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Motorcycles — Measurement method for evaporative emissions —

Part 1:
SHED test procedure

Motocycles — Méthode de mesure pour les émissions par évaporation —

Partie 1: Procédure d'essai SHED

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 38, *Motorcycles and mopeds*.

A list of all parts in the ISO 21755 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Recently, exhaust emissions from tailpipes of motorcycles have been dramatically reduced. Accordingly, evaporative emissions have begun to attract attention. Therefore, measurement methods for evaporative emissions are specified as an international standard for multi-application, e.g. certification, research, developments. This document specifies the basic measurement method by using the SHED (Sealed Housing for Evaporative Determination) test procedure for evaporative emissions from motorcycles.

Motorcycles — Measurement method for evaporative emissions —

Part 1:
SHED test procedure

1 Scope

This document specifies a basic measurement method by using the SHED (Sealed Housing for Evaporative Determination) test procedure for evaporative emissions from motorcycles. It is applicable to motorcycles equipped with a spark ignition engine (four-stroke engine, two-stroke engine or rotary piston engine).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6460-1, *Motorcycles — Measurement method for gaseous exhaust emissions and fuel consumption — Part 1: General test requirements*

ISO 6460-2, *Motorcycles — Measurement method for gaseous emissions and fuel consumption — Part 2: Test cycles and specific test conditions*

ISO 9277:2010, *Determination of the specific surface area of solids by gas adsorption — BET method*

ISO 11486, *Motorcycles — Methods for setting running resistance on a chassis dynamometer*

ISO 7117, *Motorcycles — Measurement method for determining maximum speed*

ISO 4106, *Motorcycles — Engine test code — Net power*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
evaporative emissions
hydrocarbon vapours lost from the fuel storage and supply system of a motorcycle and not those from tailpipe emissions

3.2
SHED test
motorcycle test in a constant temperature sealed house for evaporation determination, in which a special evaporative emission test is conducted

3.3

tank diurnal breathing loss

hydrocarbon emissions caused by temperature changes in the fuel storage

3.4

hot soak loss

hydrocarbon emissions arising from the fuel system of a stationary motorcycle after a period of driving

3.5

non-exposed type fuel tank

fuel tank and fuel delivery system, except the fuel tank cap, which are not directly exposed to radiation of sunlight

3.6

rated capacity

fuel capacity of the fuel tank as declared by the manufacturer

4 Evaporative emissions, SHED test

4.1 Description of SHED test

The evaporative emission SHED (Sealed Housing for Evaporative Determination) test consists of a conditioning phase and a test phase (see Figure 1):

a) conditioning phase:

    1) test cycle;

    2) motorcycle soak;

b) test phase:

    1) tank diurnal breathing loss test;

    2) test cycle;

    3) hot soak loss test.

Running loss test may be conducted during the test cycle and if it is conducted, the test procedure shall be in accordance with Annex A.

Mass emissions of hydrocarbons from the tank diurnal breathing loss and the hot soak loss phases are added together to provide an overall result for the test. If running loss test is conducted in the test cycle, mass emissions of hydrocarbons from the diurnal breathing loss, the running loss and the hot soak loss phases are summed to provide an overall result for the test.

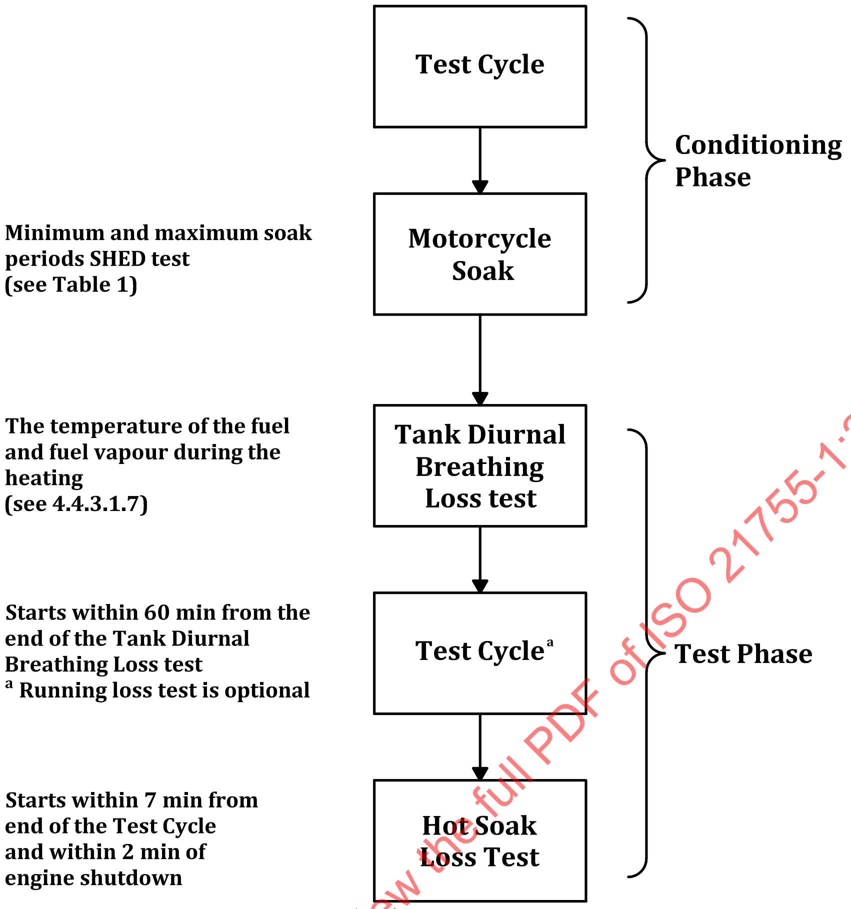


Figure 1 — Flow chart of evaporative emission SHED test

4.2 Test motorcycles and test fuel

4.2.1 Test motorcycles

The test motorcycle shall be run in at least 1 000 km after first start on the production line.

4.2.2 Test fuel

The test fuel shall be selected in accordance with agreement among the parties involved or the manufacturer's requirements, and the specifications of test fuel shall be reported. The record form is given in Annex C.

NOTE This test is influenced by the vapour pressure of the fuel property greatly, therefore the test vapour pressure is decided among the parties because the market fuel vapour pressure largely varies according to the season depending on the area.

4.3 Test equipment

4.3.1 Chassis dynamometer

The dynamometer shall have a single roll with a diameter of at least 0,400 m.

The dynamometer shall be equipped with a roll revolution counter for measuring actual distance travelled.

The methods for setting running resistance on a chassis dynamometer shall be in accordance with ISO 11486.

4.3.2 Evaporative emission measurement enclosure (SHED)

The evaporative emission measurement enclosure shall be a gas-tight rectangular measuring chamber able to contain the motorcycle under test. The motorcycle 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 and non-reactive to hydrocarbons. At least one of the surfaces shall incorporate with a flexible impermeable material or other devices 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, and if artificial cooling is used, interior surface temperatures shall not be less than 293 K.

4.3.3 Analytical systems

4.3.3.1 Hydrocarbon analyser

4.3.3.1.1 The atmosphere within the enclosure shall be 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 enclosure and any bypass flow shall be returned to the enclosure, preferably to a point immediately downstream of the mixing fan.

4.3.3.1.2 The hydrocarbon analyser shall have a response time to 90 % of final reading of less than 1,5 seconds. Its stability shall be better than 2 % of full scale at zero and at 80 % ± 20 % of full scale over a 15 minute period for all operational ranges.

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

4.3.3.1.4 The operational ranges of the analyser shall be chosen to give best resolution over the measurement, calibration and leak checking procedures. The leak checking procedure shall be accordance with analyser manufacture.

4.3.3.2 Hydrocarbon analyser data recording system.

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.

4.3.4 Fuel tank heating

4.3.4.1 The fuel tank heating system shall consist of two separate heat sources with two temperature controllers. Typically, the heat sources will be electric heating strips, but other sources may be used at the request of the manufacturer. Temperature controllers may be manual, such as variable transformers, or automated. Since vapour and fuel temperature are to be controlled separately, an automatic controller is recommended for the fuel. The heating system shall not cause hot-spots on the wetted surface of the tank which would cause local overheating of the fuel. Heating strips for the fuel should be located as low as practicable on the fuel tank and shall cover at least 10 % of the wetted surface. The centre-line of the heating strips shall be below 30 % 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 described in 4.4.3.1.7.

4.3.4.2 With temperature sensors positioned as in 4.3.5.2, 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 4.4.3.1.7. The heating system shall be capable of controlling the fuel and vapour temperatures to ±1,7 K of the required temperature during the tank heating process.

4.3.4.3 Notwithstanding the requirements of 4.3.4.2, 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, and the-alternative heat slope shall be reported.

4.3.5 Temperature recording

4.3.5.1 The temperature in the enclosure 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 m ± 0,2 m.

4.3.5.2 The temperatures of the fuel and fuel vapour shall be recorded by means of sensors positioned in the fuel tank as described in 4.4.2. When sensors cannot be positioned as specified in 4.4.2, e.g. where a fuel tank with two ostensibly separate enclosures is used, sensors shall be located at the approximate mid-volume of each fuel or vapour containing enclosure. In this case, the average of these temperature readings shall constitute the fuel and vapour temperatures.

4.3.5.3 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.

4.3.5.4 The accuracy of the temperature recording system shall be within ±1,7 K and capable of resolving to 0,4 K.

4.3.5.5 The recording or data processing system shall be capable of resolving time to ±15 s.

4.3.6 Fans

4.3.6.1 It shall be possible to reduce the hydrocarbon concentration in the enclosure to the ambient hydrocarbon level by using one or more fans or blowers with the SHED door(s) open.

4.3.6.2 The enclosure shall have one or more fans or blowers of likely capacity 0,1 to 0,5 m^3/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 enclosure during measurements. The motorcycle in the enclosure shall not be subjected to a direct stream of air from the fans or blowers.

4.3.7 Gases

4.3.7.1 The following pure gases shall be available for calibration and operation:

a) purified synthetic air (purity: <1 ppm C_1 equivalent, ≤1 ppm CO, ≤400 ppm CO_2, ≤0,1 ppm NO); oxygen content between 18 % and 21 % by volume;

b) hydrocarbon analyser fuel gas (40 % ± 2 % hydrogen, and balance helium with less than 1 ppm C_1 equivalent hydrocarbon, less than 400 ppm CO_2);

c) propane (C_3H_8): 99,5 % minimum purity.

4.3.7.2 Calibration and span gases shall be available containing mixtures of propane (C_3H_8) and purified synthetic air. The true concentrations of a calibration gas shall be within ±2 % of the stated figures. The accuracy of the diluted gases obtained when using a gas divider shall be to within ±2 % of the true value. The concentrations specified in 4.3.7.1 may also be obtained by the use of a gas divider using synthetic air as the diluting gas.

4.3.8 Additional equipment

The barometric pressure in the test area shall be measurable within ±0,1 kPa.

4.4 Test procedure

4.4.1 Test preparation

The motorcycle is mechanically prepared before the test as follows:

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

b) the motorcycle may be steam cleaned before the test;

c) the fuel tank of the motorcycle shall be equipped with temperature sensors so that the temperature of the fuel and fuel vapour in the fuel tank can be measured when the fuel tank is filled to 50 % ± 2 % of its rated capacity;

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; and

e) the evaporative emission control devices shall be run-in in accordance with running-in test procedures described in Annex B.

4.4.2 Conditioning phase

4.4.2.1 The vehicle shall be taken into the test area where the ambient temperature is between 293,2 K and 303,2 K.

4.4.2.2 The motorcycle is placed on a chassis dynamometer and driven through the selected test cycle specified in ISO 6460-2, in both conditioning phase and test phase.

4.4.2.3 The motorcycle shall be parked in the test area for periods stated in Table 1.

Table 1 — Minimum and maximum soak periods SHED test

Engine capacity	**Minimum** (hours)	**Maximum** (hours)
<170 cm^3	6	36
170 cm^3 ≤ engine capacity <280 cm^3	8	36
≥280 cm^3	12	36

4.4.3 Test phases

4.4.3.1 Tank diurnal breathing evaporative emission test

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

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

4.4.3.1.3 The fuel tank(s) shall be emptied as described in 4.4.1 and refilled with test fuel at a temperature of between 283,2 K and 287,2 K to 50 % ± 2 % of its normal volumetric capacity.

4.4.3.1.4 The test motorcycle 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.

4.4.3.1.5 The fuel and vapour may be artificially heated to the starting temperatures of 288,7 K and 294,2 K ± 1 K respectively.

4.4.3.1.6 As soon as the fuel temperature reaches 287,2 K:

a) Install the fuel filler cap(s);

b) Turn off the purge blowers, if not already off at that time; and

c) Close and seal enclosure doors.

4.4.3.1.7 As soon as the fuel reaches a temperature of 288,7 K ± 1 K the test procedure shall continue as follows:

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

b) a linear heat build of 13,3 K or 20 K ± 0,5 K over a period of 60 min ± 2 min shall begin.

The temperature of the fuel and fuel vapour during the heating shall conform to the result of Formulae (1), (2) and (3), (4) within ±1,7 K, or the closest possible function as described in 4.3.4.3:

for exposed type fuel tanks:

$$T_{\mathrm{F}} = 0{,}333\,3\,t + 288{,}5 \tag{1}$$

$$T_{\mathrm{V}} = 0{,}333\,3\,t + 294{,}0 \tag{2}$$

for non-exposed type fuel tanks:

$$T_{\mathrm{F}} = 0{,}222\,2\,t + 288{,}5 \tag{3}$$

$$T_{\mathrm{V}} = 0{,}222\,2\,t + 294{,}0 \tag{4}$$

where

T_{F} is required temperature of fuel, K;

T_{V} is required temperature of vapour, K;

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

An initial vapour temperature up to 5 K above 294 K is permissible. In this circumstance vapour shall not be heated at the start of the diurnal test. When the fuel temperature has been raised to 5,5 K below the vapour temperature by following the T_f function, the remainder of the vapour heating profile shall be followed.

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

4.4.3.1.9 If the heating requirements in 4.4.3.1.7 have been met over the 60 min ± 2 min period of the test, the final hydrocarbon concentration in the enclosure is measured ($C_{\mathrm{HC}f}$). The time of start and time of end or elapsed time of this measurement is recorded, together with the final temperature and barometric pressure T_f and p_f.

4.4.3.1.10 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 motorcycle is now removed from the enclosure with the engine switched off.

4.4.3.1.11 To prevent abnormal loading of the canister, fuel tank caps may be removed from the motorcycle during the period between the end of the diurnal test phase and the start of the test cycle. The test cycle shall begin within 60 min of the completion of the tank diurnal breathing loss test.

4.4.3.2 Test cycle

Following the tank diurnal breathing losses test, the motorcycle is pushed or otherwise manoeuvred onto the chassis dynamometer with the engine switched off. It is then driven through the test cycle specified in 4.4.2.2.

4.4.3.3 Hot soak loss test

The determination for evaporative emissions is concluded with the measurement of hydrocarbon emissions over a 60-minute hot soak period. The hot soak loss test shall begin within 7 min of the completion of the test cycle specified in 4.4.3.2 and within two minutes of engine shutdown.

4.4.3.3.1 Before the completion of the test run the measuring enclosure 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.

4.4.3.3.2 The hydrocarbon analyser shall be set to zero and spanned immediately prior to the test.

4.4.3.3.3 The motorcycle shall be pushed or otherwise moved into the measuring enclosure with the engine switched off.

4.4.3.3.4 The enclosure doors are closed and sealed gas-tight within 7 min of the end of the test cycle.

4.4.3.3.5 The 60 min ± 0,5 min hot soak period begins when the enclosure is sealed. The hydrocarbon concentration, temperature and barometric pressure are measured to give the initial readings $C_{\mathrm{HC}i}$. P_i and T_i for the hot soak loss test. These figures are used in the evaporative emission calculation, shown in Clause 5.

4.4.3.3.6 The hydrocarbon analyser shall be set to zero and spanned immediately before the end of the 60 min ± 0,5 min test period.

4.4.3.3.7 At the end of the 60 min ± 0,5 min test period measure the hydrocarbon concentration in the enclosure. The temperature and the barometric pressure shall be also measured. These are the final readings $C_{\mathrm{HC}f}$, P_f and T_f for the hot soak loss test used for the calculation in Clause 5.

4.5 Calculation of results

4.5.1 The evaporative emission tests described in Clause 5 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 mass of hydrocarbon emitted over the test phase (M_{HC}) shall be calculated in accordance with Formula (5):

$$M_{\mathrm{HC}} = k \cdot V \cdot 10^{-4} \cdot \left(\frac{C_{\mathrm{HC}f} \cdot p_f}{T_f} - \frac{C_{\mathrm{HC}i} \cdot p_i}{T_i} \right) \tag{5}$$

where

$C_{\mathrm{HC}f}$ is measured hydrocarbon concentration in the enclosure of the final reading (ppm C_1 equivalent by volume);

$C_{\mathrm{HC}i}$ is measured hydrocarbon concentration in the enclosure of the initial reading (ppm C_1 equivalent by volume);

V is net enclosure volume in cubic metres corrected for the volume of the vehicle. If the volume of the vehicle is not determined a volume of 0,14 m^3 shall be subtracted;

T_f is ambient enclosure temperature of the final reading, K;

T_i is ambient enclosure temperature of the initial reading, K;

p_f is barometric pressure of the final reading, kPa;

p_i is barometric pressure of the initial reading, kPa;

$k = 1{,}2\,(12 + \mathrm{H/C})$

where

H/C is hydrogen to carbon ratio;

H/C is taken to be 2,33 for tank diurnal breathing loss;

H/C is taken to be 2,20 for hot soak loss.

4.5.2 Overall results of test

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

a) in case where the tank diurnal breathing loss test and the hot soak loss test are conducted;

$$M_{\mathrm{total}} = M_{\mathrm{TB}} + M_{\mathrm{HS}} \tag{6}$$

b) in case where the tank diurnal breathing loss test, the hot soak loss test and the running loss test are conducted;

$$M_{\mathrm{total}} = M_{\mathrm{TB}} + M_{\mathrm{HS}} + M_{\mathrm{RL}} \tag{7}$$

where

M_{total} is overall evaporative mass emissions of the motorcycle, g;

M_{TB} is evaporative hydrocarbon mass emission for the tank diurnal breathing loss, g;

M_{HS} is evaporative hydrocarbon mass emission for the hot soak loss, g;

M_{RL} is evaporative hydrocarbon mass emission for the running loss, g.

5 Calibration of equipment for evaporative emission testing

5.1 Calibration frequency and methods

All equipment shall be calibrated before its initial use and then calibrated as often as necessary and in any case within one month before the testing.

5.2 Calibration of the enclosure

5.2.1 Initial determination of enclosure internal volume

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

5.2.1.2 The enclosure shall be checked as in item 5.2.3. If the propane mass does not agree with the injected mass to within ±2 % then corrective action is required.

5.2.2 Determination of enclosure background emissions

This operation determines that the enclosure does not contain any materials that emit significant amounts of hydrocarbons. The check shall be carried out at the enclosure's introduction to service, after any operations in the enclosure which may affect background emissions and at a frequency of at least once per year.

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

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

5.2.2.3 Seal the enclosure and measure the background hydrocarbon concentration, temperature and barometric pressure. These are the initial readings $C_{\mathrm{HC}i}$, P_i and T_i used in the enclosure background calculation.

5.2.2.4 The enclosure is allowed to stand undisturbed with the mixing fan on for a period of four hours.

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

5.2.2.6 At the end of this time use the same analyser to measure the hydrocarbon concentration in the enclosure. The temperature and the barometric pressure are also measured. These are the final readings $C_{\mathrm{HC}f}$, P_f and T_f.

5.2.2.7 Calculate the change in mass of hydrocarbons in the enclosure over the time of the test according to paragraph 5.2.4. The background emission of the enclosure shall not exceed 0,4 g.

5.2.3 Calibration and hydrocarbon retention test of the enclosure

The calibration and hydrocarbon retention test in the enclosure provides a check on the calculated volume in 5.2.1 and also measures any leak rate.

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

5.2.3.2 Seal the enclosure and measure the background concentration, temperature and barometric pressure. These are the initial readings $C_{\mathrm{HC}i}$, P_i and T_i used in the enclosure calibration.

5.2.3.3 Inject a quantity of approximately 4 g of propane into the enclosure. The mass of propane shall be measured to an accuracy of ±2 % of the measured value.

5.2.3.4 Allow the contents of the enclosure 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 $C_{\mathrm{HC}f}$, P_f and T_f for the calibration of the enclosure.

5.2.3.5 Using the readings taken in 5.2.3.3 and 5.2.3.5 and the formula in 5.2.4 calculate the mass of propane in the enclosure. This shall be within ±2 % of the mass of propane measured in 5.2.3.4.

5.2.3.6 Allow the contents of the enclosure to mix for a minimum of four hours. At the end of this period, 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.

5.2.3.7 Calculate using the formula in 5.2.4, the hydrocarbon mass from the readings taken in 5.2.3.7 and 5.2.3.3. The mass shall be within ±4 % from the hydrocarbon mass given in 5.2.3.6.

5.2.4 Calculations

The calculation of net hydrocarbon mass change within the enclosure is used to determine the enclosure's hydrocarbon background and leak rate. Initial and final readings of hydrocarbon concentration, temperature and barometric pressure are used in Formula (7) to calculate the mass change.

$$M_{\mathrm{HC}} = k \cdot V \cdot 10^{-4} \cdot \left(\frac{C_{\mathrm{HC}f} \cdot p_f}{T_f} - \frac{C_{\mathrm{HC}i} \cdot p_i}{T_i} \right) \tag{8}$$

where k = 17,6.

5.3 Checking of hydrocarbon analyser

5.3.1 Detector response optimization

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

5.3.2 Calibration of the hydrocarbon analyser

The hydrocarbon analyser should be calibrated using propane in air and purified synthetic air. A calibration curve shall be established as described in 5.4.1 to 5.4.5.

5.3.3 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 at a level to give a response of approximately 80 % of full-scale deflection, for the operating range. The concentration shall be known, to an accuracy of ±2 %

in reference to a gravimetric standard expressed in volume. In addition, the gas cylinder shall be preconditioned for 24 hours at a temperature between 293,2 K and 303,2 K (20 °C and 30 °C).

Response factors should be determined when introducing an analyser into service and thereafter at major service intervals. The reference gas to be used is propane with balance 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 $0{,}95 \leq R_f \leq 1{,}05$.

5.4 Calibration of the hydrocarbon analyser

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

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

5.4.2 Calculate the calibration curve by the method of least squares. If the resulting polynomial degree is >3, then the number of calibration points shall be at least the number of the polynomial degree +2.

5.4.3 The calibration curve shall not differ by more than 2 % from the nominal value of each calibration gas.

5.4.4 Using the coefficients of the polynomial derived from 5.4.3, a table of indicated reading against true concentration shall be drawn up in steps of no greater than 1 % of full scale. This shall be carried out for each analyser range calibrated. The table shall also contain other relevant data:

a) date of calibration;

b) span and zero potentiometer readings (where applicable), nominal scale;

c) reference data of each calibration gas used; and

d) the actual and indicated value of each calibration gas used together with the percentage differences.

5.4.5 If it can be shown to the satisfaction of the approval authority that alternative technology (e.g. computer, electronically controlled range switch) can give equivalent accuracy, then those alternatives may be used.

6 Presentation of results

6.1 The evaporative emission

Total of evaporative hydrocarbon mass emissions during the SHED test shall be rounded to one decimal place.

6.2 Test report

The presentation of test results shall be as given in Annex C.

Annex A
(informative)

Running loss test procedure

A.1 General

If an engineering analysis, or motorcycle inspection indicates the possibility of evaporative emissions during motorcycle operation, evaporative emission running loss measurements shall be made during the cold transient and stabilized portion of the exhaust emission test. Since running loss measurements cannot be made in the enclosure, the equipment described in this annex (Sampling and system) shall be used to collect these emissions.

(1) The procedure in ISO 6460-1 (Dynamometer procedure) shall be followed.

(2) Within one minute after the end of the test cycle during the test phase the vapour loss measurement system shall be disconnected from the motorcycle and the inlets and outlets sealed.

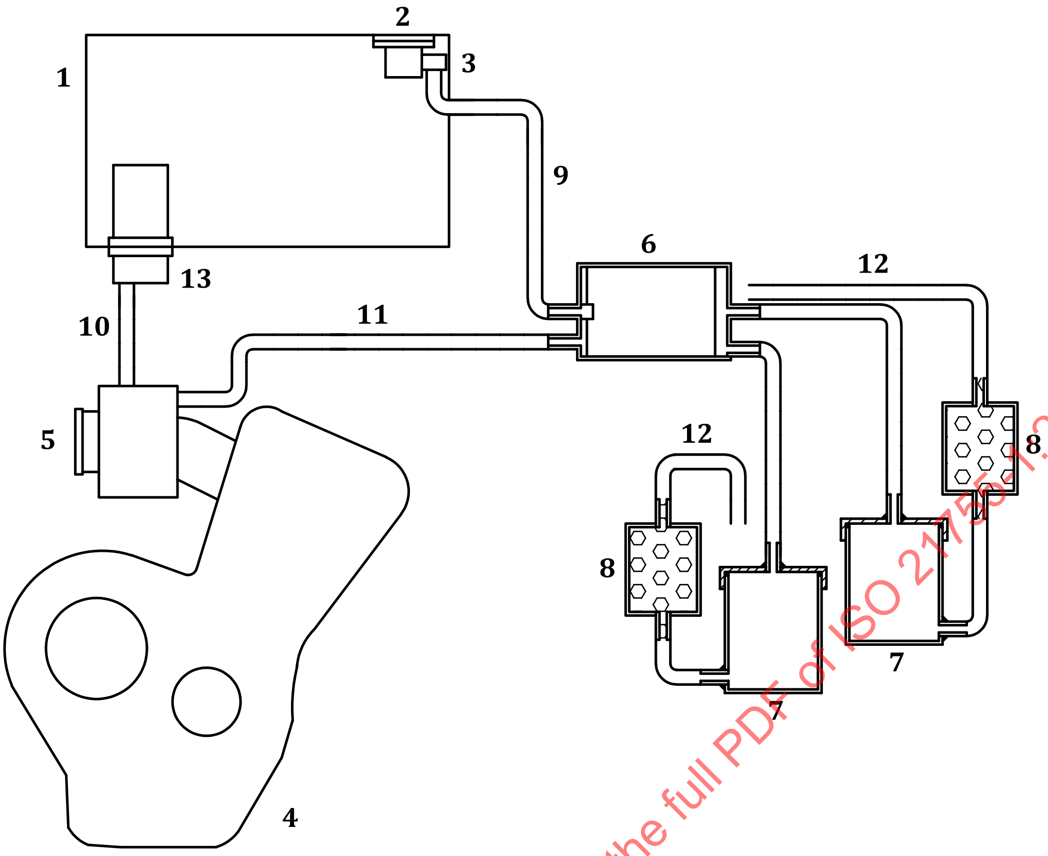
(3) Within one hour from the end of the running loss measurement, weight the vapour collection traps.

A.2 Sampling and system

A.2.1 Schematic drawing

(1) Figures A.1 and A.2 are examples of flow diagrams of evaporative loss collection applications.

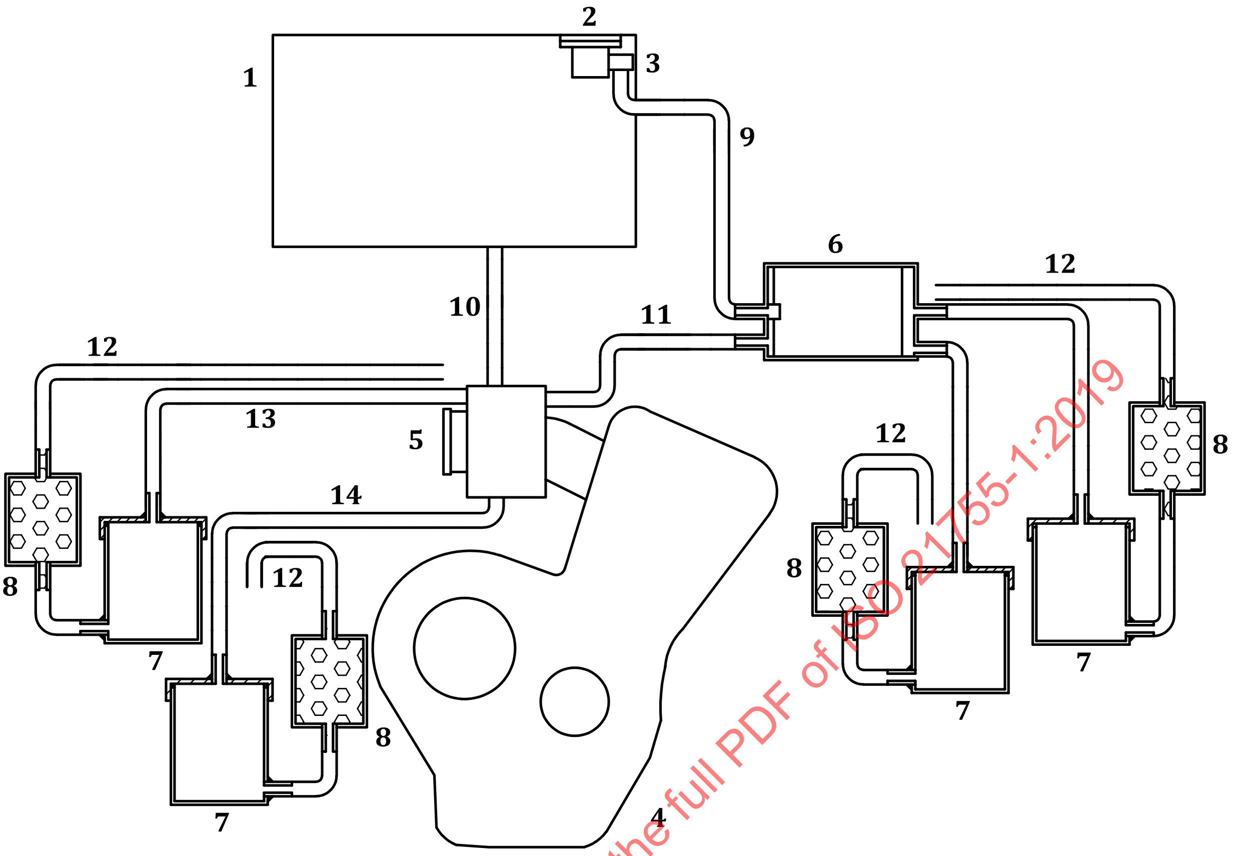
(2) Figure A.1 shows an example of an arrangement for collecting losses which emanate from fuel injection systems. Figure A.2 shows an example of an arrangement for collecting losses which emanate from carburettors.



Key

1	fuel tank
2	fuel cap
3	fuel vapour separator
4	engine
5	throttle body
6	canister
7	loss measurement trap
8	desiccator
9	breather pipe
10	fuel feed line
11	purge port line
12	vent tubing
13	fuel pump

Figure A.1 — Example of FI evaporative running loss collection arrangement (schematic)



Key

1	fuel tank	8	desiccator
2	fuel cap	9	breather pipe
3	fuel vapour separator	10	fuel feed line
4	engine	11	purge port line
5	carburettor	12	vent tubing
6	canister	13	air vent
7	loss measurement trap	14	over flow pipe

Figure A.2 — Example of carburettor evaporative running loss collection arrangement (schematic)

(3) Schematic drawings of arrangements to be employed shall be described in C.7.

A.2.2 Collection equipment

The following equipment shall be connected with all of the ports which might emit fuel evaporative emissions. (Item quantities are determined by individual test needs.)

(1) Activated carbon trap.

a) Canister 300 ml ± 25 ml, cylindrical container having a length to diameter ratio of 1,4 ± 0,1. An inlet tube, 8 mm in diameter and 25 mm long is sealed into the top of the canister, at its geometric centre. A similar outlet tube is sealed into the wall 6 mm from the bottom of the canister. The canister is designed to withstand an air pressure of 13,8 kPa above ambient air pressure, when sealed, without evidence of leaking when immersed in water for 30 s.

b) Activated carbon-meeting the following specifications:

— Surface area, min. (N2, BET method by referring to ISO 9277:2010) 1,000 m^2/g.

- Adsorption capacity, min. (carbon tetrachloride), 60 %, by weight.
- Volatile material including adsorbed water vapour, None.

All particles of activated carbon shall be within the range from 1,4 mm to 3,0 mm in diameter. More than 90 % of the activated carbon shall be within the range from 1,7 mm to 2,4 mm in diameter.

Screen analysis size	Percent
Less than 1,4 mm	0
1,7 to 2,4 mm	90-100
More than 3 mm	0

The activated carbon trap is prepared for the test by attaching clamped sections of vinyl tubing to the inlet and outlet tubes of the canister. The canister is then filled with 150 g ± 10 g hot activated carbon which had previously been oven-dried for 3 hours at 422,0 K.

Loss of carbon through the inlet and outlet tubes is prevented through the use of wire screens of 0,7 mm. mesh or wads of loosely packed glass wool. The canister is closed immediately after filling and the carbon is allowed to cool while the trap is vented through a drying tube via the unclamped outlet arm.

c) The trap is sealed and weighed after cooling and the weight, to the nearest 0,1 g, is inscribed on the canister body. Within 12 hours of the scheduled test, the weight of the trap is checked and if it has changed by more than 0,5 g., it is re-dried to constant weight. This re-drying operation is performed by passing dry nitrogen, heated to 408,2 K, through the trap, via the inlet tube, at a rate of 1 000 cm^3 per minute until checks made at 30 min intervals do not vary by more than 0,1 % of the gross weight. The trap and its contents are allowed to cool to room temperature, while vented through a drying tube via the outlet arm, before use.

(2) Auxiliary collection equipment.

a) Drying tube-transparent, tubular body 19 mm in diameter, 152 mm long, with serrated tips and removable caps.

b) Desiccant-indicating variety, 8 mesh. The drying tube is attached to the outlet tube of the collection traps to prevent ambient moisture from entering the trap. It is prepared by filling the empty drying tube with fresh desiccant using a loose wad of glass wool to hold the desiccant in place. The desiccant is renewed when three-quarters spent, as indicated by colour change.

c) Collection tubing-stainless steel, aluminium, or other suitable material, 8 mm in diameter, for connecting the collection traps to the fuel system vents.

d) Polyvinyl chloride (vinyl) tubing-flexible tubing, 8 mm in diameter, for sealing butt-to-butt joints.

e) Laboratory tubing-air tight flexible tubing, 8 mm in diameter, attached to the outlet end of the drying tubes to equalize collection system pressure.

A.2.3 Weighing equipment

The balance and weights used shall be capable of determining the net weight of the activated carbon trap within an accuracy of ±75 mg.

A.2.4 Assembly and use of the activated carbon vapour collection system

(1) The prepared activated carbon trap, dried to constant weight, cooled to the ambient temperature, and sealed with clamped sections of vinyl tubing is carefully weighed to the nearest 20 mg and the weight recorded as the "tare weight."

(2) A drying tube is attached to the outlet tube and the clamp released but not removed. A length of flexible tubing, for pressure equalization, is connected to the other end of the drying tube.

(3) The Inlet of the adsorption trap and external vent(s) of the fuel system will be connected by minimal lengths of stainless steel or aluminium tubing and short sections of vinyl tubing. Butt-to-butt joints shall be made wherever possible and precautions taken against sharp bends in the connection lines, including any manifold systems employed to connect multiple vents to a single trap.

(4) The clamp on the inlet tube of the trap shall be released but not removed. Care shall be exercised to prevent heating the vapour collection trap by radiant or conductive heat from the engine.

(5) Upon completion of the collection sequence, the vinyl tubing sections on each arm of the collection trap shall be clamped tight and the collection system dismantled.

(6) The sealed vapour collection trap shall be weighed carefully to the nearest 20 mg. This constitutes the "gross weight," which is appropriately recorded. The difference between the "gross weight" and "tare weight" represents the "net weight" for purposes of calculating the fuel vapour losses.

Annex B
(normative)

Running-in test procedure for evaporative emission control devices

B.1 Test methods for running-in of evaporative emission control devices

The SHED test shall be conducted with run-in evaporative emission control devices fitted. The running tests for those devices shall be conducted according to the procedures in this Annex.

B.2 Carbon canister running-in

B.2.1 Canister running-in test procedure

B.2.1.1 General

In the case of a multiple canister system, each canister shall undergo the procedure separately. Dwell time and subsequent purging of fuel vapour shall be run-in at an ambient temperature of 297 K ± 2 K as follows:

B.2.1.2 Canister loading part of the test cycle

B.2.1.2.1 Loading of the canister shall start within one minute of completing the purge portion of the test cycle.

B.2.1.2.2 The (clean air) vent port of the canister shall be open and the purge port shall be capped. A mix by volume of 50 % air and 50 % commercially available petrol or test petrol specified in C.3 shall enter through the tank port of the test canister at a flow rate of 40 g/h. The petrol vapour shall be generated at a petrol temperature of 313 K ± 2 K.

B.2.1.2.3 The test canister shall be loaded each time to 2,0 g ± 0,1 g breakthrough detected by:

B.2.1.2.3.1 FID reading (using a mini-SHED or similar) or 5 000 ppm instantaneous reading on the FID occurring at the (clean air) vent port; or

B.2.1.2.3.2 Gravimetrical test method using the difference in mass of the test canister charged to 2,0 g ± 0,1 g breakthrough and the purged canister.

B.2.1.3 Dwell time

A five-minute dwell period between canister loading and purging as part of the test cycle shall be applied.

B.2.1.4 Canister purging part of the test cycle

B.2.1.4.1 The test canister shall be purged through the purge port and the tank port shall be capped.

B.2.1.4.2 Four hundred canister bed volumes shall be purged at a rate of 24 000 cm^3/min into the vent port.

B.2.1.5 Number of test cycles of charging and purging the test canister

The steps of the procedure from B.2.1.2 to B.2.1.4 shall be repeated nine times. The test may be terminated prior to that, after not less than three cycles, if the weight of the canister after the last cycles has stabilised.