Proposal for a new Mutual Resolution (M.R.X) on Vehicle Interior Air Quality

This document contains a proposal to develop a new Mutual Resolution (M.R.X) on Vehicle Interior Air Quality (VIAQ) and the outcome of the VIAQ Informal Working Group under GRPE. It is submitted to GRPE for consideration as a draft proposal for Mutual Resolution No. X (M.R.X)

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

 A. Introduction

1. A variety of materials are being used for the construction of the interiors of vehicles. The materials used in the manufacturing of the vehicle include plastics, adhesives, cleaning products, plasticizers, paint, sealers, lubrication compounds, and many others.

2. Various kinds of chemical substances may be emitted from the interior materials inside the vehicle cabin. Some of the chemical substances may contain components, such as Volatile Organic Compounds (VOCs) or Aldehydes, some of them are not harmful to the human body, but some of them are known to cause various health issues. The amount of chemical substances emitted from interior materials may be particularly high, especially during the early stages of vehicle life.

3. This Mutual Resolution supports the effort to insure levels of these chemical substances are measured under real exposure conditions.

4. Many countries throughout the world have already introduced standards concerning vehicle interior air quality. Several countries have established regulations or guidelines regarding emissions from interior materials. Although these test procedures are very similar, there are many differences in test conditions.

5. This Mutual Resolution outlines the provisions and harmonized test procedure for the measurement of interior emissions, taking into account existing standards. It will encourage the reduced use of synthetic materials, and chemicals that can be harmful to humans. It also encourages the increased use of emission-friendly materials, improving the air quality inside the passenger cabin.

7. Experts also have an interest in global harmonization since it offers more efficient development, adaptation to technical progress, and potential collaboration. It also facilitates the exchange of information between interested parties.

8. The regulatory stringency of legislation is expected to be different from region to region for the foreseeable future, due to the different levels of development, different regional cultures, and the costs associated with interior emission control technology,. Therefore the setting of interior emission limit values is not part of this recommendation.

 B. Procedural background

9. At its 164th session, the World Forum for Harmonization of Vehicle Regulations (WP.29) AC.3 endorsed the proposed action plan to, in a first stage, collect information, review existing standards and develop recommendations. AC.3 noted the several aspects linked to VIAQ including safety matters (ECE/TRANS/WP.29/1112, para. 133).

10. The VIAQ Informal working group, the responsibility of the Working Party on Pollution and Energy (GRPE), reported the new recommendation of vehicle interior air quality that focuses on the interior air emissions generated from interior materials, in a first stage.

11. The new mutual recommendation (M.R.X) is providing the provisions and harmonized test procedure for the measurement of interior air emissions, taking into account existing standards. There are three test modes.

 (a) Ambient mode:

Simulating cars parked in the garage overnight using ambient conditions

(b) Parking mode

Simulating cars parked outside in the sunlight.

(c) Driving mode

Simulating driving after the vehicle has been parked in the sun.

 C. Existing regulations and standards

13. The VIAQ IWG conducted comprehensive studies for the existing individual contents regarding management of the interior air quality of vehicles. The bases of this harmonized set of recommendations are national standards from Korea, China, and the International Organization for Standardization (ISO).

15. Examples of existing regulations and standards

1. Korea
2. Automobile Management Act Article 33\_3, 18 December 2012 "Indoor air quality management for newly produced vehicles"
3. Ministry of Land, Infrastructure and Transport Announcement No. 2007\_539, 5 June 2007 “Indoor air quality management guideline for newly produced vehicles”
4. China
5. HJ/T 400\_07 December 2007 "Determination of Volatile Organic

Compounds and Carbonyl Com-pounds in Cabins of Vehicles"

1. GB/T 27630-2011 01 March 2012 “Guideline for air quality assessment of

Passenger car”

1. ISO Standards
2. ISO 12219\_1:2012 "Interior air of road vehicles - Part 1: Whole vehicle test chamber –Specification and method for the determination of volatile organic compounds in cabin interiors.

 D. Technical rationale and justification,

16. This Mutual Resolution includes a comprehensive Technical Report (VIAQ-05-08). The technical report includes the technical rationale used to harmonize existing regulations and standards.

**II. Text of the Mutual Resolution on Vehicle Interior Air Quality**

 1. Purpose

 This Mutual Resolution contains the provisions and harmonized test procedure for the measurement of interior air emission from interior materials, concerning the protection of passengers from VOCs and harmful substances emitted by interior materials used for the construction of vehicles.

  2. Scope and application

This Mutual Resolution applies to passenger vehicles and is validated for vehicles in category (1-1), as defined in the Special Resolution No. 1.[[1]](#footnote-2) Category 1-1 vehicles are designed and constructed primarily for the carriage of (a) person(s) and comprising not more than eight seating positions in addition to the driver’s seating position. 3. Definitions

For the purpose of this recommendation the following definitions apply:

3.1 “*Test vehicle*” means the new vehicle to be tested. The test age of the vehicles has to be 28d ± 5 day after the production date;

3.2 “*Production date*” is the sign off date from the production line is the date in which final tests are finished in the production;

3.3 “*Test substances*” mean substances to be measured, these are 8 substances, Formaldehyde, Acetaldehyde, Benzene, Toluene, Xylene, Ethylbenzene, Styrene, and Acrolein;

3.4. “*Background concentration*” means the analyte concentration in the whole-vehicle test chamber when the test vehicle is inside;

3.5 “*Ambient mode*” refer to the test mode in which sampling of test substances in the cabin of a test vehicle under standardized ambient temperature conditions is performed, defined by 2x °C;

3.6 “*Parking mode*” refer to the test mode in which sampling of test substances in the cabin of a test vehicle under standardized elevated temperatures using fixed radiant heat is performed

3.7 “*Driving mode*” refer to the test mode in which sampling of test substances in the cabin of a test vehicle, under standardized conditions starting at elevated temperatures and using air conditioning, is performed, simulating a vehicle driven after being parked in the sun

3.8 “*Sampling train*” means the apparatus to collect the sample gas inside the test vehicle cabin (indoor) and in the whole vehicle test chamber, trapping the test substances in sorbent tubes under standardized conditions

 4. Abbreviations

4.1 General abbreviations

|  |  |
| --- | --- |
| VIAQ | Vehicle Interior Air Quality |
| GC | Gas chromatograph |
| VOCs | Volatile organic compounds |

4.2 Chemical symbols and abbreviations

|  |  |
| --- | --- |
| CH2O | Formaldehyde |
| C6H6 | Benzene |
| C2H4O | Acetaldehyde |
| C8H10 | Ethyl benzene |
| C8H8 | Styrene |
| C3H4O | Acrolein, Acrylic Aldehyde |
| C7H8 | Toluene |
| C8H10 | Xylene |

 5. General Provisions

5.1 When instructed to include this test procedure in national standards, Contracting Parties are invited to adopt this Mutual Resolution for the measurement of interior air emissions from interior materials.

5.1 This Mutual Resolution does not hold regulatory status within Contracting Parties. Contracting Parties refer to the VIAQ recommendation when used for the assessment on vehicle interior air quality with the technical prescriptions of their own standards or regulations.

5.2 There are several test methods available for assessing vehicle interior air quality taking into account existing standards. There are three test modes, each with their own testing method. These test modes would be subject to optional acceptance by contraction parties depending on their situations. Contracting Parties may optionally decide to the test mode:

 (a) Ambient mode:

Simulating cars parked in the garage overnight using ambient conditions at standard conditions of 2x °C with no air exchange.

(b) Parking mode

Simulating cars parked outside in the sunlight at elevated temperatures using a fixed radiation heat with on air exchange.

(c) Driving mode

Simulating driving after the vehicle has been parked in the sun starting at elevated temperatures (right after the parking mode) with air-conditioning of HVAC system on.

 6. Special Provisions

6.1 This Mutual Resolution will encourage the reduced use of synthetic materials, and chemicals that can be harmful to humans. It also encourages the increased use of environmentally-friendly materials, improving the environmental air quality inside the passenger cabin.

6.2. Substances to be measured

Test Substances are Formaldehyde, Acetaldehyde, Benzene, Toluene, Xylene, Ethylbenzene, Styrene, and Acrolein.

6.3 Substances limit values

Due to the different levels of development, different regional cultures, and the costs associated with interior emission control technology, the regulatory stringency is expected to be different from region to region for the foreseeable future. The setting of interior emission limit values, therefore, is not part of this recommendation for the time being.

6.4 Testing should be performed according to:

(a) The test procedures and test conditions as described in Annex 1;

Annex 1

 Test Procedure for the measurement of VIAQ

**1. Scope**

This annex describes the test procedure for the measurement of interior air emission from interior materials including test conditions, test instrument, whole vehicle chamber, sampling method, and test mode.

**2. Normative references**

ISO 16000-3, Indoor air — Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method

ISO 16000-6:2011, Indoor air — Part 6: Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA® sorbent, thermal desorption and gas chromatography using MS or MS–FID

**3. Requirements for the test vehicle**

3.1 A test vehicle is a new vehicle. Used vehicls donot apply. Test vehicles are only new vehicles that are from serial production.

3.2 A new vehicle (i.e. one not driven more than 80 km and within 28 d ± 5 d after the sign-off date in the production/assembly line) to be tested shall have been manufactured by the normal production process.

3.3 Transportation conditions from plant to storing place and to test facility

3.3.1 Transportation of the vehicle should follow the normal transportation process

3.3.2 All windows and doors closed. HVAC outlets closed if possible to prevent contamination. Vehicles shall be transported as described in the normal transportation process.

3.3.3 Ensure that no emit materials will be transported in the same cargo area. Minimize high solar load during all transportations. Documentation of all deviations from the normal transportation process in the test protocol is needed.

3.3.4 Influence of the driver shall be as low as possible (no smoking, eating, goods transportation, no perfume...., inside the vehicle)

3.3.5 Protection covers used shall be the protection that will be used normally for transportation. Absorbers are only allowed if used in the normal transportation process.

3.4 Storing conditions for the vehicle

3.4.1 Test vehicle should be stored inside the building and all windows, doors, and HVAC outlets keep closed to prevent from contamination and avoid direct sunlight at least 24 h before measurement.

3.4.2 Remove all protecting covers/- foils/-papers, stickers, absorbers etc. at least 24 h before measurement. Do not use any cleaning agent to remove any residues. Dust wiping, vacuuming and cleaning with clear water is possible. Clear water cleaning form outside is possible.

3.4.3 No extra fuelling, only the first fuel at production shall be within the fuelling system

3.4.4 Workers should carefully deal with the vehicle to prevent contamination

3.5 Storing conditions for the vehicle (1day before measurement)

3.5.1 Storage 1 day before measurement (soak time) nearby the test facility, soak temperature as close as possible to test temperature (20-30°C).

3.5.2 Protection covers should stay in the vehicle and be taken off one day before the measurement.

**4. Requirements for the test apparatus/instrument/equipment**

4.1 Vehicle test chamber

4.1.1 The whole vehicle test chamber is big enough to house the test vehicle completely. An air-conditioning system is installed to allow standardized air conditions for a temperature of 2x °C ± 2 °C (Temperature has to be as close as possible to 2x °C. Deviations have to be documented), humidity of 50 % RH ± 10 % RH.

4.1.2 If the driving mode is, a solar radiator system is installed to heat the test vehicle cabin with a fixed irradiation.

4.1.3 If the driving mode is, purge fan is installed to purge the exhaust gas from vehicle tailpipe.

4.2 Requirements for the whole vehicle test chamber

4.2.1 The whole vehicle test chamber shall be large enough to accommodate the complete test vehicle.

4.2.2 The whole vehicle test chamber shall be capable of maintaining a temperature of 23 or 25 °C ± 2 °C. A heating and ventilation system (including the adjustment of the humidity) and, if necessary, a cooling system is necessary.

4.2.3 Relative humidity (RH) during the ambient mode in the whole vehicle test chamber shall be 50 % RH ± 10 % RH.

4.2.4 Relative humidity RH during the parking and driving mode in the whole vehicle test chamber shall be documented.

4.2.5 The maximum background concentration for each analyte shall not exceed 20 μg/m3 for each single component, or a maximum of 10 % of the respective measured values (whichever is greater). If this is not met, the source of the contamination shall be identified and removed or covered to exclude it from the test.

4.2.6 The air exchange rate of the whole vehicle test chamber should be a minimum of twice per hour.

4.3 Heating radiator.

4.3.1 Infrared radiator, halogen radiator or other radiators (simulating sunlight) (wavelengths <300 nm shall be filtered out). The heating radiators used shall be powered to create a radiation density at the reference measurement point in the middle of the roof surface of the test vehicle of 350 W/m2 to 450 W/m2 (400 W/m2 ± 50 W/m2).

4.3.2 The heating area shall cover at least the area of the test vehicle cabin and an additional 0,5 m more to each side of the lower part of the glazing (footprint) (see Figure 1). Position the heating radiators on the roof with a shining angle of 90° to the heating area. There shall be no heating radiators shining from the side. The heating area shall be calibrated in squares of 25 cm × 25 cm with a radiation density of 400 W/m2 ± 50 W/m2. The required radiation density shall be available directly after the lamps are switched on (within a few minutes). The irradiation shall be measured in accordance with ISO 9060.

4.3.3 Take care not to have too short a distance between radiator and surface in order to avoid hot spots.

4.4 Sampling trains.

4.4.1 Sampling in the test vehicle. Four sampling trains are employed: two for the VOC measurements in parallel and two for the carbonyl compound measurements in parallel in the test vehicle (to check the repeatability) (see ISO 16000-3 for carbonyl compounds and ISO 16000-6 or ISO 16017-1 for VOCs). There is one sampling line with a manifold for the division of the sampling flow outside the test vehicle (see 4.3.3). It consists of the probe, the sampling line (heated, if necessary), the sorbent tube for VOC or the DNPH cartridge for carbonyl compound sampling respectively, the gas meters and the pumps (see 4.5). All sampling trains shall be checked for leaks and shall have a maximum vacuum decay rate of 30 kPa for an average time of 10 s. For the leak check, the nozzle shall be plugged. Other equivalent leak checks can be employed.

4.4.2 Sampling in the whole vehicle test chamber. Four sampling trains are used to determine the background concentration in the whole vehicle test chamber. The sampling trains are identical to those of 4.3.1, apart from the sampling line, which is much shorter and not heated. All sampling trains shall have a maximum vacuum decay rate of 30 kPa for an average of 10 s. The nozzle is plugged for the leak check. Other equivalent leak checks can be employed.

4.4.3 Sampling line. Tubing, between the sampling points (probe) inside the test vehicle, via the manifold outside the test vehicle to the VOC sorbent tubes or DNPH cartridges respectively (see Figure 1).

4.4.4 The sampling line shall be constructed so as to be

a) as short as possible (maximum 5 m) with an internal diameter of 4 mm or more;

b) of inert, non-emitting and non-absorbing/non-adsorbing material [e.g. stainless steel or polytetrafluoroethylene (PTFE) or glass/quartz (deactivated)];

c) proven that there are no contaminations or sink effects in the sampling line;

d) with heating device, if necessary, to prevent condensation/deposition on the inner walls (best practice: temperature controlled to about 20 °C above air temperature inside the test vehicle).

4.4.5 The tubing should be inserted between the door and the door frame or between the door frame and the glazing and should be sufficiently non-compressible to ensure an unimpeded flow of air.

4.4.6 The second sampling line [tubing, between the sampling point (probe) in the whole vehicle test chamber in the vicinity of the test vehicle [see 6.1 b)] and the manifold and to the VOC sorbent tubes or DNPH cartridges, respectively] is identical to that described in the preceding, but no heating is necessary. This second sampling line is needed to monitor the background analyte concentration of the whole vehicle test chamber.

4.5. Analytical equipment and materials.

4.5.1 The analytical equipment used for the determination of VOCs and carbonyl compounds or formaldehyde alone shall be in accordance with ISO 16000-6 (VOCs) or ISO 16000-3 (carbonyl compounds), respectively.

4.5.2 It shall be proven for the VOC sorbent tubes and the DNPH cartridges that there is no breakthrough. This can be identified by a back-up sorbent tube which is analysed separately (see ISO 16017-1).

4.5.3 If necessary, an ozone scrubber filled with high purity Potassium Iodide (KI) shall be used series-connected in front of the DNPH cartridge, to minimize interference by ozone.

4.5.4 Requirements for VOC and carbonyl compound air sampling and measurement methods for VOC and carbonyl compound sampling and measurement of the air in the cabin of the test vehicle and in the whole vehicle test chamber, the following procedures shall be followed.

4.5.4.1 Carbonyl compounds including formaldehyde: ISO 16000-3; Substances to be measured are Formaldehyde, Acetaldehyde and Acrolein.

4.5.4.2 VOCs: ISO 16000-6; Substances to be measured are Benzene, Toluene, Xylene, Ethylbenzene and Styrene.

4.6 Blank measurements

4.6.1 Field blanks

4.6.1.1 The sorbent tubes used as field blanks (for VOC and carbonyl compounds) shall be from the same batch and treated in the same way as those used for sampling and analysis (including all devices and handlings), except that no gas is drawn through the sampling trains (see 7.2.4).

4.6.1.2 A field blank procedure shall be performed at least before each measurement series (series of consecutive measurements of several vehicles).

4.6.1.3 The field blank shall not be deducted from the measured value.

4.6.1.4 All field blanks shall be reported with the corresponding measured values.

Substances to be measure are Formaldehyde, Acetaldehyde, Benzene, Toluene, Xylene, Ethylbenzene, Styrene, and Acrolein.

4.6.1.5 The requirements for analytical and GC–MS blanks are specified in ISO 16000-3 and ISO 16000-6.

**5. Test procedure, test mode, and test conditions**

5.1 The test procedure is divided into three parts:

(a) Conditioning of the whole vehicle test chamber,

(b) Conditioning of the test vehicle,

(c) Performing sampling and analytical measurement.

5.2 Pre-arrangements and preconditioning of the whole vehicle test chamber and the vehicle and performing the field blanks

5.2.1 Pre-arrangements

(a) Connect the test apparatus with the test vehicle. Attach the cables and sampling lines to the door frame so that, when the doors are closed, there is a (nearly) airtight sealing. Furthermore, the sampling line for VOC and carbonyl compound sampling shall be installed in the test vehicle. The probe is positioned as specified in 6.2.5.

(b) Connect the sampling line with the manifold and the manifold with the sampling trains for VOC and carbonyl compound measurements outside the test vehicle.

(c) Connect the test apparatus within the whole vehicle test chamber.

(d) Install the heating radiators and the other installations listed in 6.1.

5.2.2 Preconditioning of the whole vehicle test chamber

5.2.2.1 Adjust the temperature of the whole vehicle test chamber to 2x °C ± 2 °C during the ambient mode test. There may be the need for a heating or cooling device. The humidity shall be 50 % RH ± 10 % RH in the ambient mode.

5.2.2.2 The whole vehicle test chamber should be under good ventilation, and the air exchange rate should be twice per hour or higher. The interior materials of the whole vehicle test chamber shall have no appreciable emissions regarding the indoor air inside the test vehicle (see 6.1 and 6.4 background concentrations).

5.2.2.3 The heating of the interior of the cabin and the surfaces of the test vehicle is performed by heating radiators from outside the test vehicle during the driving mode

5.2.3 Preconditioning of the test vehicle

5.2.3.1 The essential conditions for the surroundings are as follows. The temperature during the ambient mode is adjusted to 2x °C ± 2 °C via the whole test chamber conditioning system (see Figure 3). The preconditioning is started by opening the door for 30 min. After this, the door is closed for 16h ± 1h soak time (see Figure 3).

5.2.4 Field blanks

5.2.4.1 Prepare the field blanks before the measurements are started (see 6.4.1). Install one Tenax TA®1) sorbent tube for VOCs and one DNPH cartridge for carbonyl compounds in the sampling trains to measure the background concentration of the whole vehicle test chamber as well as one Tenax TA®1) sorbent tube and one DNPH cartridge in the sampling trains to measure the background concentration of the test vehicle. The field blank samplers shall be handled in the same way as those used for VOC or carbonyl compound measurements, but without drawing air through the sampling trains. As soon as the samplers have been connected into the sample train, they shall be removed, sealed and retained for analysis with the real samples.

5.2.4.2 Perform at least one field blank for each measurement series. Analytical GC–MS or HPLC blanks shall be performed according to 6.4.

5.3 Overview of test mode conditions

5.3.1 Ambient mode

Vehicle parking period at the specified temperature (2x oC ± 2 oC) within 16 ± 1 h at the end of which the sampling of VOC’s and carbonyl compounds in the interior air to be preformed

5.3.2 Parking mode

Vehicle parking period at the specified elevated temperature within 4 h at the end of which the sampling of carbonyl compounds in the interior air to be performed

5.3.3 Driving mode

This test mode that simulates the operation of the test vehicle after it’s parking at elevated temperature within 30 min during which the sampling of VOC’s and carbonyl compounds in the interior air to be performed

5.4 Test procedure

**5.4.1 Ambient mode,**

5.4.1.1 Time: 0:00 h

 After the conditions of the whole test chamber have been set at 23 °C or 25 °C ± 2 °C and 50 % RH ± 10 % RH and the air exchange rate in the test chamber has been adjusted to a recommended value of at least twice per hour, the test procedure is started. Start the conditioning of the test vehicle by opening all doors for 0.5 ~ 1 h. Install the sampling train including the two VOC sorbent tubes and the two DNPH cartridges, and leak-check the sampling train (see 4.3.1). An overview of the number of samples to be taken is given in Annex E.

5.4.1.2 Time: 1:00 h

Continue by conditioning the whole-vehicle test chamber and close all doors of the test vehicle for 16 h ± 1 h (e.g. overnight) at 2x °C ± 2 °C and 50 % RH ± 10 % RH and keep the air exchange rate in the whole vehicle test chamber at a minimum of twice per hour (recommended value). There is no dynamic ventilation of the test vehicle.

5.4.1.3 Time: 17:00 h

There is no dynamic ventilation of the test vehicle. Before the sampling starts, purge the dead volume of the sampling line. Switch on the pumps of the four sampling trains (two for VOC and two for carbonyl compounds, each in parallel). Perform the sampling of gaseous organic compounds in the test vehicle cabin in the ambient mode at room temperature (23 °C ± 2 °C) for 30 min. Adjust the flow rate to maximum 0,1 l/min for VOC and 1 l/min for carbonyl compound measurements. The measurement procedures specified in ISO 16000-6 (VOCs) and ISO 16000-3 (carbonyl compounds) shall be followed.

At the same time, switch on the four sampling trains in the whole vehicle test chamber to determine the VOC and carbonyl compound background concentrations (two sampling trains for VOCs and two for carbonyl compounds). The probe is positioned 1 m in front of the cabin air intake. The relative humidity and the temperature are measured in the same position.

**5.4.2 Parking mode**

5.4.2.1 Time: 17:30 h

Switch off the pumps for the VOC and carbonyl compound measurements, read and register the measurement volumes and take the VOC sorbent tubes and DNPH cartridges, which are placed outside the vehicle cabin, out of the sampling train. Seal the sorbent tubes or cartridges and analyse according to ISO 16000-6 and ISO 16000-3.

Furthermore, start the parking mode with the heating-up procedure (see Figure 3).

The following tasks shall be performed.

Start heating with the heating radiators (see 4.2). The irradiation is adjusted to 400 W/m2 ± 50 W/m2 and maintained at that level for 4,5 h.

Adjust the air exchange rate to twice per hour or higher (recommended value) in the whole vehicle test chamber.

5.4.2.2 Time: 20:30 h

Install the two DNPH cartridges in the two sampling trains for the test vehicle measurement and two for the whole vehicle test chamber. Before the sampling begins, check the sampling train for leaks (see 4.3.1) and purge the dead volume. Switch the pumps of the four sampling trains on. Perform formaldehyde sampling in the test vehicle cabin at elevated temperatures for 30 min. The flow rate is adjusted to maximum 1 l/min for carbonyl compound measurements. The measurement procedure specified in ISO 16000-3 (carbonyl compounds) shall be followed.

5.4.2.3 Switch off the pumps for the formaldehyde measurements and take the DNPH cartridges out of the sampling train to be analysed according to ISO 16000-3. Read and register the measurement volumes.

5.4.3 Driving mode

5.4.3.1 Before the sampling in the driving mode begins, install the two VOC sorbent tubes and the two DNPH cartridges, and purge the dead volume.

5.4.3.2 Open the driver’s door, start the engine, and turn on the air conditioning in less than 60 s (at 23 °C in case of automatic conditioning or lowest operation for semi-automatic and manual conditioning systems; for test vehicles without automatic air-conditioning systems, the fan is in highest performance mode with fresh-air ventilation) (see Table 1).

5.4.3.3 At the same time, switch on the pumps of the four sampling trains (two for VOCs and two for carbonyl compounds, each in parallel). The sampling of gaseous organic compounds in the test vehicle cabin is performed at elevated temperature for 30 min. The flow rate is adjusted to maximum 0,1 l/min for VOCs and 1 l/min for carbonyl compound measurements. The measurement procedures specified in ISO 16000-6 (VOCs) and ISO 16000-3 (carbonyl compounds) shall be followed.

5.4.3.4 At the same time, switch on the four sampling trains in the whole vehicle test chamber to determine the VOC and carbonyl compound background concentrations (two sampling trains for VOCs and two for carbonyl compounds).

5.4.3.5 Time: 21:30 h

Stop the pumps of the sampling trains and switch off the engine and the heating radiators. The sampling volumes are read and registered. The VOC sorbent tubes and DNPH cartridges are taken out of the sampling train for the analysis as specified in ISO 16000-6 and ISO 16000-3.

Stop the continuous measurements for temperature and humidity.

This is the end of the test cycle.

**6. Calculation, presentation of results, and precision and uncertainty**

6.1 Calculation and presentation of results are performed according to ISO 16000-6 and ISO 16000-3. The precision and uncertainty shall also be followed as specified in ISO 16000-6 and ISO 16000-3. There is an informative test report (see Annex C) which should be agreed on between the client and the laboratory.

**7. Performance characteristics**

7.1 The detection limits and standard deviations for VOCs given in ISO 16000-6 and for carbonyl compounds in ISO 16000-3 are met in this measurement procedure. The condition to meet these performance characteristics is that there are no contaminations or sink effects in the sampling lines. This shall be proven before the measurements and shall be documented.

8. Quality assurance/quality control

An appropriate level of quality control shall be employed following ISO 16000-3 and ISO 16000-6, namely:

(a) Field blanks are prepared according to 6.4;

(a) The field blank level is acceptable if artefact peaks are no greater than 10 % of the typical areas of the analytes of interest;

(c) Desorption efficiency of VOCs and carbonyl compounds should be checked according to ISO 16000-3 and ISO 16000-6;

(d) The collection efficiency can be assessed by using back-up tubes or taking samples of different sampling volumes less than the safe sampling volume;

(e) Repeatability of the measuring method shall be determined, e.g. using collection and analysis of duplicate samples — a coefficient of variation ≤15 % (ISO 16000-3 and ISO 16000-6) from the duplicate measurements should be reached;

(f) The recovery of C6 to C16 hydrocarbons shall be 95 % mass fraction (ISO 16000-6);

(g) Documentation illustrating traceable calibrations for temperature, humidity, and flow measurements.

Annex 1 - Appendix 1

 Whole vehicle chamber

(Reserved)

Annex 1 - Appendix 2

 Temperature measuring points for parking mode

(Reserved)

Annex 1 - Appendix 3

 Test report

(Reserved)

Annex 1 - Appendix 4

 Volatile organic compounds

(Reserved)

Annex 1 - Appendix 5

 Overview of the number of samples to be taken

(Reserved)

1. Document ECE/TRANS/WP.29/1045, as amended. [↑](#footnote-ref-2)