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Motorcycles and mopeds - Environmental and Propulsion Performance Requirements (EPPR) for L-category vehicles

Proposal for a new global technical regulation on the measurement procedure for two- or three-wheeled motor vehicles equipped with a combustion engine with regard to the crankcase and evaporative emissions

Submitted by the Informal Working Group on Environmental and Propulsion Performance Requirements (EPPR)*

The text reproduced below was prepared by the Informal Working Group (IWG) on Environmental and Propulsion Performance Requirements (EPPR) in line with its mandate (ECE/TRANS/WP.29/AC.3/36). A first draft of this proposal (GRPE-71-20) was introduced by the IWG on EPPR at the seventy-first session of GRPE (see report ECE/TRANS/WP.29/GRPE/71, para. 44). The text in square brackets was not yet agreed on by the IWG and, thus, a decision should be taken during the session.

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



Global technical regulation on the measurement procedure for two- or three-wheeled motor vehicles equipped with a combustion engine with regard to the crankcase and evaporative emissions

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I. Statement of technical rationale and justification

A. Introduction

1. The industry producing two- and three-wheeled vehicles in the scope of this UN global technical regulation (gtr) 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 of category 3¹ as a way to help improve air quality internationally. The aim of this UN gtr is to provide measures to strengthen the world-harmonization 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 world-wide.

2. The objective of this UN gtr is to prevent crankcase emissions from being emitted without being combusted and to reduce the evaporative emission contributions from vehicles in the scope of this UN gtr. Harmonized test procedures are set out allowing to measure the crankcase and evaporative emissions and subsequently to allow comparison of the measurement results with world-wide harmonized test thresholds for the approval of a vehicle category within the scope of this UN gtr.

3. The harmonized test procedures to determine the crankcase emissions and evaporative emissions of vehicles in the scope of this UN gtr are part of the environmental performance tests approval and assessment of such vehicles. The test procedures were developed so that they would be:

- (a) Able to provide an internationally harmonized set of tests to ensure efficient, cost-effective and practicable testing;
- (b) Corresponding to state-of-the-art testing, affordable but sampling and measurement technology fit for purpose in the area of performance testing of vehicles; and
- (c) At a later stage, when the appropriate requirements have been agreed upon and are incorporated in this UN gtr, applicable in practice to existing and foreseeable future powertrain technologies. However, the first priority has been to address crankcase and evaporative emissions from (currently) conventional vehicle configurations and propulsion unit types.

4. This UN gtr covers the following test types:

- (a) Test type III, emissions of crankcase gases;

The section on emissions from crankcase gases includes the obligation for the vehicle manufacturer to submit a statement to the approval authority to ensure that no emissions from the crankcase gas ventilation system can escape to the atmosphere in the useful life of the vehicle. In a future amendment of this UN gtr the section on test type III will be expanded with physical, harmonized test procedures which the approval authority may request under to be defined conditions. The test procedure will be designed to

¹ Special Resolution No. 1 (S.R.1), ECE/TRANS/WP.29/1045, as amended by Amends. 1 and 2

validate the statement if deemed necessary that no crankcase emissions are escaping to the environment in the useful life of the vehicle.

- (b) Test type IV, evaporative emissions.

The section on evaporative emissions includes a cascade of three tests to determine the evaporative emissions, from a simple permeability test for non-metallic fuel tanks, a fuel and delivery system permeation test, or a Sealed House for Evaporation Determination (SHED) based test to determine the evaporative emissions from the entire vehicle in a sealed house test.

5. This UN gtr is based on the work of the Informal Working Group (IWG) on Environmental and Propulsion unit Performance Requirements (EPPR) of vehicles, from now on referred to as EPPR IWG, which held its first meeting during the sixty-fifth GRPE in January 2013 and on the initial proposal by the European Union (EU, represented by the European Commission (EC)).

B. Procedural background and future development of the UN gtr

6. The EU put forward and announced their intention of setting up a working group during the sixty-third and sixty-fourth meetings of GRPE in January and June 2012 and in the 157th session of WP.29 in June 2012.

7. With the mandate (informal document: WP.29-158-15) WP.29 accepted at the 158th session (13-16 November 2012) to establish the EPPR IWG under GRPE. The official mandate document is available on the UNECE website with the symbol ECE/TRANS/WP.29/AC.3/36.

8. At the seventy-second GRPE session in January 2016, a formal proposal for this new UN gtr was tabled for adoption by the Executive Committee for the 1998 Agreement (AC.3).

9. Ongoing developments of test types and procedures and global discussion on harmonization have resulted in the technical requirements contained within this UN gtr. The final text of the UN gtr is presented in Section II of this document.

C. Existing regulations, directives and international voluntary standards

1. Technical references in the development of the UN gtr

10. For the development of the UN gtr, the following legislation and technical standards contained relevant applications of requirements for motorcycles and other vehicles in the scope of this UN gtr or transferable provisions for passenger cars:

- (a) Crankcase emissions: UN Regulation No. 83 (applicable to cars and utility vans) custom tailored for combustion engines fitted to vehicles in the scope of this UN gtr;
- (b) Evaporative emissions, permeability tests: Annex 1 to chapter 6 of Directive 97/24/EC;
- (c) Evaporative emissions, permeation tests: United States of America Federal test procedures (86.410-2006 Emission standards for 2006 and later model year motorcycles);
- (d) 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.

2. Methodology for deriving harmonized test procedures for the UN gtr

11. The European Commission launched an EPPR study for L-category vehicles in January 2012 with the objective to develop proposals to update UN gtr No. 2 for technical progress and to develop proposals for UN gtrs and UN Regulations with respect to harmonized EPPR legislation not yet covered at the international level for vehicles in the scope of this UN gtr, e.g. crankcase and evaporative emission test requirements, on-board diagnostic requirements, propulsion unit performance requirements etc. The output of this comprehensive study² was submitted for the review and comments of the EPPR IWG with the objective to identify the concerns and to provide base proposals ready for further enhancements by the EPPR IWG in order to accommodate the needs at the international level to assess a vehicle with respect to its crankcase and evaporative emissions in a scientifically based, objective and globally accepted way.

12. The outcome of this work was among others the development of a first draft UN gtr proposal based on the consolidation of existing global legislation and up-to-date technical provisions. After discussions and adopting a number of amendments the EPPR IWG decided to take the EC proposal as a basis for the first draft UN gtr of the group. This text then further evolved in many different revisions and was modified in iterative steps to reflect the discussions and decisions by the group over the period 2013 - 2015.

D. Discussion of the issues addressed by the UN gtr

1. List of issues

13. This UN gtr brings together the harmonized test procedures to determine the crankcase emissions and evaporative emissions of vehicles in the scope of this UN gtr. The process to develop this UN gtr followed the methodology discussed in Chapter C.2, where important issues discussed and addressed during the development were among others:

14. For both test types III and IV:

- (a) Scope;
- (b) Reference fuel;
- (c) Definition and provision on useful life.

15. For test type III in particular:

The need for the inclusion of physical crankcase emission test requirements and associated test procedures.

16. For test type IV in particular:

- (a) Adaptation of provisions for three-wheeled vehicles where necessary;
- (b) Providing a series of three alternative evaporative emission test types to allow testing to be carried out involving varying degree of complexity;
- (c) The appropriate SHED test preparation and preconditioning test cycle;
- (d) Durability of evaporative emission control devices:

² Document reference EPPR-07- 07

- (i) Confirmation on applying a fixed deterioration factor as alternative to physical durability testing of evaporative emission control devices;
 - (ii) The notion of "degreened" evaporative emission control device;
 - (iii) Incorporation of bench ageing durability test procedure B (based on California evaporative emission requirements);
 - (iv) The number of charging/discharging durability cycles for ageing procedure A;
 - (v) Blending of the reference fuel with ethanol affecting the durability of the carbon canister;
 - (vi) Durability requirements of evaporative emission control valves and linkages.
- (e) Criteria of the propulsion unit family.

2. Applicability

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

3. Scope

18. The EPPR IWG has discussed at length which vehicle types should be in the scope of the UN gtr. One of the objectives of the group was to discuss the substantive requirements of two-wheeled vehicles first followed by a discussion if these requirements should as well be applied to three-wheeled vehicles. In particular it was debated whether or not the classification criteria laid down in paragraph 2. of Special Resolution No. 1 (S.R.1) on category 3 vehicles should be referenced in detail or using a more generic wording, e.g. two- and three-wheeled vehicles allowing for more flexibility to allow alignment with domestic classification of three-wheeled vehicles.

19. The EPPR IWG discussed possible solutions how three-wheeled vehicles could be included in the scope of the UN gtr given the fact that S.R.1 contains recommended classification criteria for category 3 vehicles that might require an update for technical progress. Finally it was agreed to put "category 3" vehicles in paragraph 2. of the UN gtr, to reference S.R.1 in a footnote and to state the following with respect to the classification of a three-wheeled vehicle:

"With regard to a three-wheeled vehicle of category 3-4 or 3-5, Contracting Parties agree that at a minimum the following criteria should be taken into account for vehicle classification:

- (a) In their straight-ahead condition, motor vehicles having two wheels which are placed on the same straight line and equipped with one sidecar; or
- (b) Motor vehicles having a saddle-type seat, a handle-bar type steering system and three wheels, on which the side of the driver's seat is of open structure; or
- (c) Motor vehicles complying with the following criteria:
 - (i) Three wheels; and

- (ii) In which the arrangement of the wheels is symmetric with respect to the longitudinal centreline of the vehicle; and
- (iii) The distance between the lines passing through the centres of the ground-contact sections of the outermost wheels on the axle on the same line is less than 460 mm; and
- (iv) Constructed to turn with part or all of the wheels and vehicle body inclined."

20. Contracting Parties may expand the scope to other types of three-wheeled vehicles in order to align with their domestic classifications of three-wheeled vehicles as deemed appropriate."

4. Definitions

21. The definitions used in the UN gtr are aligned as much as possible with definitions in international legislation and from the work of the Vehicle Propulsion System Definitions (VPSD) group operating under GRPE with the goal to harmonize high level powertrain definitions as well as from other regional legislation as listed in Chapter C.1.

5. Requirements

22. For test type III crankcase emissions: 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 atmosphere as a first step. The EPPR IWG decided that the physical crankcase emission test(s) which a Contracting Party may require to validate the declaration under certain conditions to be defined will be developed together and when agreed this UN gtr will be amended accordingly.

23. For evaporative emissions, there is a choice of three alternative test procedures:

- (a) Non-metallic fuel tank permeability test as assessment of the evaporative emissions from the most relevant component on the vehicle– the fuel tank is half filled and weighed daily over an 8-week period to determine the mass of fuel lost over that period;
- (b) Fuel tank 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;
- (c) SHED test as assessment of the evaporative emissions of the whole vehicle, 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 the engine warming up to the operational temperature by driving over a pre-conditioning test cycle on a chassis dynamometer) of the complete vehicle.

24. In order to take into account that the assessment will become more accurate, but at the same time that the cost of testing will become more expensive, the EPPR IWG has developed a test hierarchy in which the whole vehicle assessment with respect to evaporative emissions in a SHED test is higher placed on the hierarchy ladder than the permeation test, assessing only the relevant system of fuel tank and tubing in the assumption that the larger share of evaporative emissions stems from the fuel tank and fuel delivery system, respectively assessment through the permeability test of a non-metallic fuel tank as the one of the main relevant components only. For a two-wheeled motorcycle, a motorcycle with side-car and a tricycle the EPPR IWG decided that a SHED test shall be

conducted. For two- and three-wheeled mopeds, Contracting Parties are left the choice which of the three alternative test types should apply. Only one out of the three alternative test types shall be required for these types of mopeds.

25. The provision on control valves, cables and linkages set out in the evaporative emission legislation for motorcycles in the State of California, United States of America, was initially proposed as provision in the draft UN gtr, but the vehicle manufacturers and authorities participating in the EPPR IWG required more clarity on the test procedure and especially on the "5,000" cycles. As no harmonized test procedure to age valves, linkages and cables was readily available the EPPR IWG decided to delete the initially proposed provision from Section II of the proposal and to make note in Section I so as to reinsert this provision in the future through an amendment upon availability of harmonized and agreed test procedures for these devices.

6. Performance requirements

26. 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.

27. The performance requirements for the three evaporative emissions have been derived from a mix of the United States of America, UNECE and EU requirements, which are proposed to be adopted for the evaporative emission performance of vehicles in the scope of this UN gtr world-wide. Test limits for a first stage were agreed upon. It should be considered in the future to update these test limits, (i.e. establish a second stage with the SHED test limit proposed to be 1,500 mg/test).

7. Reference fuel

28. For the crankcase emissions and the evaporative emissions test, the reference fuels specified Annex 8 may be selected by the Contracting Parties in order to be representative for the local market fuel. In the future, upon availability of scientific evidence and agreement among the Contracting Parties the number of reference fuel specifications should be reduced in order to further reduce test and administrative burden on vehicle manufacturers and approval authorities.

29. With respect to application of the appropriate evaporative emission test type IV procedure the EPPR IWG agreed that a two-wheeled motorcycle and a motorcycle with side car should be subject to the class C SHED test. With respect to tricycles the same concept of classification could be accepted as explained in Chapter D.4. and also for such types of three-wheeled vehicles it could be agreed that the class C SHED test should apply. This decision was set-out in paragraph 7.2.4.2. of Chapter 7 of Section II. For two- and three-wheeled mopeds the EPPR IWG felt that more time was needed to assess and decide if class B permeation test or class C SHED test was more appropriate for such vehicle types. Subsequently some flexibility to Contracting Parties is provided in paragraph 7.2.4.3. of Chapter 7 of Section II pending the outcome of this assessment and decision. In order to take this future decision into account and to further harmonize test type IV requirements paragraph 7.2.4.3. should be amended accordingly in due course.

8. Regulatory impact and economic effectiveness

30. Increasingly, mopeds, motorcycles and other vehicles in the scope of UN gtr 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 CO₂ 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 harmonized definition of the test procedures for measuring crankcase emissions and evaporative emissions. It is anticipated that the test procedures in this UN gtr will provide a common test programme for manufacturers to use in countries worldwide and thus reduce the amount of resources utilized to test vehicles in the scope of this UN gtr. 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 UN gtr was first started, which is to reduce hydrocarbon emissions from crankcase gas and evaporative emissions.

9. Potential cost effectiveness

31. At the time of writing this revision of the UN 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 UN gtr.]

II. Text of the global technical regulation

1. Purpose

This UN global technical regulation (gtr) provides worldwide-harmonized test methods for the determination of crankcase gas emissions (Test Type III).

This UN gtr also provides world-harmonized test procedures to determine evaporative emissions (Test Type IV) owing to evaporation of fuel through the vehicle's fuel tank and fuel delivery system.

2. Scope and application

Two- and three-wheeled vehicles of category 3³ equipped with a PI engine in accordance with Table 1:

Table 1
Scope with regard to the propulsion unit and fuel type

| <i>Propulsion unit and fuel type</i> | | | | <i>Test type III</i> | <i>Test type IV</i> |
|--|---------------------------|--------------------|--------------------|----------------------|-----------------------|
| Vehicle with PI engine | Mono-fuel* | Petrol | | Yes | Yes* |
| | | LPG | | Yes | No |
| | | NG / Biomethane | | Yes | No |
| | | Hydrogen | | Yes | No |
| | Bi-fuel | Petrol | LPG | Yes | Yes (petrol only)* |
| | | Petrol | NG / Biomethane | Yes | Yes (petrol only)* |
| | | Petrol | Hydrogen | Yes | Yes (petrol only)* |
| | Flex-fuel | Petrol | Ethanol (E85) | Yes | Yes (petrol only)* |
| | | NG / Biomethane | HCNG | Yes | No |
| | Vehicle with CI engine | Flex-fuel | Diesel | Bio-Diesel | Yes |
| Mono-fuel | | Diesel | | Yes | No |
| Pure electric vehicle or vehicle propelled with compressed air (CA) | | | | No | No |
| Hydrogen Fuel cell vehicle | | | | No | No |

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

³ ECE/TRANS/WP.29/1045, as amended by Amends. 1 and 2

3. Definitions

The definitions set out in UN gtr No. 2 shall apply. In addition 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 meaning the hydrocarbon vapours lost from the fuel tank and fuel supply system of a motor vehicle and not those from tailpipe emissions;
- 3.4. "*Fuel storage breathing losses*" means hydrocarbon emissions caused by temperature changes in the fuel storage;
- 3.5. "*Fuel tank*" means a type of energy storage system that stores the [liquid] fuel;
- 3.6. "*Hot soak losses*" means hydrocarbon emissions arising from the fuel system of a stationary vehicle after a period of driving (assuming a ratio of $C_1H_{2.20}$);
- 3.7. "*Non-exposed*" type of fuel 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 evaporative total hydrocarbon emission limits has to be assured;
- 3.13. "*Vehicle propulsion unit family*" for the purpose of evaporative emission testing means a manufacturers grouping of vehicles which, through their design as defined in Annex 6 of this UN gtr, have similar evaporative emission characteristics for the purpose of this UN gtr.

4. List of acronyms and symbols

Table 2
List of acronyms and symbols

| <i>Item</i> | <i>Unit</i> | <i>Term</i> |
|-------------------------------|------------------------|--|
| LPG | - | liquefied petroleum gas |
| NG | - | natural gas |
| H ₂ | - | hydrogen gas |
| HCNG | | hydrogen-natural gas mixtures |
| CO | ppm | carbon monoxide |
| NO | ppm | nitric oxide |
| CO ₂ | ppm | carbon dioxide |
| C ₃ H ₈ | ppm | propane |
| T _f | °C | temperature of fuel |
| T _v | °C | temperature of fuel vapour |
| t | minutes | time from start of the fuel tank heat build |
| m _{HC} | grams | mass of hydrocarbon emitted over the test phase |
| C _{HC} | ppm C1 | hydrocarbon concentration measured in the enclosure |
| T | K or °C | ambient chamber temperature |
| DF | mg/m ² /day | deterioration factor for permeation test |
| DF | mg/test | deterioration factor for SHED test |
| V | m ³ | net enclosure volume corrected for the volume of the vehicle |
| p | kPa | barometric pressure |
| H/C | - | hydrogen to carbon ratio |
| m _{total} | grams | overall evaporative mass emissions of the vehicle |
| m _{TH} | grams | evaporative hydrocarbon mass emission for the fuel tank heat build |
| m _{HS} | grams | evaporative hydrocarbon mass emission for the hot soak |
| v _{max} | km/h | maximum vehicle speed |
| R _f | - | response factor for a particular hydrocarbon species |
| FID | - | flame ionisation detector |
| SHED | - | sealed housing for evaporation determination |
| r ² | - | regression correlation coefficient |
| HC | - | hydrocarbon |

5. General requirements

- 5.1. Vehicles, systems, and components shall be so designed, constructed and assembled by the manufacturer, so as to enable the vehicle, in normal use and maintained according to the prescriptions of the manufacturer, to comply with the provisions of this UN gtr during its useful life.

6. Test type III requirements: Emissions of crankcase gases

6.1. Introduction

- 6.1.1. 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.

6.2. General provisions

- 6.2.1 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:

- 6.2.1.1 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 test⁴ requirements may be waived.

- 6.2.2. 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.

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

- 6.2.3. 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).

7. Test type IV requirements: Evaporative emissions

7.1. Introduction – evaporative and permeation emissions

- 7.1.1. 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 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.

⁴ The Type III test procedure to be conducted in accordance with the requirements to be agreed upon by the UN EPPR IWG and to be supplemented in a subsequent amendment to this UN gtr.

- 7.1.2. The test procedure in Annex 1 sets out the procedure for testing the permeability of a non-metallic fuel tank.
- 7.1.3. The evaporative emission test procedure laid down in Annex 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.
- 7.1.4. The procedure laid down in Annex 3 sets out the evaporative hydrocarbon emission determination requirements of the whole vehicle and it is therefore the most comprehensive test methodology.
- 7.2. General requirements
- 7.2.1. 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 paragraph 7.2.2.
- 7.2.2. Hydraulic test
- 7.2.2.1. 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.
- 7.2.2.2. The fuel 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 fuel 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 paragraph 7.2.2.1. 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.
- 7.2.3. The following three classes of type IV testing are listed in hierarchical order as follows:
- 7.2.3.1. Class A; the test procedure in Annex 1 sets out the permeability test procedure of a non-metallic fuel storage; as a component.
- 7.2.3.2. Class B; the test procedure in Annex 2 sets out the permeation test procedures of the fuel storage and supply systems.
- 7.2.3.3. Class C; the SHED test is described in Annex 3 and sets out the evaporative emission test procedure for a whole vehicle.
- 7.2.4. Test hierarchy and obligations of contracting parties
- Each class shall consist of one or more tests, which are listed in Table 3, together with the SHED type required for the tests, if any.

Table 3
Evaporative emission test class

| Test | Evaporative emissions test class | | | SHED type |
|--|----------------------------------|---|---|--------------------------------|
| | A | B | C | |
| Permeability test of a non-metallic fuel 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⁾ |

⁽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.

- 7.2.4.2. A category 3 two-wheeled motorcycle, a motorcycle with sidecar and a tricycle shall be tested according to the class C evaporative emission test procedure.
- 7.2.4.3. For other category 3 types of two- or three-wheeled vehicles the Contracting Party may decide to apply one test procedure only from the three evaporative emission test procedure classes listed in paragraph 7.2.3.
- 7.2.4.4. The Contracting Parties shall accept test reports for the approval of a vehicle according to Table 4.

Table 4
Hierarchy of evaporative emission tests

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

7.2.5. Test fuel

The appropriate test fuel, as defined in Annex 2 of UN gtr No. 2 (type: Petrol E0) and Annex 8. of this UN gtr (types: Petrol E5 and Petrol E10), shall be used, as decided by the Contracting Party.

- 7.2.5.1. 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.

7.2.5.2.⁵

7.3. Durability

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

Table 5
Overview durability test procedure

| <i>Type IV test class mandated by the Contracting Party for the whole vehicle in its territory</i> | <i>Durability test procedure</i> |
|--|---|
| A | Points 2.1.2.to 2.1.4 of Annex 1 (pre-storage period) |
| B | Point 6 of Annex 2 |
| C | Point 2.1 of Annex 3 |

7.4. Test limits

Table 6
Test type IV limits

| <i>Type IV test class mandated by the Contracting Party for the whole vehicle in its territory</i> | <i>Test conditions / Test subject</i> | <i>Test limits (stage 1)</i> |
|--|---------------------------------------|----------------------------------|
| A | 40 °C± 2 °C: | 20,000 mg / 24h |
| | 23 °C ± 2 °C: | 10,000 mg / 24h |
| B | Fuel tank | 1,500 mg / m ² / 24h |
| | Fuel tubing | 15,000 mg / m ² / 24h |
| C | - | 2,000 mg / test |

7.5. 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 6. All members of the family shall comply with the applicable requirements and performance limits set out in this UN gtr.

7.6. Documentation

The vehicle manufacturer shall fill out the information document in accordance with the template laid down in Annex 7 and submit it to the approval authority of the Contracting Party or its designated agency.

⁵ A test fuel hierarchy for the compliance to the type IV test taking in considering the properties of the specified test fuels according to paragraph 7.2.5. may be developed in future.

Annex 1

Fuel tank permeability test procedure

1. Scope
 - 1.1. This requirement shall apply to vehicles in the scope of this UN gtr that are equipped with a non-metallic fuel tank.
 2. Fuel tank permeability test
 - 2.1. Test method
 - 2.1.1. Test temperature

The fuel tank shall be tested at a temperature of $40\text{ °C} \pm 2\text{ °C}$.
 - 2.1.2. The fuel tank is filled with the test fuel up to 50 per cent 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 the weight loss has stabilised. That period shall be at least four weeks (pre-storage period). The fuel tank is emptied and then refilled with test fuel to 50 per cent of its rated capacity. 2.1.3. The fuel 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 fuel tank is then sealed. The pressure rise in the fuel 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, the maximum quantity escaping on average, every 24 hours from the fuel tank, shall be no greater than the applicable test limit set out in paragraph 7.4. of Section II.
 - 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 the applicable test limits set out in paragraph 7.4. of Section II.
 - 2.2. The permeability evaporation test results shall not be averaged between the different tested fuel tanks, but the worst-case diffusion loss rate observed of any one of those fuel tanks shall be taken and compared against the maximum permitted loss rate set out in paragraph 2.1.4 and, if applicable, in paragraph 2.1.5.
 - 2.3. Fuel tank permeability test conducted with internal pressure compensation

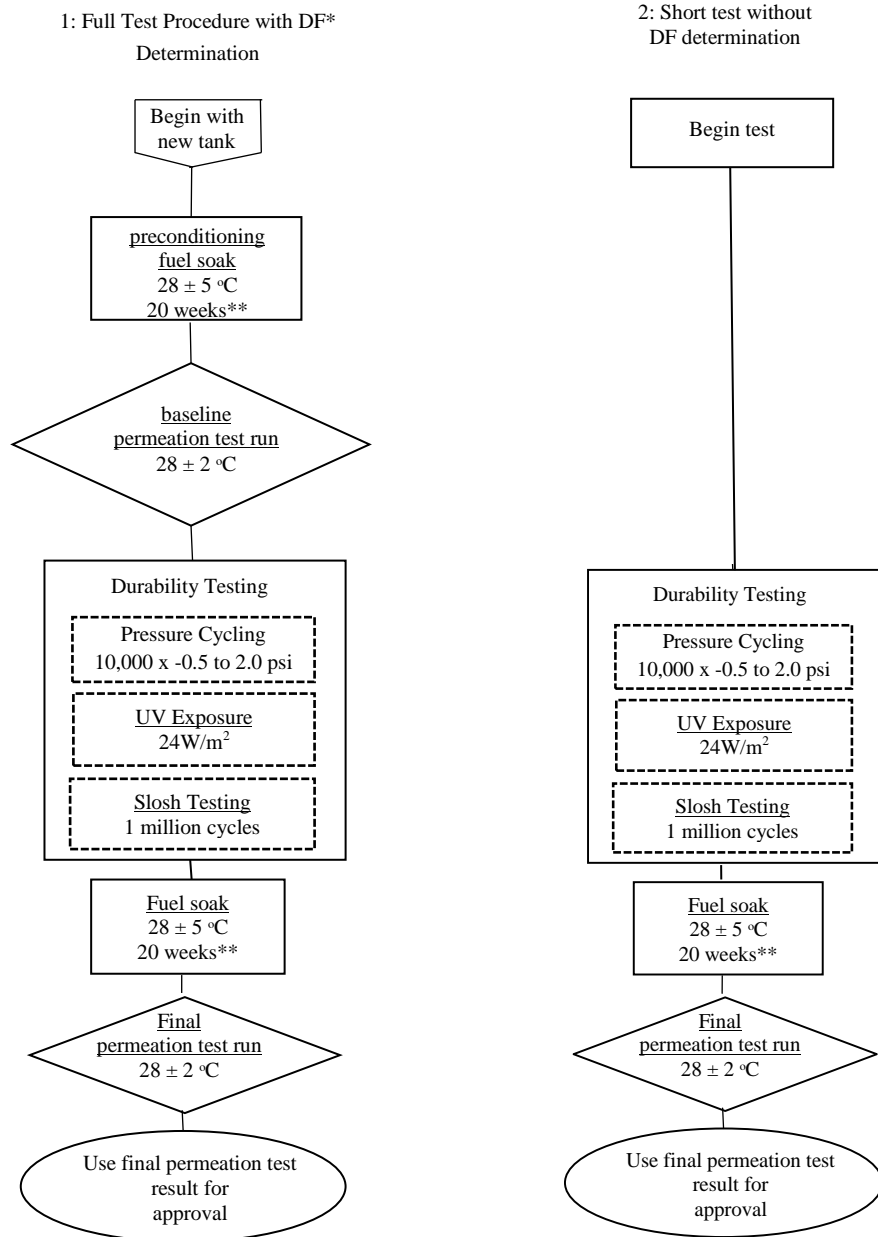
If the fuel tank permeability test is conducted with internal pressure compensation, which shall be noted in the test report, the fuel loss resulting from the pressure compensation shall be taken into account when the diffusion loss is calculated.

Annex 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 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 tank before and after a temperature-controlled soak according to the flow charts shown in Figure A2/1.

Figure A2/1
Fuel storage tank permeation full and short tests



* DF means deterioration factor in accordance with paragraph 5.6.

** The length of "soak" during durability testing may be included in the fuel soak period provided that fuel remains in the tank. Soak periods can be shortened to 10 weeks if performed at 43 ± 5 °C

- 2.2. Metallic fuel tanks are exempted from durability testing.
3. Preconditioning fuel soak for the fuel storage and supply system permeation test

To precondition the fuel tank in the fuel storage and supply system permeation test, the following five steps shall be followed:
- 3.1. The fuel tank shall be filled with reference fuel and sealed. The filled tank shall be soaked at an ambient temperature of $28\text{ °C} \pm 5\text{ °C}$ for 20 weeks or at $43\text{ °C} \pm 5\text{ °C}$ 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 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 tank shall be filled with the reference fuel to its nominal capacity.
- 3.4. The fuel tank and fuel shall equilibrate to $28\text{ °C} \pm 5\text{ °C}$ or $43\text{ °C} \pm 5\text{ °C}$ in the case of the alternative short test.
- 3.5. The fuel tank shall be sealed using fuel caps and other fittings (excluding petcocks) that can be used to seal openings in a production fuel tank. In cases where openings are not normally sealed on the fuel 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 tank preconditioned as specified in paragraph 3.
- 4.1. Weigh the sealed fuel tank and record the weight in mg. This measurement shall be taken within eight hours of filling of the fuel tank with test fuel.
- 4.2. The fuel 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 $28\text{ °C} \pm 5\text{ °C}$ 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 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 tank at the end of the test shall be subtracted from the weight of the filled fuel tank at the beginning of the test.

- 5.3. The difference in mass shall be divided by the internal surface area of the fuel tank.
- 5.4. The result of the calculation under paragraph 5.3., expressed in mg/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 paragraph 7.4. of Section II.
- 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 paragraphs 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 paragraph 5.6.1. shall be multiplied with the measured permeation test result determined in paragraph 5.4.; or
- 5.7.1.2. The fixed additive deterioration factor set out in paragraph 5.6.2. shall be added to the measured permeation test result determined in paragraph 5.4;
- 5.7.1.3. The calculation results determined in paragraph 5.7.1.1. or 5.7.1.2. shall be no greater than the applicable permeation test limits set out in paragraph 7.4. of Section II.
- 5.7.2. Accelerated (short) test procedure
- The measured permeation test result determined in paragraph 5.4. or 5.5. if applicable, shall be no greater than the applicable permeation test limit set out in paragraph 7.4. of Section II.
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 10,000 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 tank to an ultraviolet light of at least $24 \text{ W} / \text{m}^2$ ($0.40 \text{ W-hr} / \text{m}^2 / \text{min}$) on the tank

surface for at least 450 hours. Alternatively, the non-metallic fuel 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 tank to 40 per cent 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 tank assembly shall be rocked at a rate of 15 cycles per minute until one million total cycles are reached. An angle deviation of $+15^\circ$ to -15° from level shall be used and the slosh test shall be conducted at an ambient temperature of $28\text{ }^\circ\text{C} \pm 5\text{ }^\circ\text{C}$.

6.2. Final fuel tank durability test results

Following the durability testing, the fuel tank shall be soaked according to the requirements of paragraph 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 tank shall be drained and refilled with fresh reference fuel. The permeation test run laid down in paragraph 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 paragraph 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 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 $43\text{ }^\circ\text{C} \pm 5\text{ }^\circ\text{C}$.

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 paragraphs 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 tank" in paragraphs 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 paragraph 7.4. of Section II shall be met when conducting the test procedures laid down in paragraph 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 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 paragraph 7.4. of Section II shall be considered as fulfilled.

Annex 3

Sealed Housing for Evaporation Determination (SHED) test procedure

1. Description of SHED test

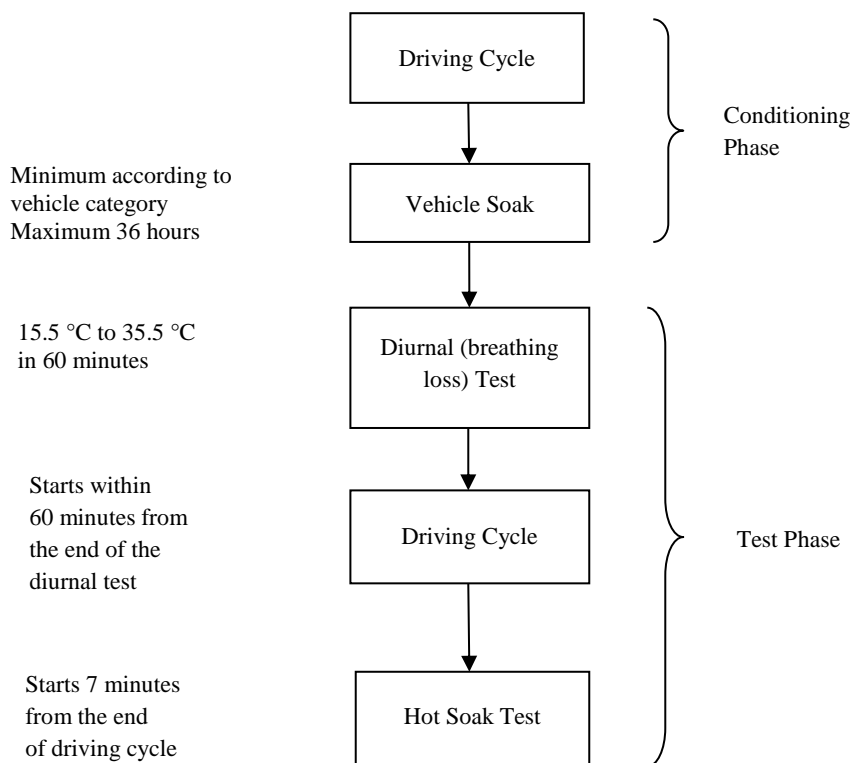
The evaporative emission SHED test (Figure A3/1) consists of a conditioning phase and a test phase, as follows:

- (a) Conditioning phase:
 - (i) Driving cycle;
 - (ii) Vehicle soak.
- (b) Test phase:
 - (i) Diurnal (breathing loss) test;
 - (ii) Driving cycle;
 - (iii) 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 A3/1

Fuel storage tank permeation full and short tests



2. Test vehicle requirements
 - 2.1. Durability

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. The appropriate procedure to run-in these devices shall be left to the choice of the manufacturer under the condition that the test procedure to "degreen" the devices is reported in detail and evidence is provided that this test procedure is actually followed.

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 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 1,000 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 canister¹ 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 UN gtr No. 2 provided that in the case of 3 wheeled vehicles the chassis dynamometer shall be capable of accommodating three-wheeled vehicles (e.g. two 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.

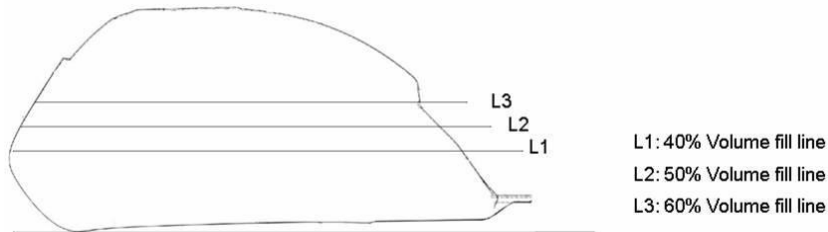
¹ Or the canister with HC absorbent material or other equivalent.

- 3.3.1.2. The hydrocarbon analyser shall have a response time to 90 per cent of final reading of less than 1.5 seconds. Its stability shall be better than 2 per cent of full scale at zero and at 80 ± 20 per cent 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 per cent of full scale deflection at zero and at 80 ± 20 per cent of full scale on all ranges used.
- 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 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 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 tank and shall cover at least 10 per cent of the wetted surface. The centre line of the fuel heating strips if used, shall be below 30 per cent of the fuel depth as measured from the bottom of the fuel 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 paragraph 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 per cent volume fill line from bottom. Likewise no vapour heating pad for the tank evaporative test shall be below the 60 per cent volume fill line from bottom.

Figure A3/1

Example fuel tank with appropriate positioning of fuel tank heating pads to control fuel and vapour temperatures



- 3.4.4. With temperature sensors positioned as in paragraph 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 $\pm 1.7^\circ\text{C}$ of the required temperature during the tank heating process.
- 3.4.5. Notwithstanding the requirements of paragraph 3.4.2., if a manufacturer is unable to meet the heating requirement specified, due to use of thick-walled plastic fuel 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 ± 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 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 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 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 ± 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 ± 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 m³/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. The following pure gases shall be available for calibration and operation:
- (a) Purified synthetic air (purity: < 1 ppm C₁ equivalent < 1 ppm CO, < 400 ppm CO₂, 0.1 ppm NO); oxygen content between 18 and 21 per cent by volume;
 - (b) Hydrocarbon analyser fuel gas (40 \pm 2 per cent hydrogen, and balance helium with less than 1 ppm C₁ equivalent hydrocarbon, less than 400 ppm CO₂);
 - (c) Propane (C₃H₈), 99.5 per cent minimum purity.
- 3.7.2. Calibration and span gases shall be available containing mixtures of propane (C₃H₈) and purified synthetic air. The true concentrations of a calibration gas shall be within ± 2 per cent of the stated figures. The accuracy of the diluted gases obtained when using a gas divider shall be to within ± 2 per cent of the true value. The concentrations specified in paragraph 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 per cent of full scale.
- 3.8. Additional equipment
- 3.8.1. The relative humidity in the test area shall be measurable to within ± 5 per cent.
- 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 tank of the vehicle shall be equipped with temperature sensors so that the temperature of the fuel and fuel vapour in the fuel tank can be measured when it is filled to 50 per cent \pm 2 per cent 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 tank. Alternatively, the fuel 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 test vehicle is placed on a chassis dynamometer and driven a single time through the applicable [Type I] test cycle specified before switching off the engine:
- 4.2.2.1. In Annex 5 of UN gtr No. 2 as appropriate for the class of vehicle in the scope of UN gtr No. 2;
- [4.2.2.2.] Alternatively to 4.2.2.1. for three-wheeled vehicles in the scope of this UN gtr at the choice of the Contracting Party the applicable Type I test set out in the national regulation of the Contracting Party under the following conditions:
- [4.2.2.2.1.] The oil temperature of the engine reaching its warm operational temperature and a total accumulated test type I time of 780 s after start; or
- [4.2.2.2.2.] For an air-cooled engine operated on a mixture of petrol and lubrication oil the sparkplug seat temperature having reached its warm operational temperature and a total accumulated test type I time of 780 s after start.
- [4.2.2.2.3.] By means of exemption, a base two-wheeled motorcycle equipped with a sidecar may be approved based on the type IV evaporative emission test results of the base two-wheeled motorcycle.
- 4.2.3. The vehicle is parked in the test area for the minimum period stated in Table A3/1.

Table A3/1

SHED test – minimum and maximum soak periods

| <i>Engine capacity</i> | <i>Minimum (hours)</i> | <i>Maximum (hours)</i> |
|--|------------------------|------------------------|
| < 170 cm ³ | 6 | 36 |
| 170 cm ³ \leq engine capacity < 280 cm ³ | 8 | 36 |
| \geq 280 cm ³ | 12 | 36 |

- 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 tank(s) shall be emptied as described in paragraph 4.1.1. and refilled with test fuel at a temperature of between 10 °C and 14 °C to 50 per cent ± 2 per cent 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 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 vapour temperature up to 5 °C above 21.0 °C may be used. For this condition, the vapour shall not be heated at the beginning of the diurnal test. When the fuel temperature has been raised to 5.5 °C below the vapour temperature by following the T_f function, the remainder of the vapour heating profile shall be followed.
- 4.3.1.6. As soon as the fuel temperature reaches 14.0 °C:
 Install the fuel filler cap(s);
 Turn off the purge blowers, if not already off at that time;
 Close and seal enclosure doors.
 As soon as the fuel reaches a temperature of 15.5 °C ± 1 °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 °C or 20 °C ± 0.5 °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 ± 1.7 °C, or the closest possible function as described in 3.4.3.:

For exposed type of fuel tanks:

Equations A3/1:

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

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

For non-exposed type of fuel tanks:

Equations A3/2:

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

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

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 paragraph 4.3.1.6. have been met over the 60 ± 2 minute period of the test, the final hydrocarbon concentration in the enclosure is measured ($C_{HC,f}$). 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 carbon canister, fuel 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 tested.
- 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 paragraph 4.2. and within two minutes of engine shutdown.
- 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 ± 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 laid down in paragraph 5.
- 4.3.3.6. The hydrocarbon analyser shall be zeroed and spanned immediately before the end of the 60 ± 0.5 minute test period.
- 4.3.3.7. At the end of the 60 ± 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 paragraph 5. 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 paragraph 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 A3/3:

$$m_{\text{HC}} = k \cdot V \cdot 10^{-4} \cdot \left(\frac{C_{\text{HC}_f} \cdot p_f}{T_f} - \frac{C_{\text{HC}_i} \cdot p_i}{T_i} \right)$$

where:

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

C_{HC} = hydrocarbon concentration measured in the enclosure (ppm (volume) C_1 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 m³ shall be subtracted;

T = ambient chamber temperature, K;

p = barometric pressure in kPa;

H/C = hydrogen to carbon ratio;

$k = 1.2 (12 + \text{H/C})$;

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 A3/4:

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

where:

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

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

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

6. Test limit values

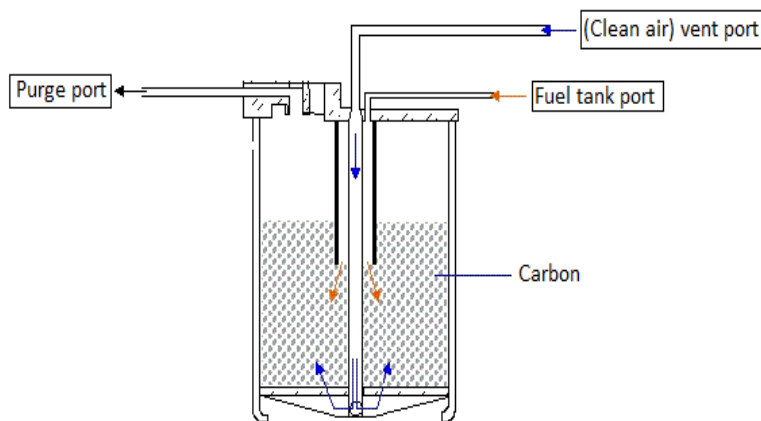
When tested according to this annex, overall evaporative total hydrocarbon mass emission for the vehicle (m_{total}) shall not exceed the limit values as specified in paragraph 7.4. of Section II.

Annex 4

Ageing test procedures 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 annex.
2. Carbon canister ageing
A carbon canister representative of the propulsion family as set out in Annex 6. shall be selected as test canister. Canister aging shall be conducted at the choice of manufacturer by the carbon canister aging procedure A or B.

Figure A4/1
Carbon canister gas flow diagram and ports



- 2.1. Canister ageing test procedure A
In the case of a multiple carbon canister system, each carbon canister shall undergo the procedure separately. The number of test cycles of carbon canister loading and discharging shall correspond to the number set out in Table A4/1.

Table A4/1
Vehicle classification and the required number of loading and discharging of the carbon canister for rapid ageing

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

The dwell time and subsequent purging of fuel vapour shall be run to age the test carbon 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 carbon 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 carbon canister shall be open and the purge port shall be capped. A mix by volume of 50 per cent air and 50 per cent commercially available petrol or reference fuel shall enter through the tank port of the test carbon canister at a flow rate of 40 grams/hour. The petrol vapour shall be generated at a petrol temperature of $40 \pm 2\text{ }^{\circ}\text{C}$.
 - 2.1.1.3. The test carbon canister shall be loaded each time to 2,000 mg or more breakthrough detected by:
 - 2.1.1.3.1. FID analyser reading (using a mini-SHED or similar) or 5,000 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 carbon canister charged to 2,000 mg or more breakthrough and the purged carbon 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 carbon 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 carbon canister shall be purged through the purge port and the tank port shall be capped.
 - 2.1.3.2. Four hundred carbon 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 per cent 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 $28.3 \pm 5.5\text{ l/min}$ at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ 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 $80\text{ }^{\circ}\text{C}$. At $80\text{ }^{\circ}\text{C}$ approximately one third of the petrol will evaporate. The evaporated petrol should be equivalent to 80 per cent (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 A4/1.

3.¹

4. Reporting

The manufacturer shall report the results of the tests referred to in paragraphs 2. and 3. of this Annex in the information document according to the template set out in Annex 7.

¹ An ageing test procedure of evaporative emission control valves, cables and linkages may be developed in the future

Annex 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 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 m³ 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 paragraph 2.3. If the propane mass does not tally to within ± 2 per cent 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_{HCl_i} , 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_{HCl_f} , 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 paragraph 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 paragraph 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 ± 2 per cent 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 paragraphs 2.3.2. and 2.3.4. and the formula in paragraph 2.4., calculate the mass of propane in the enclosure. This shall be within ± 2 per cent of the mass of propane measured in accordance with paragraph 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 paragraphs 2.3.6. and 2.3.2. The mass may not differ by more than 4 per cent from the hydrocarbon mass calculated in accordance with paragraph 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 A5/1:

$$m_{HC} = k \cdot V \cdot 10^{-4} \cdot \left(\frac{C_{HCf} \cdot p_f}{T_f} - \frac{C_{HCi} \cdot p_i}{T_i} \right)$$

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 paragraph 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 paragraphs 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 per cent of full scale deflection, for the operating range. The concentration shall be known to an accuracy of ± 2 per cent 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 per cent 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 per cent from the nominal value of each calibration gas.
- 4.4. Using the coefficients of the polynomial derived from paragraph 4.2., a table of indicated reading against true concentration shall be drawn up in steps of no greater than 1 per cent 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 6

Propulsion family definition with regard to test type IV requirements

1. A vehicle in the scope of this UN gtr 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.
2. For the test types IV a representative parent vehicle shall be selected within the boundaries set by the classification criteria laid down in paragraph 2.
3. The following propulsion family classification criteria with regard to test type IV requirements shall apply:

Table A6/1

Classification criteria propulsion family with regard to test type IV

| <i>No.</i> | <i>Classification criteria description</i> | <i>Test type IV</i> |
|------------|--|---------------------|
| 1. | Vehicle | |
| 1.1. | Category; Note: Two-wheeled motorcycles and two-wheeled motorcycles with sidecars are considered to be of the same family | X |
| 1.2. | Subcategory if applicable and per the classification followed by the Contracting Party; Note: may become applicable after S.R.1 includes subcategories | X |
| 2. | System | |
| | [Note:]Applicability of evaporative emission test class A, B or C, subject to provisions of paragraph 7.2.4.4. of Section II; | X |
| 2.1. | Propulsion (not) equipped with evaporative emission control system | X |
| 2.1.1. | Evaporative emission control system type; | X |
| 2.1.2. | Operation principle of evaporative emission control system (active / passive / mechanically or electronically controlled); | X |
| 2.1.3. | Identical basic principle of fuel/air metering (e.g. carburettor / single point injection / multi point injection / engine speed density through MAP/ mass airflow); | X |
| 2.1.4. | Identical material of the fuel tank; Note: material of all metallic fuel tanks are considered to be identical. | X |
| 2.1.5. | Liquid fuel hoses are identical and the surface area is lower; | X |

| | | |
|---------|--|---|
| 2.1.6. | The fuel storage capacity declared by the manufacturer is within a range of +10 / - 50 % of the nominal fuel tank volume If the approval authority determines that, with regard to the fuel storage capacity, the parent vehicle does not fully represent the family, an alternative or additional vehicle may be selected. | X |
| 2.1.7. | The fuel storage relief valve pressure setting is identical or higher; | X |
| 2.1.8. | Identical method of storage of the fuel vapour (i.e. trap form, storage medium, air cleaner (if used for evaporative emission control) etc.); | X |
| 2.1.9. | Identical or higher volume of the carbon canister ¹ ; | X |
| 2.1.10. | Identical method of purging of the stored vapour (e.g. air flow, purge volume over the driving cycle); | X |
| 2.1.11. | Identical method of sealing and venting of the fuel metering system; | X |

¹ Or the canister with HC absorbent material or other equivalent.

- 3.1. In the case of evaporative emission class[es B and]C, the details are given in Table A6/1.
- ~~3.2. In the case of evaporative emission class B, the details given at serial no. 2.1, 2.1.4, 2.1.5 and 2.1.6 of Table A6/1.]~~
- 3.2. In the case of evaporative emission class A, the details are given at Nos. 2.1., 2.1.4. and 2.1.6. in Table A6/1.

Annex 7

Administrative provisions test type IV

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 understandable system and the marking shall be written / typed for all sheets in the space provided.
2. The following data shall be provided by the vehicle manufacturer:
 - 2.1. General information:
 - 2.2. Detailed information with regard to the type IV test:
 - 2.2.1. Date (day/month/year):
 - 2.2.2. Place of the test:
 - 2.2.3. Name of recorder:
 - 2.2.4. Atmospheric pressure (kPa):
 - 2.2.5. Atmospheric temperature (°C):
 - 2.2.6. Evaporative emissions control system: yes / no
 - 2.2.7. Detailed description of the evaporative emission control devices and their state of tune:
 - 2.2.8. Schematic drawing of the fuel storage tank with indication of capacity and material:
 - 2.2.9. Drawing of the heat shield between tank and exhaust system:
 - 2.2.10. Drawing of the evaporative control system:
 - 2.2.11. Drawing of the carbon canister:
 - 2.2.12. Series numbers evaporative emission control components:
 - 2.2.13. Part numbers evaporative emission control components:
 - 2.2.14. Marking number:
 - 2.2.15. Carbon canister type:
 - 2.2.16. Carbon canister size (bed volume in dm³):
 - 2.2.17. Mass of dry charcoal (g):
 - 2.2.18. Evaporative emission purge valve type:
 - 2.2.19. Details test vehicle(s) if different from vehicle used for type I testing (include copy of type I required documentation:

- 2.2.20. Type IV, Fuel storage permeability test (yes / no)
- 2.2.20.1. Result fuel storage permeability test (mg/24h/test):
- 2.2.21. Type IV, Fuel storage and supply system permeation test (yes / no)
- 2.2.21.1. Result fuel storage tank (mg / m²/ day):
- 2.2.21.2. Result fuel tubing (mg / m²/ day):
- 2.2.22. Type IV, SHED test (yes / no)
- 2.2.22.1. Result SHED test (mg/test):

Annex 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 vehicles in the scope of this UN gtr.

| A8/1 Type: Petrol E0 (nominal 90 RON) | | | | |
|--|-------------------|--------------------|----------------|--|
| <i>Fuel Property or Substance Name</i> | <i>Unit</i> | <i>Standard</i> | | <i>Test method</i> |
| | | <i>Minimum</i> | <i>Maximum</i> | |
| Research octane number, RON | | 90 | 92 | JIS K2280 |
| Motor octane number, MON | | 80 | 82 | JIS K2280 |
| Density | g/cm ³ | 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 |

| A8/2. Type: Petrol E0 (nominal 100 RON) | | | | |
|--|-------------------|--------------------|----------------|--|
| <i>Fuel Property or Substance Name</i> | <i>Unit</i> | <i>Standard</i> | | <i>Test method</i> |
| | | <i>Minimum</i> | <i>Maximum</i> | |
| Research octane number, RON | | 99 | 101 | JIS K2280 |
| Motor octane number, MON | | 86 | 88 | JIS K2280 |
| Density | g/cm ³ | 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 |

| A8/3. Type: Petrol E5 (nominal 95 Octane) | | | | |
|--|-------------------|---------------------------|----------------|-----------------------------|
| <i>Parameter</i> | <i>Unit</i> | <i>Limits¹</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 ³ | 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 ² | minutes | 480 | - | EN ISO 7536 |
| Oxygen content ⁴ | % m/m | Report | | EN 1601 |
| Existent gum | mg/ml | - | 0.04 | EN ISO 6246 |
| Sulphur content ³ | 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 ⁵ | % v/v | 4.7 | 5.3 | EN 1601 / EN 13132 |

¹ 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.

² 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.

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

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

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

| A8/4. Type: Petrol E10 (nominal 90 RON) | | | | |
|--|-------------------|--------------------|----------------|--|
| <i>Fuel Property or Substance Name</i> | <i>Unit</i> | <i>Standard</i> | | <i>Test method</i> |
| | | <i>Minimum</i> | <i>Maximum</i> | |
| Research octane number, RON | | 89 | | JIS K2280 |
| Density | g/cm ³ | | 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 |

| A8/5. Type: Petrol E10 (nominal 95 RON) | | | | |
|--|-------------------|---|----------------|------------------------------|
| <i>Parameter</i> | <i>Unit</i> | <i>Limit</i> ¹ | | <i>Test method</i> |
| | | <i>Minimum</i> | <i>Maximum</i> | |
| Research octane number, RON ² | | 95.0 | 98.0 | EN ISO 5164 |
| Motor octane number, MON ² | | 85.0 | 89.0 | EN ISO 5163 |
| Density at 15 °C | kg/m ³ | 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 ³ | minutes | 480 | — | EN ISO 7536 |
| Oxygen content ⁴ | % m/m | 3.3 | 3.7 | EN 22854 |
| Solvent washed gum (Existent gum content) | mg/100ml | — | 4 | EN ISO 6246 |
| Sulphur content ⁵ | 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 ⁶ | mg/l | — | 1.3 | ASTM D 3231 |
| Ethanol ⁴ | % v/v | 9.0 | 10.0 | EN 22854 |

¹ 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; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility).

² 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.

³ 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.

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 Ethanol is the only oxygenate that shall be intentionally added to the reference fuel. The Ethanol used shall conform to EN 15376.

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

⁷ There shall be no intentional addition of compounds containing phosphorus, iron, manganese, or lead to this reference fuel.

| A8/6. Type: Petrol E10 (nominal 100 RON) | | | | |
|---|-------------------|--------------------|----------------|--|
| <i>Fuel Property or Substance Name</i> | <i>Unit</i> | <i>Standard</i> | | <i>Test method</i> |
| | | <i>Minimum</i> | <i>Maximum</i> | |
| Research octane number, RON | | 96 | | JIS K2280 |
| Density | g/cm ³ | | 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 |