres as measured in accordance with point 2.1.1 above;

T = ambient temperature in the enclosure, K;

p = barometric pressure in kPa;

k = 17.6;

where:

i is the initial reading;

f is the final reading.

### **3. Checking of FID hydrocarbon analyser**

#### **3.1. Detector response optimisation**

The FID analyser shall be adjusted as specified by the instrument manufacturer. Propane in air shall be used to optimise the response on the most common operating range.

#### **3.2. Calibration of the HC analyser**

The analyser shall be calibrated using propane in air and purified synthetic air. A calibration curve shall be established as described in points 4.1 to 4.5 below.

#### **3.3. Oxygen interference check and recommended limits**

The response factor ( $R_f$ ) for a particular hydrocarbon species is the ratio of the FID  $C_1$  reading to the gas cylinder concentration, expressed as ppm  $C_1$ .

The concentration of the test gas shall be such as to give a response of approximately 80 % of full scale deflection, for the operating range. The concentration shall be known to an accuracy of  $\pm 2$  % in reference to a gravimetric standard expressed in volume. In addition, the gas cylinder shall be preconditioned for 24 hours at between 20.0 °C and 30.0 °C.

Response factors shall be determined when introducing an analyser into service and thereafter at major service intervals. The reference gas to be used is propane balanced with purified air which shall be taken to give a response factor of 1,00.

The test gas to be used for oxygen interference and the recommended response factor range are given below:

Propane and nitrogen  $0.95 \leq R_f \leq 1,05$ .

### **4. Calibration of the hydrocarbon analyser**

Each of the normally used operating ranges are calibrated by the following procedure:

4.1. Establish the calibration curve by at least five calibration points spaced as evenly as possible over the operating range. The nominal concentration of the calibration gas with the highest concentrations shall be at least 80 % of the full scale.

4.2. Calculate the calibration curve by the method of least squares. If the resulting polynomial degree is greater than 3, then the number of calibration points shall be at least the number of the polynomial degree plus 2.

- 4.3. The calibration curve shall not differ by more than 2 % from the nominal value of each calibration gas.
- 4.4. Using the coefficients of the polynomial derived from point 4.2, a table of indicated reading against true concentration shall be drawn up in steps of no greater than 1 % of full scale. This is to be carried out for each analyser range calibrated. The table shall also contain:
- (a) date of calibration;
  - (b) span and zero potentiometer readings (where applicable), nominal scale;
  - (c) reference data of each calibration gas used;
  - (d) the actual and indicated value of each calibration gas used together with the percentage differences.
- 4.5. Alternative technology (e.g. computer, electronically controlled range switch) may be used if it can be shown [to the satisfaction of the approval authority] that it can ensure equivalent accuracy.



**[ Annex B.3.6.:  
propulsion family definition with regard to test type IV requirements**

- 1.1. A two-[ or three-]wheeled vehicle may continue to be regarded as belonging to the same vehicle propulsion family with regard to test type IV provided that the vehicle parameters below are identical and remain within the prescribed and declared tolerances.
- 1.2. For the test types IV a representative parent vehicle shall be selected within the boundaries set by the classification criteria laid down in point 2.
2. The following propulsion family classification criteria with regard to test type IV requirements shall apply:

#	Classification criteria description	Test type IV
<b>1.</b>	<b>Vehicle</b>	
1.1.	Category; Note: [g41]Class 3-3 and 3-4] [g42]Two-wheeled motorcycles and two-wheeled motorcycles with sidecars] are considered to be same family	<b>X</b>
1.2.	Subcategory [g43]if applicable and per the classification followed by the Contracting Party); [g44]Note: will become applicable after SR1 includes subcategories]	<b>X</b>
<b>2.</b>	<b>System</b>	
2.1	[g45]Note:] A[g46]pplicability of evaporative emission test class A, B or C, subject to provisions of item 2.4.4 of Section B.3;	<b>X</b>
2.2.	propulsion (not) equipped with evaporative emission control system	<b>X</b>
2.2.1.	evaporative emission control system type;	<b>X</b>
2.2.2.	operation principle of evaporative emission control system (active / passive / mechanically or electronically controlled);	<b>X</b>
2.2.3.	identical basic principle of fuel/air metering (e.g. carburettor / single point injection / multi point injection / engine speed density through MAP/ mass airflow);	<b>X</b>
2.2.4.	identical material of the fuel storage tank and liquid fuel hoses is identical[tv47]; N[g48]ote: material of all metallic fuel storage tanks are considered to be identical.	<b>X</b>
2.2.5.	the fuel storage [g49] capacity declared by the manufacturer is within a range of [+/- 50] % [TV50] the nominal volume [g51]	<b>X</b>
2.2.6.	the fuel storage relief valve pressure setting is identical or higher[tv52];	<b>X</b>

2.2.7.	identical method of storage of the fuel vapour (i.e. trap form and volume, storage medium, air cleaner (if used for evaporative emission control) etc.);	<b>X</b>
2.2.8.	identical method of purging of the stored vapour (e.g. air flow, purge volume over the driving cycle);	<b>X</b>
2.1.9.	identical method of sealing and venting of the fuel metering system;	<b>X</b>

Table B.3.6.-1 classification criteria propulsion family with regard to test type IV

- 2.1. [I<sub>g53</sub>](#) in the case of Evaporative emission class C, the details given in Table 3.6-1
- 2.2. [I<sub>g54</sub>](#) in the case of Evaporative emission class B, the details given at serial no. 2.1, 2.2.4, 2.2.5 and 2.2.6 of Table 3.6-1.
- 2.3. [I<sub>g55</sub>](#) in the case of Evaporative emission class A, the details given at serial no. 2.1, 2.2.4 and 2.2.6 in Table 3.6-1. ]

**Annex B.3.7.:**  
**administrative provisions test type IV**

1. The vehicle manufacturer shall fill out the information [and submit to the approval authority] with regard to test type IV according to the following template.
- 1.1. Where documents, diagrams or long descriptions are required the vehicle manufacturer shall attach those as a separate file, appropriately marked in a clear and understandably system and the marking shall be written / typed for all sheets in the space provided.
- 1.2. The following data shall be provided by the vehicle manufacturer:
  - 1.2.1. General information (only applicable if not already provided for test type III set out in point 1.2.1. in Annex B.1.7.):
  - 1.2.2. Detailed information with regard to the type IV test
    - 1.2.2.1. Date (day/month/year):
    - 1.2.2.2. Place of the test:
    - 1.2.2.3. Name of recorder:
    - 1.2.2.4. Atmospheric pressure (kPa):
    - 1.2.2.5. Atmospheric temperature (°C):
    - 1.2.2.6. Evaporative emissions control system: yes / no
    - 1.2.2.7. Detailed description of the evaporative emission control devices and their state of tune:
    - 1.2.2.8. Schematic drawing of the fuel storage tank with indication of capacity and material:
    - 1.2.2.9. Drawing of the heat shield between tank and exhaust system:
    - 1.2.2.10. Drawing of the evaporative control system:
    - 1.2.2.11. Drawing of the carbon canister:
    - 1.2.2.12. Series numbers evaporative emission control components:
    - 1.2.2.13. Part numbers evaporative emission control components:
    - 1.2.2.14. Marking number:
    - 1.2.2.15. Carbon canister type:
    - 1.2.2.16. Carbon canister size (bed volume in dm<sup>3</sup>):
    - 1.2.2.17. Mass of dry charcoal (g):
    - 1.2.2.18. Evaporative emission purge valve type:
    - 1.2.2.19. Details test vehicle(s) if different from vehicle used for type I testing (include copy of type I required documentation, Annex B.6.11. to Revision 1 of GTR No. 2):
    - 1.2.2.20. Type IV, Fuel storage permeability test (yes / no)

- 1.2.2.20.1. Result fuel storage permeability test (mg/24h/test):
- 1.2.2.21. Type IV, Fuel storage and supply system permeation test (yes / no)
- 1.2.2.21.1. Result fuel storage tank (mg/m<sup>2</sup>/ day):
- 1.2.2.21.2. Result fuel tubing (mg/m<sup>2</sup>/ day):
- 1.2.2.22. Type IV, SHED test (yes / no)
- 1.2.2.22.1. Result SHED test ( mg/test):

**[B.3.8.      Reference fuel specifications**

1.            Specifications of reference fuels for testing vehicles in environmental tests, in particular for tailpipe and evaporative emissions testing:
  - 1.1.        The following tables list the technical data on liquid reference fuels that Contracting Parties may require to be used for environmental performance testing of two- and three-wheeled vehicles. These reference fuels were used to define the emission limits set out in point X. of section B.Y.

<b>B.3.8.1. Type: Petrol E0 (nominal 90 RON)</b>				
Fuel Property or Substance Name	Unit	Standard		Test method
		Minimum	Maximum	
Research octane number, RON		90	92	JIS K2280
Motor octane number, MON		80	82	JIS K2280
Density	g/cm <sup>3</sup>	0.72	0.77	JIS K2249
Vapour pressure	kPa	56	60	JIS K2258
Distillation:				
— 10 % distillation temperature	K (°C)	318 (45)	328 (55)	JIS K2254
— 50 % distillation temperature	K (°C)	363 (90)	373 (100)	JIS K2254
— 90 % distillation temperature	K (°C)	413 (140)	443 (170)	JIS K2254
— final boiling point	K (°C)		488 (215)	JIS K2254
— olefins	% v/v	15	25	JIS K2536-1 JIS K2536-2
— aromatics	% v/v	20	45	JIS K2536-1 JIS K2536-2 JIS K2536-3
— benzene	% v/v		1.0	JIS K2536-2 JIS K2536-3 JIS K2536-4
Oxygen content		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-6
Existent gum	mg/100ml		5	JIS K2261
Sulphur content	Wt ppm		10	JIS K2541-1 JIS K2541-2 JIS K2541-6 JIS K2541-7
Lead content		not to be detected		JIS K2255
Ethanol		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-6
Methanol		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
MTBE		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
Kerosene		not to be detected		JIS K2536-2 JIS K2536-4

B.3.8.2. Type: Petrol E0 (nominal 95 RON)					
Parameter	Unit	Limits (1)		Test method	Publication
		Minimum	Maximum		
Research octane number, RON		95.0		EN 25164	1993
Motor octane number, MON		85.0		EN 25163	1993
Density at 15 °C	kg/m <sup>3</sup>	748	762	ISO 3675	1995
Reid vapour pressure	kPa	56.0	60.0	EN 12	1993
Distillation:					
- initial boiling point	°C	24	40	EN-ISO 3205	1988
- evaporated at 100 °C	per cent v/v	49.0	57.0	EN-ISO 3205	1988
- evaporated at 150 °C	per cent v/v	81.0	87.0	EN-ISO 3205	1988
- final boiling point	°C	190	215	EN-ISO 3205	1988
Residue	per cent		2	EN-ISO 3205	1988
Hydrocarbon analysis:					
- olefins	per cent v/v		10	ASTM D 1319	1995
- aromatics(3)	per cent v/v	28.0	40.0	ASTM D 1319	1995
- benzene	per cent v/v		1.0	pr. EN 12177	1998 (2)
- saturates	per cent v/v		balance	ASTM D 1319	1995
Carbon/hydrogen ratio		report	report		
Oxidation stability (4)	min.	480		EN-ISO 7536	1996
Oxygen content (5)	per cent m/m		2.3	EN 1601	1997 (2)
Existent gum	mg/ml		0.04	EN-ISO 6246	1997 (2)
Sulphur content (6)	mg/kg		100	pr.EN-ISO/DIS 14596	1998 (2)
Copper corrosion at 50 °C			1	EN-ISO 2160	1995
Lead content	g/l		0.005	EN 237	1996
Phosphorus content	g/l		0.0013	ASTM D 3231	1994

- (1) The values quoted in the specification are "true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products - Determination and application of precision data in relation to methods of test," have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

- (2) The month of publication will be completed in due course.
- (3) The reference fuel used shall have a maximum aromatics content of 35 per cent v/v.
- (4) The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersive additives and solvent oils shall not be added.
- (5) The actual oxygen content of the fuel for the tests shall be reported. In addition the maximum oxygen content of the reference fuel shall be 2.3 per cent.
- (6) The actual sulphur content of the fuel used for the tests shall be reported. In addition the reference fuel shall have a maximum sulphur content of 50 ppm.

<b>B.3.8.3. Type: Petrol E0 (nominal 100 RON)</b>				
Fuel Property or Substance Name	Unit	Standard		Test method
		Minimum	Maximum	
Research octane number, RON		99	101	JIS K2280
Motor octane number, MON		86	88	JIS K2280
Density	g/cm <sup>3</sup>	0.72	0.77	JIS K2249
Vapour pressure	kPa	56	60	JIS K2258
Distillation:				
— 10 % distillation temperature	K (°C)	318 (45)	328 (55)	JIS K2254
— 50 % distillation temperature	K (°C)	363 (90)	373 (100)	JIS K2254
— 90 % distillation temperature	K (°C)	413 (140)	443 (170)	JIS K2254
— final boiling point	K (°C)		488 (215)	JIS K2254
— olefins	% v/v	15	25	JIS K2536-1 JIS K2536-2
— aromatics	% v/v	20	45	JIS K2536-1 JIS K2536-2 JIS K2536-3
— benzene	% v/v		1.0	JIS K2536-2 JIS K2536-3 JIS K2536-4
Oxygen content		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-6
Existent gum	mg/100ml		5	JIS K2261
Sulphur content	Wt ppm		10	JIS K2541-1 JIS K2541-2 JIS K2541-6 JIS K2541-7
Lead content		not to be detected		JIS K2255
Ethanol		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-6
Methanol		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
MTBE		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
Kerosene		not to be detected		JIS K2536-2 JIS K2536-4



<b>B.3.8.4. Type: Petrol E5 (nominal 95 Octane)</b>				
<i>Parameter</i>	<i>Unit</i>	<i>Limits<sup>1</sup></i>		<i>Test method</i>
		<i>Minimum</i>	<i>Maximum</i>	
Research octane number, RON		95.0	-	EN 25164 / prEN ISO 5164
Motor octane number, MON		85.0	-	EN 25163 / prEN ISO 5163
Density at 15 °C	kg/m <sup>3</sup>	743	756	EN ISO 3675 / EN ISO 12185
Vapour pressure	kPa	56.0	60.0	EN ISO 13016-1 (DVPE)
Water content	% v/v		0.015	ASTM E 1064
Distillation:				
– Evaporated at 70 °C	% v/v	24.0	44.0	EN ISO 3405
– Evaporated at 100 °C	% v/v	48.0	60.0	EN ISO 3405
– Evaporated at 150 °C	% v/v	82.0	90.0	EN ISO 3405
– Final boiling point	°C	190	210	EN ISO 3405
Residue	% v/v	—	2.0	EN ISO 3405
Hydrocarbon analysis:				
– Olefins	% v/v	3.0	13.0	ASTM D 1319
– Aromatics	% v/v	29.0	35.0	ASTM D 1319
– Benzene	% v/v	-	1.0	EN 12177
– Saturates	% v/v	Report		ASTM 1319
Carbon/hydrogen ratio		Report		
Carbon/oxygen ratio		Report		
Induction period <sup>2</sup>	minutes	480	-	EN ISO 7536
Oxygen content <sup>4</sup>	% m/m	Report		EN 1601
Existent gum	mg/ml	-	0.04	EN ISO 6246
Sulphur content <sup>3</sup>	mg/kg	-	10	EN ISO 20846 / EN ISO 20884
Copper corrosion		-	Class 1	EN ISO 2160
Lead content	mg/l	-	5	EN 237
Phosphorus content	mg/l	-	1.3	ASTM D 3231
Ethanol <sup>5</sup>	% v/v	4.7	5.3	EN 1601 / EN 13132

<sup>1</sup> The values quoted in the specifications are ‘true values’. For establishing the limit values, the terms of ISO 4259:2006 (Petroleum products — Determination and application of precision data in relation to methods of test) have been applied and for fixing a minimum value, a minimum difference of 2R above zero has been taken into account; for fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

Notwithstanding this measure, which is necessary for technical reasons, the fuel manufacturer shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value when quoting maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO 4259:2006 shall be applied.

<sup>2</sup> The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery petrol streams, but detergent/dispersive additives and solvent oils shall not be added.

<sup>3</sup> The actual sulphur content of the fuel used for the type I test shall be reported.

<sup>4</sup> Ethanol meeting the specification of prEN 15376 is the only oxygenate that shall be intentionally added to the reference fuel.

<sup>5</sup> There shall be no intentional addition to this reference fuel of compounds containing phosphorus, iron, manganese or lead.

<b>B.3.8.5. Type: Petrol E10 (nominal 90 RON)</b>				
Fuel Property or Substance Name	Unit	Standard		Test method
		Minimum	Maximum	
Research octane number, RON		89		JIS K2280
Density	g/cm <sup>3</sup>		0.783	JIS K2249
Vapour pressure	kPa	56	60	JIS K2258
Distillation:				
— 10 % distillation temperature	K (°C)		343 (70)	JIS K2254
— 50 % distillation temperature	K (°C)	343 (70)	378 (105)	JIS K2254
— 90 % distillation temperature	K (°C)		453 (180)	JIS K2254
— final boiling point	K (°C)		493 (220)	JIS K2254
— benzene	% v/v		1.0	JIS K2536-2 JIS K2536-3 JIS K2536-4
Oxygen content	% w/w		3.7	JIS K2536-2 JIS K2536-4 JIS K2536-6
Existent gum	mg/100ml		5	JIS K2261
Sulphur content	Wt ppm		10	JIS K2541-1 JIS K2541-2 JIS K2541-6 JIS K2541-7
Lead content		not to be detected		JIS K2255
Ethanol	% v/v	9	10	JIS K2536-2 JIS K2536-4 JIS K2536-6
Methanol		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
MTBE		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
Kerosene		not to be detected		JIS K2536-2 JIS K2536-4

<b>B[g63].3.8.6. Type: Petrol E10 (nominal 95 RON)</b>				
<i>Parameter</i>	<i>Unit</i>	<i>Limits</i> <sup>1</sup>		<i>Test method</i>
		<i>Minimum</i>	<i>Maximum</i>	
Research octane number, RON <sup>2</sup>		95.0	98.0	EN ISO 5164
Motor octane number, MON <sup>2</sup>		85.0	89.0	EN ISO 5163
Density at 15°C	kg/m <sup>3</sup>	743.0	756.0	EN ISO 12185
Vapour pressure (DVPE)	kPa	56.0	60.0	EN 13016-1
Water content	% m/m	max 0.05 Appearance at -7°C: Clear & Bright		EN 12937
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
– final boiling point	°C	170	195	EN ISO 3405
Residue	% v/v	—	2.0	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 EN 238
– saturates	% v/v	report		EN 22854
Carbon/hydrogen ratio		report		
Carbon/oxygen ratio		report		
Induction Period <sup>3</sup>	minutes	480	—	EN ISO 7536
Oxygen content <sup>4</sup>	% m/m	3.3	3.7	EN 22854
Solvent washed gum (Existent gum content)	mg/100ml	—	4	EN ISO 6246
Sulphur content <sup>5</sup>	mg/kg	—	10	EN ISO 20846 EN ISO 20884
Copper corrosion 3hrs, 50°C		—	class 1	EN ISO 2160
Lead content	mg/l	—	5	EN 237
Phosphorus content <sup>6</sup>	mg/l	—	1.3	ASTM D 3231
Ethanol <sup>4</sup>	% v/v	9.0	10.0	EN 22854

<sup>1</sup> The values quoted in the specifications are 'true values'. In establishment of their limit values the terms of ISO 4259 Petroleum products - Determination and application of precision data in relation to methods of test have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account and in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

<sup>2</sup> Notwithstanding this measure, which is necessary for technical reasons, the manufacturer of fuels shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO 4259 shall be applied.

<sup>3</sup> A correction factor of 0.2 for MON and RON shall be subtracted for the calculation of the final result in accordance with EN 228:2008.

<sup>4</sup> The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersive additives and solvent oils shall not be added.

<sup>5</sup> Ethanol is the only oxygenate that shall be intentionally added to the reference fuel. The Ethanol used shall conform to EN 15376.

<sup>6</sup> The actual sulphur content of the fuel used for the Type 1 test shall be reported.

<sup>7</sup> There shall be no intentional addition of compounds containing phosphorus, iron, manganese, or lead to the reference fuel.

<b>B.3.8.1. Type: Petrol E10 (nominal 100 RON)</b>				
Fuel Property or Substance Name	Unit	Standard		Test method
		Minimum	Maximum	
Research octane number, RON		96		JIS K2280
Density	g/cm <sup>3</sup>		0.783	JIS K2249
Vapour pressure	kPa	56	60	JIS K2258
Distillation:				
— 10 % distillation temperature	K (°C)		343 (70)	JIS K2254
— 50 % distillation temperature	K (°C)	343 (70)	378 (105)	JIS K2254
— 90 % distillation temperature	K (°C)		453 (180)	JIS K2254
— final boiling point	K (°C)		493 (220)	JIS K2254
— benzene	% v/v		1.0	JIS K2536-2 JIS K2536-3 JIS K2536-4
Oxygen content	% w/w		3.7	JIS K2536-2 JIS K2536-4 JIS K2536-6
Existent gum	mg/100ml		5	JIS K2261
Sulphur content	Wt ppm		10	JIS K2541-1 JIS K2541-2 JIS K2541-6 JIS K2541-7
Lead content		not to be detected		JIS K2255
Ethanol		9	10	JIS K2536-2 JIS K2536-4 JIS K2536-6
Methanol		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
MTBE		not to be detected		JIS K2536-2 JIS K2536-4 JIS K2536-5 JIS K2536-6
Kerosene		not to be detected		JIS K2536-2 JIS K2536-4

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