

Comparison of Test Procedures by Indian Experts					
Sr. No.	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
1	Equipment Specifications				
	<p>101 Overview. (a) This procedure specifies equipment, other than measurement instruments, related to emission testing. This equipment includes two broad categories—dynamometers and emission-sampling hardware.</p>	Not mentioned	Not mentioned	Not mentioned	
	(b) Other related subparts in this procedure identify measurement instruments, describe how to evaluate the performance of these instruments, and specify vehicle fluids and analytical gases.				
2	110 Chassis Dynamometer				
	<p>Dynamometers shall incorporate the following general features for testing vehicles:</p> <ul style="list-style-type: none"> •Accurate and precise road load determination (traceable to a recognized standards organization) and simulation that recreates the mechanical inertia and frictional forces that would be present on the road with electrically generated load forces based on specific equations, coefficients, and response characteristics. •Vehicle loading applied to the tires by rolls connected to intermediate motor/absorbers that contacts vehicle drive tires. •Capability of testing all light duty vehicles, medium-duty passenger vehicles and complete heavy duty vehicles on a Federal Test Register US06 Driving Trace which has a maximum acceleration rate of 8.0 MPH/second, in two wheel drive and four wheel drive configurations. Vehicle testing shall be accomplished by simulating all load conditions that the vehicle can experience on a dry smooth road. <p>•The dynamometer shall have a force</p>	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 4 CHASSIS DYNAMOMETER</p> <p>Section I 1. Definition of a Chassis Dynamometer with Fixed Load Curve 1.1. Introduction : In the event that total resistance to progress on the road is not reproduced on the chassis dynamometer between speeds of 10 and 120 km/h, it is recommended to use a chassis dynamometer having the characteristics defined below. 1.2. Definition 1.2.1. The chassis dynamometer may have one or two rollers. The front roller</p> <p>drives, directly or indirectly, the</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 92 Annex 4</p> <p>4. TEST EQUIPMENT 4.1. Chassis dynamometer 4.1.1. The dynamometer shall be capable of simulating road load within one of the following classifications: dynamometer with fixed load curve, i.e. a dynamometer whose physical characteristics provide a fixed load curve shape, dynamometer with adjustable load curve, i.e. a dynamometer with at least two road load parameters that can be adjusted to shape the load curve. 4.1.2. The setting of the dynamometer shall not be affected by the lapse of time. It shall not produce any vibrations perceptible</p> <p>to the vehicle and likely to impair the</p>	<p>5-4 Setting of chassis dynamometer load The chassis dynamometer load shall be set, after measuring the running resistance of the test vehicle on a test road as specified in Attached Sheet 4, in such a way that the running resistance value of the test vehicle will be reproduced. In this case, the test vehicle and chassis dynamometer shall be warmed up thoroughly by operating the test vehicle continuously on the chassis dynamometer at a speed of 60 km/h or more.</p>	

<p>measurement system to indicate the forces being applied by the dynamometer rolls to the vehicle tires. The load cell is the primary method of measuring force. This system shall be capable of indicating force readings to a resolution of 0.1% of rated output. The load applied by the dynamometer shall model and simulate forces acting on the vehicle during normal road operation, including rolling resistance, aerodynamic drag, road grade, drive train losses and inertia forces according to the following formula:</p> $FR = A + B * V + C * V^2 + D * W + M * dV / dt \quad (\text{See Note})$ <p>where:</p> <p>FR= total vehicle road load force to be applied at the surfaces of the rolls A = constant load term (friction) B = load coefficient dependent on velocity (drag and rolling resistance) C = load coefficient dependent on velocity squared (frontal windage and drag) D = incline grade coefficient (-,+)= [sin θ] including variable grade mode D=f(t) W = weight of vehicle M = effective vehicle mass, taking into account the rotational masses of driven and non-driven power trains on both 2WD and 4WD vehicles V = linear velocity at the roller surfaces = dX / dt, where X is a point on the roll surface dV / dt = acceleration rate of the roller surfaces</p> <p>Note: The total force is the sum of the individual tractive forces applied at each roller surface.</p> <p>The measured simulation error of the total road force, including the inertia force shall not exceed the greater of ± 2.0 pounds or ± 1 % of the target value, according to the above force formula, under all operating conditions and at all velocities. This measurement shall utilize the 1-second average of force and speed when acquired at 10-Hz, or faster.</p>	<p>inertia masses and the power absorption device.</p> <p>1.2.2. The load absorbed by the brake and the chassis dynamometer internal frictional effects from the speed of 0 to 120 km/h is as follows:</p> $F = (a + b * V^2) +/- 0.1 * F80$ <p>(without being negative) where: F = total load absorbed by the chassis dynamometer (N) a = value equivalent to rolling resistance (N) b = value equivalent to coefficient of air resistance (N/(km/h)²) V = speed (km/h) F80 = load at the speed of 80 km/h (N)</p>	<p>vehicle's normal operations.</p> <p>4.1.3. It shall be quipped with means to simulate inertia and load. These simulators are connected to the front roller in the case of a two-roller dynamometer.</p> <p>4.1.4. Accuracy</p> <p>4.1.4.1. It shall be possible to measure and read the indicated load to an accuracy of " 5 per cent.</p> <p>4.1.4.2. In the case of a dynamometer with a fixed load curve, the accuracy of the load setting at 80 km/h shall be ± 5 per cent. In the case of a dynamometer with adjustable load curve, the accuracy of matching dynamometer load to road load shall be ± 5 per cent at 120, 100, 80, 60, and 40 km/h and ± 10 per cent at 20 km/h. Below this, dynamometer absorption shall be positive.</p> <p>4.1.4.3. The total inertia of the rotating parts (including the simulated inertia where applicable) shall be known and shall be within ± 20 kg of the inertia class for the test.</p> <p>4.1.4.4. The speed of the vehicle shall be measured by the speed of rotation of the roller (the front roller in the case of a two-roller dynamometer). It shall be measured with an accuracy of ± 1 km/h at speeds above 10 km/h.</p> <p>4.1.4.5. The distance actually driven by the vehicle shall be measured by the movement of rotation of the roller (the front roller in the case of a two-roller dynamometer).</p> <p>4.1.5. Load and inertia setting</p> <p>4.1.5.1. Dynamometer with fixed load curve: the load simulator shall be adjusted to absorb the power exerted on the driving wheels at a steady speed of 80 km/h and the absorbed power at 50 km/h shall be noted. The means by which this</p>		
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			<p>load is determined and set are described in Appendix 3 to this annex.</p> <p>4.1.5.2. Dynamometer with adjustable load curve: the load simulator shall be adjusted in order to absorb the power exerted on the driving wheels at steady speeds of 120, 100, 80, 60 and 40 and 20 km/h. The means by which these loads are determined and set are described in Appendix 3 to this annex.</p> <p>4.1.5.3. Inertia Dynamometers with electric inertia simulation shall be demonstrated to be equivalent to mechanical inertia systems. The means by which equivalence is established are described in Appendix 4 to this annex.</p> <p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 117 Annex 4 – Appendix 2</p> <p>1.2.1. The chassis dynamometer may have one or two rollers. The front roller shall drive, directly or indirectly, the inertial masses and the power absorption device.</p> <p>1.2.2. The load absorbed by the brake and the chassis dynamometer internal frictional effects between the speeds of 0 and 120 km/h is as follows: $F = (a + b.V^2) \cdot 0.1.F80$ (without being negative) where: F = total load absorbed by the chassis dynamometer (N) a = value equivalent to rolling resistance (N) b = value equivalent to coefficient of air resistance (N/(km/h)²) V = speed (km/h) F80 = load at 80 km/h (N)</p>		
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3	115 Driver's Aid Place Holder				
4	140 Dilution for gaseous and PM constituents.			Attached Sheet 9 METHOD OF MEASURING PM AND CALCULATING THE EMISSION AMOUNT (RELATED TO 8.)	
	(a) <u>General</u> . You may dilute exhaust with ambient air, synthetic air, or nitrogen. For gaseous emission measurement the diluent must be at least 15 °C. Note that the composition of the diluent affects some gaseous emission measurement instruments' response to emissions. We recommend diluting exhaust at a location as close as possible to the location where ambient air dilution would occur in use.	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 6 GAS SAMPLING SYSTEMS</p> <p>1 Scope: 1.1 This Chapter describes two types of gas sampling systems in paragraphs 2.1 and 2.2 meeting the requirements specified in Para 4.2 of Chapter 3 of this Part. Another type described in paragraph 2.3, may be used if it meets these requirements. 1.2 The laboratory shall mention, in its communications, the system of sampling used when performing the test. Systems not described in this chapter could be used, if it is proven to give equivalent results. 2.0 Criteria relating to the variable-dilution system for measuring exhaust-Gas Emissions</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 134 Annex 4 – Appendix 5</p> <p>DEFINITION OF GAS-SAMPLING SYSTEMS</p> <p>1. INTRODUCTION 1.1. There are several types of sampling devices capable of meeting the requirements set out in paragraph 4.2. of Annex 4. The devices described in paragraphs 3.1. and 3.2. shall be deemed acceptable if they satisfy the main criteria relating to the variable dilution principle. 1.2. In its communications, the laboratory shall mention the system of sampling used when performing the test.</p>	<p>1. Measurement Method for PM The measurement for PM shall be carried out either by the full flow single-stage dilution method (hereinafter referred to as the "single-stage dilution method") in which, after the full flow of the dilution air and exhaust gas are mixed, part of the diluted exhaust gas is diverted and passed through the PM collecting system, or by the full flow double-stage dilution method (hereinafter referred to as the "double-stage dilution method") in which part of the diluted exhaust gas is diluted again and passed through the PM collecting system. 1-1 In the case of single-stage dilution method In the case of the single-stage dilution method, PM is collected as follows: The diluted exhaust gas inside the main dilution tunnel is passed through the filter holder incorporating the PM collecting filter from the PM sampling probe. The diluted exhaust gas is sucked by the sampling suction pump</p>	

				<p>and the sample flow rate shall be measured by means of the sample flow rate meter.</p> <p>1–2 In the case of double-stage dilution method In the case of the double-stage dilution method, PM is collected as follows: The diluted exhaust gas inside the main dilution tunnel is introduced into the secondary dilution tunnel from the sampling transfer tube. There, the full flow of the secondary diluted exhaust gas that has been diluted by air again is passed through the filter holder incorporating the PM collecting filter from the PM sampling probe. Furthermore, the flow rate of the secondary diluted exhaust gas sucked by the sampling suction pump shall be measured by means of the sample flow rate meter.</p>	
	<p>(b) <u>Dilution-air conditions and background concentrations</u>. Before a diluent is mixed with exhaust, you may precondition it by increasing or decreasing its temperature or humidity. You may also remove constituents to reduce their background concentrations. The following provisions apply to removing constituents or accounting for background concentrations:</p> <p>(1) You may measure constituent concentrations in the diluent and compensate for background effects on test results. See 650 for calculations that compensate for background concentrations.</p> <p>(2) Either measure these background concentrations the same way you measure diluted exhaust constituents, or measure them in a way that does not affect your ability to demonstrate compliance with the applicable standards. For example, you may use the</p>	<p>2.1 Scope This section specifies the operating characteristics of an exhaust-gas sampling system intended to be used for measuring the true mass emissions of a vehicle exhaust in accordance with the provisions of TAP 115/116. The principle of variable-dilution sampling for measuring mass emissions requires three conditions to be satisfied:</p> <p>2.1.1 The vehicle exhaust gases must be continuously diluted with ambient air under specified conditions;</p> <p>2.1.2 The total volume of the mixture of exhaust gases and</p>	<p>2. CRITERIA RELATING TO THE VARIABLE-DILUTION SYSTEM FOR MEASURING EXHAUST-GAS EMISSIONS</p> <p>2.1. Scope This section shall specify the operating characteristics of an exhaust-gas sampling system intended to be used for measuring the true mass emissions of a vehicle exhaust in accordance with the provisions of this Regulation. The principle of variable-dilution sampling for measuring mass emissions shall require three conditions to be satisfied:</p> <p>2.1.1. The vehicle exhaust gases shall be continuously diluted with</p>	<p>2. Structure, Performance, Etc. of Measuring Devices, Equipment, Etc.</p> <p>21 Weighing room The weighing room in which the measurement of mass of the filter (hereinafter referred to as the “collecting filter”) used for collecting PM and PMb is conducted shall be maintained under the following conditions:</p> <p>(1) The temperature of the weighing room shall be kept at 295 ±3 K (22 ±3°C).</p> <p>(2) The humidity of the weighing room shall be 45 ±8%.</p> <p>(3) Airborne dust inside the</p>	

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	<p>following simplifications for background sampling:</p> <p>(i) You may disregard any proportional sampling requirements.</p> <p>(ii) You may use unheated gaseous sampling systems.</p> <p>(iii) You may use unheated PM sampling systems.</p> <p>(iv) You may use continuous sampling if you use batch sampling for diluted emissions.</p> <p>(v) You may use batch sampling if you use continuous sampling for diluted emissions.</p> <p>(3) For removing background PM, we recommend that you filter all dilution air, including primary full-flow dilution air, with high-efficiency particulate air (HEPA) filters that have an initial minimum collection efficiency specification of 99.97 % (see §1001 for procedures related to HEPA-filtration efficiencies). Ensure that HEPA filters are installed properly so that background PM does not leak past the HEPA filters. If you choose to correct for background PM without using HEPA filtration, demonstrate that the background PM in the dilution air contributes less than 50 % to the net PM collected on the sample filter. You may correct net PM without restriction if you use HEPA filtration.</p>	<p>dilution air must be measured accurately;</p> <p>2.1.3 A continuously proportional sample of the dilution exhaust gases and the dilution air must be collected for analysis. The quantity of gaseous pollutants emitted is determined from the proportional sample concentrations and the total volume measured during the test. The sample concentrations are corrected to take account of the pollutant content of the ambient air. In addition, where vehicles are equipped with compression ignition engines, their particulate emissions are measured.</p>	<p>ambient air under specified conditions;</p> <p>2.1.2. The total volume of the mixture of exhaust gases and dilution air shall be measured accurately;</p> <p>2.1.3. A continuously proportional sample of the diluted exhaust gases and the dilution air shall be collected for analysis. Mass gaseous emissions shall be determined from the proportional sample concentrations and the total volume measured during the test. The sample concentrations shall be corrected to take account of the pollutant content of the ambient air. In addition, where vehicles are equipped with compression-ignition engines, their particulate emissions shall be plotted.</p>	<p>weighing room shall be kept to a minimum.</p> <p>22 Main dilution tunnel</p> <p>The main dilution tunnel, where the exhaust gas and the air diluting the gas are mixed, shall comply with the following requirements:</p> <p>(1) The main dilution tunnel shall be a straight pipe and be placed in the test room.</p> <p>(2) The inner diameter of the main dilution tunnel shall be 200 mm or more in the case of the single-stage dilution method; and 75 mm or more in the case of the double-stage dilution method.</p> <p>(3) The inner surface of the main dilution tunnel shall be smooth without any irregularities at the flange joint sections.</p> <p>(4) The flange joint sections of the main dilution tunnel shall not leak the diluted exhaust gas.</p> <p>(5) A mixing orifice that promotes full mixing of the diluted exhaust gas shall be provided in close proximity to the exhaust inlet section of the main dilution tunnel.</p>	
	<p>(c) <u>Full-flow dilution; constant-volume sampling (CVS)</u>. You may dilute the full flow of raw exhaust in a dilution tunnel that maintains a nominally constant volume flow rate, molar flow rate or mass flow rate of diluted exhaust, as follows:</p> <p>(1) <u>Construction</u>. Use a tunnel with inside surfaces of 300 series stainless steel. Electrically ground the entire dilution tunnel. We recommend a thin-walled and insulated dilution tunnel to minimize temperature differences between the wall and the exhaust gases.</p> <p>(2) <u>Pressure control</u>. Maintain static pressure at the location where raw exhaust is introduced</p>	<p>2.2 Technical summary:</p> <p>Figure 7 gives a schematic diagram of the sampling system.</p> <p>2.2.1 The vehicle exhaust gases must be diluted with a sufficient of ambient air to prevent any water condensation in the sampling and measuring system.</p> <p>2.2.2 The exhaust-gas sampling system must be so designed as to make it possible to measure the average volume concentrations of the CO₂, CO, HC and NO_x, and in addition, in the case of vehicles equipped with compression-ignition</p>	<p>2.2. Technical summary</p> <p>Figure 5/1 gives a schematic diagram of the sampling system.</p> <p>2.2.1.1. The vehicle exhaust gases shall be diluted with a sufficient amount of ambient air to prevent any water condensation in the sampling and measuring system.</p> <p>2.2.2. The exhaust-gas sampling system shall be so designed as to make it possible to measure the average volume concentrations of the CO₂, CO, HC and NO_x, and, in addition, in the case of vehicles equipped with compression-ignition</p>	<p>(6) The main dilution tunnel (including the sampling probe for PM and the mixing orifice, etc.) shall be electrically conductive and corrosion-resistant. Moreover, the main dilution tunnel shall be grounded.</p> <p>(7) The Reynolds number of the diluted exhaust gas inside the main dilution tunnel shall be much greater than 4000.</p> <p>(8) The sampling probe for THC and the sampling</p>	

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<p>into the tunnel within ± 1.2 kPa of atmospheric pressure. You may use a booster blower to control this pressure. If you test a vehicle using more careful pressure control and you show by engineering analysis or by test data that you require this level of control to demonstrate compliance at the applicable standards, we will maintain the same level of static pressure control when we test that vehicle.</p> <p>(3) <u>Mixing</u>. Introduce raw exhaust into the tunnel by directing it downstream along the centerline of the tunnel. You may introduce a fraction of dilution air radially from the tunnel's inner surface to minimize exhaust interaction with the tunnel walls. You may configure the system with turbulence generators such as orifice plates or fins to achieve good mixing. We recommend a minimum Reynolds number, <i>Re#</i>, of 4000 for the diluted exhaust stream, where <i>Re#</i> is based on the inside diameter of the dilution tunnel. <i>Re#</i> is defined in 640.</p> <p>(4) <u>Flow measurement preconditioning</u>. You may condition the diluted exhaust before measuring its flow rate, as long as this conditioning takes place downstream of any heated HC or PM sample probes, as follows:</p> <p>(i) You may use flow straighteners, pulsation dampeners, or both of these.</p> <p>(ii) You may use a filter.</p> <p>(iii) You may use a heat exchanger to control the temperature upstream of any flow meter, but you must take steps to prevent aqueous condensation as described in paragraph (c)(6) of this section.</p> <p>(5) <u>Flow measurement</u>. Section 240 describes measurement instruments for diluted exhaust flow.</p> <p>(6) <u>Aqueous condensation</u>. This paragraph (c)(6) describes how you must address aqueous condensation in the CVS. As described below, you may meet these requirements by preventing or limiting aqueous condensation in the CVS from the exhaust inlet to the last emission sample probe. See that paragraph for provisions related to the CVS between the last emission sample probe and the CVS flow meter. You may heat and/or insulate the dilution tunnel walls, as well as the</p>	<p>engines, of the particulate emissions, contained in the exhaust gases emitted during the vehicle testing cycle.</p> <p>2.2.3 The mixture of air and exhaust gases must be homogeneous at the point where the sampling probe is located (see 2.3.1.2 below).</p> <p>2.2.4 The probe must extract a representative sample of the diluted gases.</p> <p>2.2.5 The system must make it possible to measure the total volume of the diluted exhaust gases from the vehicle being tested.</p> <p>2.2.6 The sampling system must be gas-tight. The design of the variable-dilution sampling system and the material that go to make it up must be such that they do not affect the pollutant concentration in the diluted exhaust gases. Should any component in the system (heat exchanger, cyclone separator, blower etc) change the concentration of any of the pollutants in the diluted exhaust gases and the fault cannot be corrected, then sampling for that pollutant must be carried out before that component.</p> <p>2.2.7 If the vehicle tested is equipped with an exhaust system comprising more than one tailpipe, the connecting tubes must be connected together by a manifold installed as near as possible to the vehicle.</p> <p>2.2.8 The gas samples must be collected in sampling bags of adequate capacity so as to hinder the gas flow during the sampling period. These bags must be made of such materials as will not affect the concentration of pollutant gases (see 2.3.4.4 below).</p>	<p>engines, of the particulate emissions, contained in the exhaust gases emitted during the vehicle testing cycle.</p> <p>2.2.3. The mixture of air and exhaust gases shall be homogeneous at the point where the sampling probe is located (see paragraph 2.3.1.2. below).</p> <p>2.2.4. The probe shall extract a representative sample of the diluted gases.</p> <p>2.2.5. The system shall enable the total volume of the diluted exhaust gases to be measured.</p> <p>2.2.6. The sampling system shall be gas-tight. The design of the variable-dilution sampling system and the materials that go to make it up shall be such that they do not affect the pollutant concentration in the diluted exhaust gases. Should any component in the system (heat exchanger, cyclone separator, blower, etc.) change the concentration of any of the pollutants in the diluted exhaust gases and the fault cannot be corrected, then sampling for that pollutant shall be carried out upstream from that component.</p> <p>2.2.7. If the vehicle tested is equipped with an exhaust system with several outlets, the connecting tubes shall be connected by a manifold installed as near as possible to the vehicle.</p> <p>2.2.8. The gas samples shall be collected in sampling bags of adequate capacity so as not to hinder the gas flow during the sampling period. These bags shall be made of materials which will not affect the concentration of pollutant gases (see paragraph 2.3.4.4. below).</p> <p>2.2.9. The variable-dilution system</p>	<p>probe for PM which are to be installed in the main dilution tunnel shall be located at a position such that the distance from the exhaust inlet section of the main dilution tunnel is about ten times the inner diameter of the main dilution tunnel.</p> <p>(9) The sampling probe for THC and sampling probe for PM to be installed in the main dilution tunnel shall be provided in such a way that the forward ends thereof face toward the upstream of the flow of the diluted exhaust gas and are located within a circle (concentric with the tunnel cross section) whose diameter is half the inner diameter of the main dilution tunnel.</p> <p>(10) The sampling probe for PM to be installed in the main dilution tunnel shall measure 12 mm or more in inner diameter. Furthermore, it shall measure 1020 mm or less in length (distance from the forward end of the said sampling probe for PM to the filter holder). Its bend section shall have the largest possible curvature.</p> <p>(11) A dust-proof filter shall be provided at the dilution air inlet section of the main dilution tunnel. Moreover, in addition to this, the following filter may be installed:</p> <p>(a) Filter having the HEPA performance or higher; and</p> <p>(b) Active carbon filter.</p> <p>(12) When a sampling probe for PMb is to be provided, it shall be installed at the front</p>	
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<p>bulk stream tubing downstream of the tunnel to prevent or limit aqueous condensation. Where we allow aqueous condensation to occur, use accepted measurement practices to ensure that the condensation does not affect your ability to demonstrate that your engines comply with the applicable standards.</p> <p>(i) <u>Preventing aqueous condensation.</u> To prevent condensation, you must keep the temperature of internal surfaces, excluding any sample probes, above the dew point of the dilute exhaust passing through the CVS tunnel. Use accepted measurement practices to monitor temperatures in the CVS. For the purposes of this paragraph (c)(6), assume that aqueous condensation is pure water condensate only, even though the definition of "aqueous condensation" in 1001 includes condensation of any constituents that contain water. No specific verification check is required under this paragraph (c)(6)(i), but we may ask you to show how you comply with this requirement. You may use engineering analysis, CVS tunnel design, alarm systems, measurements of wall temperatures, and calculation of water dew point to demonstrate compliance with this requirement. For optional CVS heat exchangers, you may use the lowest water temperature at the inlet(s) and outlet(s) to determine the minimum internal surface temperature.</p> <p>(ii) <u>Limiting aqueous condensation.</u> This paragraph (c)(6)(ii) specifies limits of allowable condensation and requires you to verify that the amount of condensation that occurs during each test interval does not exceed the specified limits.</p> <p>(A) Use chemical balance equations in 655 to calculate the mole fraction of water in the dilute exhaust continuously during testing. Alternatively, you may continuously measure the mole fraction of water in the dilute exhaust prior to any condensation during testing. Use accepted measurement practices to select, calibrate and verify water analyzers/detectors. The linearity verification requirements of §307 do not apply to water analyzers/detectors used to correct for the water content in exhaust</p>	<p>2.2.9 The variable-dilution system must be so designed as to enable the exhaust gases to be sampled without appreciably changing the back-pressure at the exhaust pipe outlet (see 2.3.1.1 below).</p> <p>2.3 Specific requirements:</p> <p>2.3.1 Exhaust-gas collection and dilution device.</p> <p>2.3.1.1 The connection tube between the vehicle exhaust tailpipe(s) and the mixing chamber must be as short as possible; it must in no case:</p> <ul style="list-style-type: none"> - cause the static pressure at the exhaust tailpipe(s) on the vehicle being tested to differ by more than ± 0.75 kPa at 50 km/h or more than ± 1.25 kPa for the whole duration of the test from the static pressures recorded when nothing is connected to the vehicle tailpipes. The pressure must be measured in the exhaust tailpipe or in an extension having the same diameter, as near as possible to the end of the pipe. - Change the nature of the exhaust gas. <p>2.3.1.2 There must be a mixing chamber in which the vehicle exhaust gases and the dilution air are mixed so as to produce a homogeneous mixture at the chamber outlet. The homogeneity of the mixture in any cross-section at the location of the sampling probe must not vary by more than ± 2 % from the average of the values obtained at least five points located at equal intervals on the diameter of the gas system. In order to minimize the effects on the conditions at the exhaust tailpipe and to limit the drop in pressure inside the dilution air-conditioning device, if any, the pressure inside the mixing</p>	<p>shall be so designed as to enable the exhaust gases to be sampled without appreciably changing the back-pressure at the exhaust pipe outlet (see paragraph 2.3.1.1. below).</p> <p>Fig- 5/1</p> <p>2.3. Specific requirements</p> <p>2.3.1. Exhaust-gas collection and dilution device</p> <p>2.3.1.1. The connecting tube between the vehicle exhaust outlets and the mixing chamber shall be as short as possible; it shall in no event:</p> <ul style="list-style-type: none"> (i) cause the static pressure at the exhaust outlets on the vehicle being tested to differ by more than " 0.75 kPa at 50 km/h or more than " 1.25 kPa for the whole duration of the test from the static pressures recorded when nothing is connected to the vehicle exhaust outlets. The pressure shall be measured in the exhaust outlet or in an extension having the same diameter, as near as possible to the end of the pipe; (ii) change the nature of the exhaust gas. <p>2.3.1.2. Provision shall be made for a mixing chamber in which the vehicle exhaust gases and the dilution air are mixed so as to produce a homogeneous mixture at the chamber outlet. The homogeneity of the mixture in any cross-paragraph at the location of the sampling probe shall not vary by more than 2 per cent from the average of the values obtained for at least five points located at equal intervals on the diameter of the gas stream. In order to minimise the effects on the conditions at the exhaust outlet and to limit the drop</p>	<p>end of the main dilution tunnel. Furthermore, a flowmeter shall be connected to the said sampling probe for PMb, which measures the flow rate of the dilution air sucked by the sampling suction pump for PMb (hereinafter referred to as the "dilution air sample flow rate").</p> <p>(13) The temperature of the dilution air shall be 288 K (15°C) or above.</p> <p>(14) Necessary measures shall be taken so that no water condensation will take place inside the main dilution tunnel.</p> <p>2-3 Secondary dilution tunnel The secondary dilution tunnel where the diluted exhaust gas and secondary dilution air diluting it are mixed shall comply with the following requirements:</p> <p>(1) The secondary dilution tunnel shall be of a straight pipe and placed indoor, for example, inside the test room, but outside the main dilution tunnel.</p> <p>(2) The secondary dilution tunnel shall have such a length that the time required for the secondary diluted exhaust gas (referring to the mixture of the diluted exhaust gas and secondary dilution air. Hereinafter the same.) to pass through the tunnel may be 0.25 second or more. The inner diameter thereof shall be at least 75 mm.</p> <p>(3) The sampling probe for</p>	
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<p>samples.</p> <p>(B) Use accepted measurement practices to select and monitor locations on the CVS tunnel walls prior to the last emission sample probe. If you are also verifying limited condensation from the last emission sample probe to the CVS flow meter, use accepted measurement practices to select and monitor locations on the CVS tunnel walls, optional CVS heat exchanger, and CVS flow meter. For optional CVS heat exchangers, you may use the lowest water temperature at the inlet(s) and outlet(s) to determine the minimum internal surface temperature. Identify the minimum surface temperature on a continuous basis.</p> <p>(C) Identify the maximum potential mole fraction of dilute exhaust lost on a continuous basis during the entire test interval. This value must be less than or equal to 0.02 (i.e. 2 %). Calculate on a continuous basis the mole fraction of water that would be in equilibrium with liquid water at the measured minimum surface temperature. Subtract this mole fraction from the mole fraction of water that would be in the exhaust without condensation (either measured or from the chemical balance), and set any negative values to zero. This difference is the potential mole fraction of the dilute exhaust that would be lost due to water condensation on a continuous basis.</p> <p>(D) Integrate the product of the molar flow rate of the dilute exhaust and the potential mole fraction of dilute exhaust lost, and divide by the totalized dilute exhaust molar flow over the test interval. This is the potential mole fraction of the dilute exhaust that would be lost due to water condensation over the entire test interval. Note that this assumes no re-evaporation. This value must be less than or equal to 0.005 (i.e. 0.5%).</p> <p>(7) <u>Flow compensation</u>. Maintain nominally constant molar, volumetric or mass flow of diluted exhaust. You may maintain nominally constant flow by either maintaining the temperature and pressure at the flow meter or by directly controlling the flow of diluted exhaust. You may also directly control the flow of proportional samplers to maintain</p>	<p>chamber must not differ by more than 0.25 kPa from atmospheric pressure.</p> <p>2.3.2 Suction device/volume measuring device This device may have a range of fixed speeds so as to ensure sufficient flow to prevent any water condensation. This result is generally obtained by keeping the concentration of CO₂ in the dilute exhaust gas-sampling bag lower than 3% by volume.</p> <p>2.3.3 Volume measurement:</p> <p>2.3.3.1 The volume-measuring device must retain its calibration accuracy to within ± 2% under all operating conditions. If the device cannot compensate for variations in the temperature of the mixture of exhaust gases and dilution air at the measuring point, a heat exchanger must be used to maintain the temperature to within ± 6 K of the specified operating temperature. If necessary, a cyclone separator can be used to protect the volume-measuring device.</p> <p>2.3.3.2 A temperature sensor must be installed immediately before the volume-measuring device. This temperature sensor must have an accuracy and a precision of ± 1 K and a response time of 0.1 second at 62% of a given temperature variation (value measured in silicone oil).</p> <p>2.3.3.3 The pressure measurements must have a precision and an accuracy of ± 0.4 kPa during the test.</p> <p>2.3.3.4 The measurement of the pressure difference from atmospheric pressure is taken before and, if necessary, after the volume-measuring device.</p>	<p>in pressure inside the dilution-air conditioning device, if any, the pressure inside the mixing chamber shall not differ by more than " 0.25 kPa from atmospheric pressure.</p> <p>2.3.2. Suction device/volume measuring device This device may have a range of fixed speeds as to ensure sufficient flow to prevent any water condensation. This result is generally obtained by keeping the concentration of CO₂ in the dilute exhaust gas sampling bag lower than 3 per cent by volume.</p> <p>2.3.3. Volume measurement</p> <p>2.3.3.1. The volume measuring device shall retain its calibration accuracy to within " 2 per cent under all operating conditions. If the device cannot compensate for variations in the temperature of the mixture of exhaust gases and dilution air at the measuring point, a heat exchanger shall be used to maintain the temperature to within " 6 K of the specified operating temperature. If necessary, a cyclone separator may be used to protect the volume measuring device.</p> <p>2.3.3.2. A temperature sensor shall be installed immediately before the volume measuring device. This temperature sensor shall have an accuracy and a precision of ± 1 K and a response time of 0.1 s at 62 per cent of a given temperature variation (value measured in silicone oil).</p> <p>2.3.3.3. The pressure easurements shall have a precision and an accuracy of ± 0.4 kPa during the test.</p>	<p>PM by which the secondary diluted exhaust gas is taken from the secondary dilution tunnel to the filter holder shall have an inner diameter of at least 12 mm and a length (referring to the distance from the outlet of the secondary dilution tunnel, or the outlet of the classifier in cases where a classifier is provided, to the filter holder) of 300 mm or less. The bend section thereof shall have the largest possible curvature.</p> <p>(4) The secondary dilution tunnel and sampling probe for PM shall have electric conductivity and corrosion-resistance. Moreover, they shall be grounded.</p> <p>2-4 Sampling transfer tube The sampling transfer tube which takes the diluted exhaust gas from the main dilution tunnel to the exhaust gas introducing section of the secondary dilution tunnel shall comply with the following requirements:</p> <p>(1) The length (referring to the distance from the forward end of the main dilution tunnel to the exhaust gas introducing section of the secondary dilution tunnel) of the sampling transfer tube shall not exceed 915 mm and the inner diameter shall be 12 mm or more.</p> <p>(2) The bend section of the sampling transfer tube shall have the largest possible curvature.</p> <p>(3) The sampling transfer</p>	
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	<p>proportional sampling. For an individual test, validate proportional sampling as described in 545.</p>		<p>2.3.3.4. The measurement of the pressure difference from atmospheric pressure shall be taken upstream from and, if necessary, downstream from the volume measuring device.</p>	<p>tube shall have electric conductivity and corrosion-resistance. Moreover, it shall be grounded.</p>	
	<p>(d) <u>Partial-flow dilution (PFD)</u>. You may dilute a partial flow of raw or previously diluted exhaust before measuring emissions. Section 240 describes PFD-related flow measurement instruments. PFD may consist of constant or varying dilution ratios as described in paragraphs (d)(2) and (3) of this section. An example of a constant dilution ratio PFD is a "secondary dilution PM" measurement system. (1) <u>Applicability</u>. (i) You may use PFD to extract a proportional raw exhaust sample for any batch or continuous PM emission sampling over any test cycle. (ii) You may use PFD to extract a proportional raw exhaust sample for any batch or continuous gaseous emission sampling over any transient duty cycle, any steady-state duty cycle, or any ramped-modal cycle. (iii) You may use PFD to extract a proportional raw exhaust sample for any batch or continuous field-testing. (iv) You may use PFD to extract a proportional diluted exhaust sample from a CVS for any batch or continuous emission sampling. (v) You may use PFD to extract a constant raw or diluted exhaust sample for any continuous emission sampling. (vi) You may use PFD to extract a constant raw or diluted exhaust sample for any steady-state emission sampling. (2) Constant dilution-ratio PFD. Do one of the following for constant dilution-ratio PFD: (i) Dilute an already proportional flow. For example, you may do this as a way of performing secondary dilution from a CVS tunnel to achieve overall dilution ratio for PM sampling. (ii) Continuously measure constituent concentrations. For example, you might dilute to precondition a sample of raw exhaust to control its temperature, humidity, or constituent</p>	<p>2.3.4 Gas sampling: 2.3.4.1 Dilute exhaust gases 2.3.4.1.1 The sample of dilute exhaust gases is taken before the suction devices but after the conditioning devices (if any). 2.3.4.1.2 The flow-rate must not deviate by more than ± 2% from the average. 2.3.4.1.3 The sampling rate must not fall below 5 liters per minute and must not exceed 0.2% of the flow-rate of the dilute exhaust gases. 2.3.4.1.4 An equivalent limit applies to constant-mass sampling systems. 2.3.4.2 Dilution air 2.3.4.2.1 A sample of the dilution air is taken at a constant flow-rate near the ambient air inlet (after the filter if one is fitted). 2.3.4.2.2 The air shall not be contaminated by exhaust gases from the mixing area. 2.3.4.2.3 The sampling rate for the dilution air must be comparable to that used in the case of the dilute exhaust gases.</p>	<p>2.3.4 Gas sampling: 2.3.4.1 Dilute exhaust gases 2.3.4.1.1 The sample of dilute exhaust gases is taken before the suction devices but after the conditioning devices (if any). 2.3.4.1.2 The flow-rate must not deviate by more than ± 2% from the average. 2.3.4.1.3 The sampling rate must not fall below 5 liters per minute and must not exceed 0.2% of the flow-rate of the dilute exhaust gases . 2.3.4.1.4 An equivalent limit applies to constant-mass sampling systems. 2.3.4.2 Dilution air 2.3.4.2.1 A sample of the dilution air is taken at a constant flow-rate near the ambient air inlet (after the filter if one is fitted). 2.3.4.2.2 The air shall not be contaminated by exhaust gases from the mixing area. 2.3.4.2.3 The sampling rate for the dilution air must be comparable to that used in the case of the dilute exhaust gases.</p>		

<p>concentrations upstream of continuous analyzers. In this case, you must take into account the dilution ratio before multiplying the continuous concentration by the sampled exhaust flow rate.</p> <p>(iii) Extract a proportional sample from a separate constant dilution ratio PFD system. For example, you might use a variable-flow pump to proportionally fill a gaseous storage medium such as a bag from a PFD system. In this case, the proportional sampling must meet the same specifications as varying dilution ratio PFD in paragraph (d)(3) of this section.</p> <p>(3) Varying dilution-ratio PFD. All the following provisions apply for varying dilution-ratio PFD:</p> <p>(i) Use a control system with sensors and actuators that can maintain exhaust flow and maintain proportional sampling over intervals as short as 200 ms (i.e., 5 Hz control).</p> <p>(ii) Account for any emission transit time in the PFD system, as necessary.</p> <p>(iii) You may not use a PFD system that requires preparatory tuning or calibration with a CVS or with the emission results from a CVS. Rather, you must be able to independently calibrate the PFD.</p>				
<p>(e) <u>Dilution air temperature, dilution ratio, residence time, and temperature control of PM samples.</u> Dilute PM samples at least once upstream of transfer lines. You may dilute PM samples upstream of a transfer line using full-flow dilution, or partial-flow dilution immediately downstream of a PM probe. In the case of partial-flow dilution, you may have up to 26 cm of insulated length between the end of the probe and the dilution stage, but we recommend that the length be as short as practical. The intent of these specifications is to minimize heat transfer to or from the emission sample before the final stage of dilution, other than the heat you may need to add to prevent aqueous condensation. This is accomplished by initially cooling the sample through dilution. Configure dilution systems as follows:</p> <p>(1) Set the diluent (i.e., dilution air) temperature to (25 ±5) °C. Measure this temperature as</p>				

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	<p>close as practical upstream of the point where diluent mixes with raw exhaust.</p> <p>(2) For any PM dilution system (i.e., CVS or PFD), dilute raw exhaust with diluent such that the minimum overall ratio of diluted exhaust to raw exhaust is within the range of (5:1 - 7:1) and is at least 2:1 for any primary dilution stage. Base this minimum value on the maximum vehicle exhaust flow rate for a given test interval. Either measure the maximum exhaust flow during a practice run of the test interval or estimate it based on accepted measurement practices (for example, you might rely on manufacturer-published literature).</p> <p>(3) Configure any PM dilution system to have an overall residence time of (1 to 5) s, as measured from the location of initial diluent introduction to the location where PM is collected on the sample media. Also configure the system to have a residence time of at least 0.5 s, as measured from the location of final diluent introduction to the location where PM is collected on the sample media. When determining residence times within sampling system volumes, use an assumed flow temperature of 25 °C and pressure of 101.325 kPa.</p> <p>(4) Control sample temperature to a (47 ±5) °C tolerance, as measured anywhere within 20 cm upstream or downstream of the PM storage media (such as a filter). Measure this temperature with a bare-wire junction thermocouple with wires that are (0.500 ±0.025) mm diameter, or with another suitable instrument that has equivalent performance.</p>				
5	145 Gaseous and PM probes, transfer lines, and sampling system components.				
	(a) <u>Continuous and batch sampling.</u> Determine the total mass of each constituent with continuous or batch sampling. Both types of sampling systems have probes, transfer lines, and other sampling system components that are described in this section.				
	(c) <u>Gaseous and PM sample probes.</u> A probe	MoRTH / CMVR / TAP-115/116	E/ECE/324 Rev.1/Add.82/Rev.3	3. PM and PMb Collection	

<p>is the first fitting in a sampling system. It protrudes into a raw or diluted exhaust stream to extract a sample, such that its inside and outside surfaces are in contact with the exhaust. A sample is transported out of a probe into a transfer line, as described in paragraph (d) of this section. The following provisions apply to sample probes:</p> <p>(1) <u>Probe design and construction</u>. Use sample probes with inside surfaces of 300 series stainless steel or, for raw exhaust sampling, use any nonreactive material capable of withstanding raw exhaust temperatures. Locate sample probes where constituents are mixed to their mean sample concentration. Locate each probe to minimize interference with the flow to other probes. We recommend that all probes remain free from influences of boundary layers, wakes, and eddies—especially near the outlet of a raw-exhaust tailpipe where unintended dilution might occur. Make sure that purging or back-flushing of a probe does not influence another probe during testing. You may use a single probe to extract a sample of more than one constituent as long as the probe meets all the specifications for each constituent.</p> <p>(2) <u>Gaseous sample probes</u>. Use either single-port or multi-port probes for sampling gaseous emissions. You may orient these probes in any direction relative to the raw or diluted exhaust flow. For some probes, you must control sample temperatures, as follows:</p> <p>(i) For probes that extract NO_x from diluted exhaust, control the probe's wall temperature to prevent aqueous condensation.</p> <p>(ii) For probes that extract hydrocarbons for THC or NMHC analysis from the diluted exhaust of compression-ignition engines, heat the probe section to approximately 190 °C to minimize contamination.</p> <p>(3) <u>PM sample probes</u>. Use PM probes with a single opening at the end. Orient PM probes to face directly upstream. If you shield a PM probe's opening with a PM pre-classifier such as a hat, you may not use the preclassifier we specify in paragraph (f)(1) of this section.</p>	<p>(Issue 4) Part XIV Chapter 6</p> <p>2.4.5 The particulate sampling probe shall be arranged as follows: It must be installed in the vicinity of the tunnel centerline; roughly 10 tunnel diameters downstream of the gas inlet, and have an internal diameter of at least 12 mm. The distance from the sampling tip to the filter mount must be at least five probe diameters, but must not exceed 1020 mm.</p> <p>2.4.6 The sample gas flow measuring unit consists of pumps, gas flow regulators and flow measuring units.</p> <p>Figure-8</p> <p>2.4.7 The hydrocarbon sampling system consists of a heated sampling probe, line, filter and pump. The sampling probe must be installed in such a way, at the same distance from the exhaust gas inlet as the particulate sampling probe that neither interferes with samples taken by the other. It must have a minimum internal diameter of 4 mm.</p> <p>2.4.8 All heated parts must be maintained at a temperature of 463 K (190 °C) ± 10 K by heating system.</p> <p>2.4.9 If it is not possible to compensate for variations in the flow rate there must be a heat exchanger and a temperature control device as specified in 2.3.3.1 above so as to ensure that the flow rate in the system is constant and the sampling rate is accordingly proportional.</p>	<p>E/ECE/TRANS/505 Regulation No. 83 page 140 Annex 4 – Appendix 5</p> <p>2.4.5. The particulate sampling probe shall meet the following conditions: It shall be installed near the tunnel centreline, roughly ten tunnel diameters downstream of the gas inlet, and have an internal diameter of at least 12 mm. The distance from the sampling tip to the filter mount shall be at least five probe diameters, but shall not exceed 1,020 mm.</p> <p>2.4.6. The sample gas flow measuring unit shall consist of pumps, gas flow regulators and flow measuring units.</p> <p>2.4.7. The hydrocarbon sampling system shall consist of a heated sampling probe, line, filter and pump. The sampling probe shall be installed at the same distance from the exhaust gas inlet as the particulate sampling probe, in such a way that neither interferes with samples taken by the other. It shall have a minimum internal diameter of 4 mm.</p> <p>2.4.8. All heated parts shall be maintained at a temperature of 463 K (190 °C) ± 10 K by the heating system.</p> <p>2.4.9. If it is not possible to compensate for variations in the flow rate provision shall be made for a heat exchanger and a temperature control device as specified in paragraph 2.3.3.1. so as to ensure that the flow rate in the system is constant and the sampling rate</p>	<p>(1) The collection of PMb may be conducted during the test measurement, before the start of the test or after completion of the test.</p> <p>(2) The whole exhaust gas shall be introduced into the dilution tunnel system, and PM in the diluted exhaust gas sucked by the PM sampling pump and PMb in the dilution air shall be collected in separate collecting filters. Furthermore, PM and PMb collection shall be started at the sampling start time and ended at the sampling end time prescribed in Attached Sheet 6. Moreover, in cases where PMb is measured, using the PM sampling device, the measurement shall be conducted by collecting the dilution air for the same length of period as that of the collection of PM before the start of the test or after completion of the test under a condition that the exhaust gas is not allowed to flow into the dilution tunnel for the same length of period as that of the collection of PM. In cases where the measurement has been conducted both before the start of the test and after completion of the test, the mean value of the respective measured values shall be determined.</p> <p>(3) The flow velocity of the diluted exhaust gas passing through the PM collecting filter shall be 35 cm/s or</p>
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		<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 6</p> <p>GAS SAMPLING SYSTEMS</p> <p>1 Scope:</p> <p>1.1 This Chapter describes two types of gas sampling systems in paragraphs 2.1 and 2.2 meeting the requirements specified in Para 4.2 of Chapter 3 of this Part. Another type described in paragraph 2.3, may be used if it meets these requirements.</p> <p>1.2 The laboratory shall mention, in its communications, the system of sampling used when performing the test. Systems not described in this chapter could be used, if it is proven to give equivalent results.</p> <p>2.0 Criteria relating to the variable-dilution system for measuring exhaust Gas Emissions</p> <p>2.1 Scope</p> <p>This section specifies the operating characteristics of an exhaust-gas sampling system intended to be used for measuring the true mass emissions of a vehicle exhaust in accordance with the provisions of TAP 115/116. The principle of variable-dilution sampling for measuring mass emissions requires three conditions to be satisfied:</p> <p>2.1.1 The vehicle exhaust gases must be continuously diluted with ambient air under specified conditions;</p> <p>2.1.2 The total volume of the mixture of exhaust gases and dilution air must be measured accurately;</p> <p>2.1.3 A continuously proportional sample of the dilution exhaust</p>	<p>accordingly proportional. Figure-5/2</p> <p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 173 Annex 5</p> <p>3. SAMPLING OF GASES</p> <p>3.1. The sampling probe shall be inserted into the exhaust pipe to a depth of at least 300 mm into the pipe connecting the exhaust with the sampling bag and as close as possible to the exhaust.</p> <p>3.2. The concentration in CO (CCO) and CO₂ (CCO₂) shall be determined from the measuring instrument readings or recordings, by use of appropriate calibration curves.</p> <p>3.3. The corrected concentration for carbon monoxide regarding four-stroke engines is:</p> <p>3.4. The concentration in CCO (see paragraph 3.2.) measured according to the formulae contained in paragraph 3.3. need not be corrected if the total of the concentrations measured (CCO + CCO₂) is for four-stroke engines at least:</p> <ul style="list-style-type: none"> - for petrol 15 per cent - for LPG 13.5 per cent - for NG 11.5 per cent 	<p>more and 100 cm/s or less. In this case, the increase of the pressure loss by the PM collecting filter at the end of the measurement from that at the start of the measurement shall not exceed 25 kPa.</p> <p>(4) The temperature of the diluted exhaust gas immediately before the PM collecting filter shall be 325 K (52 °C) (464 K (191 °C) in the case of the measurement of the exhaust gas during the periodic control operation of Attached Sheet 11) or below.</p>	
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		<p>gases and the dilution air must be collected for analysis. The quantity of gaseous pollutants emitted is determined from the proportional sample concentrations and the total volume measured during the test. The sample concentrations are corrected to take account of the pollutant content of the ambient air. In addition, where vehicles are equipped with compression ignition engines, their particulate emissions are measured. 2.2 Technical summary: Figure 7 gives a schematic diagram of the sampling system. 2.2.1 The vehicle exhaust gases must be diluted with a sufficient of ambient air to prevent any water condensation in the sampling and measuring system. 2.2.2 The exhaust-gas sampling system must be so designed as to make it possible to measure the average volume concentrations of the CO₂, CO, HC and NO_x, and in addition, in the case of vehicles equipped with compression-ignition engines, of the particulate emissions, contained in the exhaust gases emitted during the vehicle testing cycle.</p>			
	<p>(d) <u>Transfer lines</u>. You may use transfer lines to transport an extracted sample from a probe to an analyzer, storage medium, or dilution system, noting certain restrictions for PM sampling in §140(e). Minimize the length of all transfer lines by locating analyzers, storage media, and dilution systems as close to probes as practical. Minimize the number of bends in transfer lines and maximize the radius of any unavoidable bend. Avoid using 90° elbows, tees, and cross-fittings in transfer lines. Where such connections and fittings are necessary you must meet the temperature tolerances in</p>	<p>Not mentioned</p>	<p>Not mentioned</p>	<p>Not mentioned</p>	

<p>this paragraph (d). This may involve measuring temperature at various locations within transfer lines and fittings. You may use a single transfer line to transport a sample of more than one constituent, as long as the transfer line meets all the specifications for each constituent. The following construction and temperature tolerances apply to transfer lines:</p> <p>(1) <u>Gaseous samples</u>. Use transfer lines with inside surfaces of 300 series stainless steel, PTFE, Viton™, or any other material that you demonstrate has better properties for emission sampling. For raw exhaust sampling, use a non-reactive material capable of withstanding raw exhaust temperatures. You may use in-line filters if they do not react with exhaust constituents and if the filter and its housing meet the same temperature requirements as the transfer lines, as follows:</p> <p>(i) For NO_x transfer lines upstream of either an NO₂-to-NO converter that meets the specifications of 378 or a chiller that meets the specifications of 376, maintain a sample temperature that prevents aqueous condensation.</p> <p>(ii) For THC transfer lines for testing compression-ignition engines, maintain a wall temperature tolerance throughout the entire line of (191 ±11) °C. If you sample from raw exhaust, you may connect an unheated, insulated transfer line directly to a probe. Design the length and insulation of the transfer line to cool the highest expected raw exhaust temperature to no lower than 191 °C, as measured at the transfer line's outlet. For dilute sampling, you may use a transition zone between the probe and transfer line of up to 92 cm to allow your wall temperature to transition to (191 ±11) °C.</p> <p>(2) <u>PM samples</u>. Use heated transfer lines or a heated enclosure to minimize temperature differences between transfer lines and exhaust constituents. Use transfer lines made of 300 series stainless steel. Electrically ground the inside surface of PM transfer lines.</p> <p>(e) <u>Optional sample-conditioning components for gaseous sampling</u>. You may use the following sample-conditioning components to</p>				
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<p>prepare gaseous samples for analysis, as long as you do not install or use them in a way that adversely affects your ability to show that your vehicles comply with all applicable gaseous emission standards.</p> <p>(1) <u>NO₂-to-NO converter</u>. You may use an NO₂-to-NO converter that meets the converter conversion verification specified in 378 at any point upstream of a NO_x analyzer, sample bag, or other storage medium.</p> <p>(2) <u>Sample dryer</u>. You may use either type of sample dryer described in this paragraph (e)(2) to decrease the effects of water on gaseous emission measurements. You may not use a chemical dryer, or use dryers upstream of PM sample filters.</p> <p>(i) <u>Osmotic-membrane</u>. You may use an osmotic-membrane dryer upstream of any gaseous analyzer or storage medium, as long as it meets the temperature specifications in paragraph (d)(1) of this section. Because osmotic-membrane dryers may deteriorate after prolonged exposure to certain exhaust constituents, consult with the membrane manufacturer regarding your application before incorporating an osmotic-membrane dryer. Monitor the dewpoint, T_{dew}, and absolute pressure, p_{total}, downstream of an osmotic-membrane dryer. You may use continuously recorded values of T_{dew} and p_{total} in the amount of water calculations specified in 645. For our testing we may use average temperature and pressure values over the test interval or a nominal pressure value that we estimate as the dryer's average pressure expected during testing as constant values in the amount of water calculations specified in 645. For your testing, you may use the maximum temperature or minimum pressure values observed during a test interval or duty cycle or the high alarm temperature setpoint or low alarm pressure setpoint as constant values in the calculations specified in 645. For your testing, you may also use a nominal p_{total}, which you may estimate as the dryer's lowest absolute pressure expected during testing.</p> <p>(ii) <u>Thermal chiller</u>. You may use a thermal chiller upstream of some gas analyzers and</p>				
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<p>storage media. You may not use a thermal chiller upstream of a THC measurement system for compression-ignition engines, 2-stroke spark-ignition engines, or 4-stroke spark-ignition engines below 19 kW. If you use a thermal chiller upstream of an NO₂-to-NO converter or in a sampling system without an NO₂-to-NO converter, the chiller must meet the NO₂ loss-performance check specified in 376. Monitor the dewpoint, T_{dew}, and absolute pressure, p_{total}, downstream of a thermal chiller. You may use continuously recorded values of T_{dew} and p_{total} in the amount of water calculations specified in 645. If it is valid to assume the degree of saturation in the thermal chiller, you may calculate T_{dew} based on the known chiller performance and continuous monitoring of chiller temperature, $T_{chiller}$. If it is valid to assume a constant temperature offset between $T_{chiller}$ and T_{dew}, due to a known and fixed amount of sample reheat between the chiller outlet and the temperature measurement location, you may factor in this assumed temperature offset value into emission calculations. If we ask for it, you must show by engineering analysis or by data the validity of any assumptions allowed by this paragraph (e)(2)(ii). For our testing we may use average temperature and pressure values over the test interval or a nominal pressure value that we estimate as the dryer's average pressure expected during testing as constant values in the calculations specified in 645. For your testing you may use the maximum temperature and minimum pressure values observed during a test interval or duty cycle or the high alarm temperature setpoint and the low alarm pressure setpoint as constant values in the amount of water calculations specified in 645. For your testing you may also use a nominal p_{total}, which you may estimate as the dryer's lowest absolute pressure expected during testing.</p> <p>(3) <u>Sample pumps</u>. You may use sample pumps upstream of an analyzer or storage medium for any gas. Use sample pumps with inside surfaces of 300 series stainless steel, PTFE, or any other material that you</p>				
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<p>demonstrate has better properties for emission sampling. For some sample pumps, you must control temperatures, as follows: (i) If you use a NO_x sample pump upstream of either an NO₂-to-NO converter that meets 378 or a chiller that meets 376, it must be heated to prevent aqueous condensation. (ii) For testing compression-ignition engines, if you use a THC sample pump upstream of a THC analyzer or storage medium, its inner surfaces must be heated to a tolerance of (191 ±11) °C. (4) <u>Ammonia Scrubber</u>. You may use ammonia scrubbers for any or all gaseous sampling systems to prevent interference with NH₃, poisoning of the NO₂-to-NO converter, and deposits in the sampling system or analyzers. Follow the ammonia scrubber manufacturer's recommendations or use accepted measurement practices in applying ammonia scrubbers.</p>				
<p>(f) <u>Optional sample-conditioning components for PM sampling</u>. You may use the following sample-conditioning components to prepare PM samples for analysis, as long as you do not install or use them in a way that adversely affects your ability to show that your engines comply with the applicable PM emission standards. You may condition PM samples to minimize positive and negative biases to PM results, as follows: (1) <u>PM preclassifier</u>. You may use a PM preclassifier to remove large-diameter particles. The PM preclassifier may be either an inertial impactor or a cyclonic separator. It must be constructed of 300 series stainless steel. The preclassifier must be rated to remove at least 50 % of PM at an aerodynamic diameter of 10 μm and no more than 1 % of PM at an aerodynamic diameter of 1 μm over the range of flow rates for which you use it. Follow the preclassifier manufacturer's instructions for any periodic servicing that may be necessary to prevent a buildup of PM. Install the preclassifier in the dilution system downstream of the last dilution stage. Configure the preclassifier outlet with a means of bypassing</p>	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.3.2.5. The particulate sampling unit consists of a dilution tunnel, a sampling probe, a filter unit, a partial flow pump, and a flow rate regulator and measuring unit. The particulate sampling part flow is drawn through two series mounted filters. The sampling probe for the test gas flow for particulates shall be so arranged within the dilution tract that a representative sample gas flow can be taken from the homogenous air / exhaust mixture and an air / exhaust gas mixture temperature of 325 K (52 °C) shall not exceed immediately before the particulate filter. The temperature of the gas flow in the flow meter shall not fluctuate more than ± 3K, nor the mass flow rate shall fluctuate more than ± 5%. If the</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 144 Annex 4 – Appendix 5 Particulate sampling system: S4 Sampling probe in the dilution tunnel, Fp Filter unit consisting of two series-mounted filters; switching arrangement for further parallel-mounted pairs of filters, Sampling line, Pumps, flow regulators, flow measuring units. 3.2. Critical-flow venturi dilution device (CFV-CVS) (Figure 5/4) 3.2.1. The use of a critical-flow venturi in connection with the CVS sampling procedure is based on the principles of flow mechanics for critical flow. The variable mixture flow rate of dilution and exhaust gas is maintained at sonic velocity which is directly proportional to the square root of the gas temperature. Flow is</p>		

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	<p>any PM sample media so the preclassifier flow may be stabilized before starting a test. Locate PM sample media within 75 cm downstream of the preclassifier's exit. You may not use this preclassifier if you use a PM probe that already has a preclassifier. For example, if you use a hat-shaped preclassifier that is located immediately upstream of the probe in such a way that it forces the sample flow to change direction before entering the probe, you may not use any other preclassifier in your PM sampling system.</p>	<p>volume of flow changes unexpectedly as a result of excessive filter loading, the test should be stopped. When it is repeated, the rate of flow shall be decreased and / or larger filter shall be used. The filters shall be removed from the chamber not earlier than an hour before the test begins.</p> <p>4.3.2.6. The necessary particulate filters should be conditioned (as regards temperature and humidity) in an open dish which shall be protected against dust ingress for at least 8 and not more than 56 hours before the test in an air-conditioned chamber. After this conditioning, the uncontaminated filters shall be weighed and stored until they are used. The temperature of the chamber (or room) in which particulate filters are conditioned and weighed shall be maintained to within 295 +/- 3 K (22°C +/- 3°C) during all filters conditioning and weighing. The humidity shall be maintained to a dew point of 282.5 K +/- 3 K (9.5°C +/- 3°C) and a relative humidity of 45% +/- 8%.</p>	<p>continually monitored, computed and integrated throughout the test. The use of an additional critical-flow sampling venturi ensures the proportionality of the gas samples taken. As both pressure and temperature are equal at the two venturi inlets the volume of the gas flow diverted for sampling is proportional to the total volume of diluted exhaust-gas mixture produced, and thus the requirements of this annex are met.</p>		
6	170 Batch sampling for gaseous and PM constituents.	Not mentioned	Not mentioned		
	<p>Batch sampling involves collecting and storing emissions for later analysis. Examples of batch sampling include collecting and storing gaseous emissions in a bag or collecting and storing PM on a filter. You may use batch sampling to store emissions that have been diluted at least once in some way, such as with CVS, PFD, or BMD. You may use batch-sampling to store undiluted emissions.</p>				
	<p>(a) <u>Sampling methods</u>. Sample at a flow rate proportional to the CVS as follows:</p>				

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<p>(1) Validate proportional sampling after an emission test as described in 545.</p> <p>(2) Select storage media that will not significantly change measured emission levels (either up or down). For example, do not use sample bags for storing emissions if the bags are permeable with respect to emissions or if they off gas emissions to the extent that it affects your ability to demonstrate compliance with the applicable gaseous emission standards.</p> <p>(3) You must follow the requirements in 140(e)(2) related to PM dilution ratios</p>				
<p>(b) <u>Gaseous sample storage media.</u> Store gas volumes in sufficiently clean containers that minimally off-gas or allow permeation of gases. Use accepted measurement practices to determine acceptable thresholds of storage media cleanliness and permeation. To clean a container, you may repeatedly purge and evacuate a container and you may heat it. Use a flexible container (such as a bag) within a temperature-controlled environment, or use a temperature controlled rigid container that is initially evacuated or has a volume that can be displaced, such as a piston and cylinder arrangement. Use containers meeting the specifications in the following table 1 of 170</p>				
<p>c) <u>PM sample media.</u> Apply the following methods for sampling particulate emissions:</p> <p>(1) If you use filter-based sampling media to extract and store PM for measurement, your procedure must meet the following specifications:</p> <p>(i) If you expect that a filter's total surface concentration of PM will exceed 400 µg, assuming a 38 mm diameter filter stain area, for a given test interval, you may use filter media with a minimum initial collection efficiency of 98 %; otherwise you must use a filter media with a minimum initial collection efficiency of 99.7 %.</p> <p>(ii) The filter must be circular, with an overall diameter of 46.50 ±0.6 mm and an exposed diameter of at least 38 mm. See the cassette specifications in paragraph (c)(1)(vii) of this section.</p>				

<p>(iii) Use a pure PTFE filter material that does not have any flow-through support bonded to the back and has an overall thickness of 40 ±20 μm. An inert polymer ring may be bonded to the periphery of the filter material for support and for sealing between the filter cassette parts. We consider Polymethylpentene (PMP) and PTFE inert materials for a support ring, but other inert materials may be used. See the cassette specifications in paragraph (c)(1)(vii) of this section. We allow the use of PTFE-coated glass fiber filter material, as long as this filter media selection does not affect your ability to demonstrate compliance with the applicable standards, which we base on a pure PTFE filter material.</p> <p>(v) To minimize turbulent deposition and to deposit PM evenly on a filter, use a filter holder with a 12.5° (from center) divergent cone angle to transition from the transfer-line inside diameter to the exposed diameter of the filter face. Use 300 series stainless steel for this transition.</p> <p>(vi) Maintain a filter face velocity near 100 cm/s with less than 5% of the recorded flow values exceeding 100 cm/s, unless you expect either the net PM mass on the filter to exceed 400 μg, assuming a 38 mm diameter filter stain area. Measure face velocity as the volumetric flow rate of the sample at the pressure upstream of the filter and temperature of the filter face as measured in 140(e), divided by the filter's exposed area. You may use the exhaust stack or CVS tunnel pressure for the upstream pressure if the pressure drop through the PM sampler up to the filter is less than 2 kPa.</p> <p>vii) Use a clean cassette designed to the specifications of Figure 1 of 170. In auto changer configurations, you may use cassettes of similar design. Cassettes must be made of one of the following materials: Delrin™, 300 series stainless steel, polycarbonate, acrylonitrile-butadiene-styrene (ABS) resin, or conductive polypropylene. We recommend that you keep filter cassettes clean by periodically washing or wiping them with a compatible solvent applied using a lint-free cloth. Depending upon your cassette material,</p>				
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	<p>ethanol (C₂H₅OH) might be an acceptable solvent. Your cleaning frequency will depend on your vehicle's PM and HC emissions.</p> <p>(viii) If you keep the cassette in the filter holder after sampling, prevent flow through the filter until either the holder or cassette is removed from the PM sampler. If you remove the cassettes from filter holders after sampling, transfer the cassette to an individual container that is covered or sealed to prevent communication of semi-volatile matter from one filter to another. If you remove the filter holder, cap the inlet and outlet. Keep them covered or sealed until they return to the stabilization or weighing environments.</p> <p>(ix) The filters should be loaded into cassettes, filter holders, or auto changer apparatus before removal from the PM stabilization and weighing environments.</p>				
7	<p>190 PM-stabilization and weighing environments for gravimetric analysis.</p>				
	<p>(a) This section describes the two environments required to stabilize and weigh PM for gravimetric analysis: the PM stabilization environment, where filters are stored before weighing; and the weighing environment, where the balance is located. The two environments may share a common space. These volumes may be one or more rooms, or they may be much smaller, such as a glove box or an automated weighing system consisting of one or more countertop-sized environments.</p>	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 7</p> <p>4.2 Metering a limited quantity of pure gas (CO or C₃H₈) by means of a gravimetric technique.</p> <p>4.2.1 The following gravimetric procedure may be used to verify the CVS system. The mass of a small cylinder filled with either carbon monoxide or propane is determined with a precision of ± 0.01 gram. For about 5 to 10 minutes the CVS system is operated as in a normal exhaust emission test, while CO or propane is injected into the system. The quantity of pure gas involved is determined by means of differential weighing. The gas accumulated in the bag is then analysed by means of the equipment normally used for the exhaust gas analysis. The results</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 Annex 4 – Appendix 7</p> <p>3. Metering a limited quantity of pure gas (CO or C₃H₈) by means of a gravimetric technique</p> <p>3.1. The following gravimetric procedure may be used to verify the CVS system.</p> <p>The weight of a small cylinder filled with either carbon monoxide or propane is determined with a precision of " 0.01 g. For about 5 to 10 minutes, the CVS system is operated as in a normal exhaust emission test, while CO or propane is injected into the system. The quantity of pure gas involved is determined by means of differential weighing. The gas accumulated in the bag is then analysed by means of the equipment normally used for</p>	<p>214 Weighing balance</p> <p>The weighing balance to be used for measuring the weight of the collecting filter shall comply with the following requirements:</p> <p>(1) The weighing balance shall be installed inside the weighing room in such a way that it is not affected by vibration.</p> <p>(2) The readable limit of the weighing balance shall be 0.1 µg or less, and the standard deviation shall be 0.25 µg or less.</p> <p>(3) The weighing balance shall be calibrated before measuring the weight of the collecting filter, using an internal calibration method (sensitivity calibration by internal calibration weights) or an external calibration method (sensitivity</p>	

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		are then compared to the concentration figures computed previously.	exhaust-gas analysis. The results are then compared to the concentration figures computed previously.	calibration by external standard weights). In addition, the external standard weights to be used shall be of E2 or higher.	
	(b) Keep both the stabilization and the weighing environments free of ambient contaminants, such as dust, aerosols, or semi-volatile material that could contaminate PM samples. We recommend that these environments conform with an "as-built" Class Six clean room specification according to ISO 14644-1 Deviate from ISO 14644-1 as necessary to minimize air motion that might affect weighing. We recommend maximum air-supply and air-return velocities of 0.05 m/s in the weighing environment.			(4) Prior to the weighing of the collecting filter, static electricity shall be eliminated using a Polonium static eliminator or a device with the similar effect.	
	(d) Maintain the following ambient conditions within the two environments during all stabilization and weighing: (1) <u>Ambient temperature and tolerances.</u> Maintain the weighing environment at a tolerance of $(22 \pm 1) \text{ }^{\circ}\text{C}$. If the two environments share a common space, maintain both environments at a tolerance of $(22 \pm 1) \text{ }^{\circ}\text{C}$. If they are separate, maintain the stabilization environment at a tolerance of $(22 \pm 3) \text{ }^{\circ}\text{C}$. (2) <u>Dewpoint.</u> Maintain a dewpoint of $9.5 \text{ }^{\circ}\text{C}$ in both environments. This dewpoint will control the amount of water associated with sulfuric acid (H_2SO_4) PM, such that 1.2216 grams of water will be associated with each gram of H_2SO_4 . (3) <u>Dewpoint tolerances.</u> If the expected fraction of sulfuric acid in PM is unknown, we recommend controlling dewpoint at within $\pm 1 \text{ }^{\circ}\text{C}$ tolerance. This would limit any dewpoint-related change in PM to less than $\pm 2 \%$, even for PM that is 50 % sulfuric acid. If you know your expected fraction of sulfuric acid in PM, we recommend that you select an appropriate dewpoint tolerance for showing compliance with emission standards using the following table as a guide: Table 1 of 190			4. Standard Filter As regards the standard filter, two unused filters shall be soaked in the weighing room in advance. Then, weighing shall be conducted at the same time before and after the test when the collecting filter is measured. At this time, in cases where the mean weight of the two standard filters has changed more than $10\mu\text{g}$, the collecting filter concerned shall be disposed and the exhaust gas test shall be conducted again. Moreover, the standard filter shall have the same diameter and same material as those of the collecting filter.	

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	<p>e) Verify the following ambient conditions using measurement instruments that meet the specifications in subpart C of this part:</p> <p>(1) Continuously measure dewpoint and ambient temperature. Use these values to determine if the stabilization and weighing environments have remained within the tolerances specified in paragraph (d) of this section for at least 60 min before weighing sample media (e.g., filters).</p> <p>(2) Continuously measure atmospheric pressure within the weighing environment. An acceptable alternative is to use a barometer that measures atmospheric pressure outside the weighing environment, as long as you can ensure that atmospheric pressure at the balance is always within ± 100 Pa of that outside environment during weighing operations. Record atmospheric pressure as you weigh filters, and use these pressure values to perform the buoyancy correction in 690.</p>				
	<p>(f) We recommend that you install a balance as follows:</p> <p>(1) Install the balance on a vibration-isolation platform to isolate it from external noise and vibration.</p> <p>(2) Shield the balance from convective airflow with a static-dissipating draft shield that is electrically grounded.</p> <p>(3) Follow the balance manufacturer's specifications for all preventive maintenance.</p> <p>(4) Operate the balance manually or as part of an automated weighing system.</p>				
	<p>(g) Minimize static electric charge in the balance environment, as follows:</p> <p>(1) Electrically ground the balance.</p> <p>(2) Use 300 series stainless steel tweezers if PM sample media (e.g., filters) must be handled manually.</p> <p>(3) Ground tweezers with a grounding strap, or provide a grounding strap for the operator such that the grounding strap shares a common ground with the balance. Make sure grounding</p>				

	<p>straps have an appropriate resistor to protect operators from accidental shock.</p> <p>(4) Provide a static-electricity neutralizer that is electrically grounded in common with the balance to remove static charge from PM sample media (e.g., filters), as follows:</p> <p>(i) You may use radioactive neutralizers such as a Polonium (²¹⁰Po) source. Replace radioactive sources at the intervals recommended by the neutralizer manufacturer.</p> <p>(ii) You may use other neutralizers, such as corona-discharge ionizers. If you use a corona-discharge ionizer, we recommend that you monitor it for neutral net charge according to the ionizer manufacturer's recommendations.</p> <p>(5) We recommend that you use a device to monitor the static charge of PM sample media (e.g., filter) surface.</p> <p>(6) We recommend that you neutralize PM sample media (e.g., filters) to within ±2.0 V of neutral. Measure static voltages as follows:</p> <p>(i) Measure static voltage of PM sample media (e.g., filters) according to the electrostatic voltmeter manufacturer's instructions.</p> <p>(ii) Measure static voltage of PM sample media (e.g., filters) while the media is at least 15 cm away from any grounded surfaces to avoid mirror image charge interference.</p>				
	Measurement Instruments				
8	201 Overview and general provisions.	Not mentioned	Not mentioned	Not mentioned	
	<p>(a) <u>Scope</u>. This section specifies measurement instruments and associated system requirements related to emission testing in a laboratory or similar environment. This includes laboratory instruments for measuring test parameters, ambient conditions, flow-related parameters, and emission concentrations.</p>				
	<p>(b) <u>Instrument types</u>. You may use any of the specified instruments as described in this section to perform emission tests. Where we specify more than one instrument for a particular measurement, we may identify which</p>				

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	instrument serves as the reference for comparing with an alternate procedure.				
	(d) <u>Redundant systems</u> . For all measurement instruments described in this subpart, you may use data from multiple instruments to calculate test results for a single test. If you use redundant systems, use accepted measurement practices to use multiple measured values in calculations or to disregard individual measurements. Note that you must keep your results from all measurements. This requirement applies whether or not you actually use the measurements in your calculations				
	(e) <u>Range</u> . You may use an instrument's response above 100 % of its operating range if this does not affect your ability to show that your emissions comply with the applicable emission standards. Note that we require additional testing and reporting if an analyzer responds above 100 % of its range. See 550. Auto-ranging analyzers do not require additional testing or reporting.				
	(f) <u>Related subparts for laboratory testing</u> . Section 300 of this part describes how to evaluate the performance of the measurement instruments in this subpart. In general, if an instrument is specified in a specific section of this subpart, its calibration and verifications are typically specified in a similarly numbered section in subpart D of this part. For example, 290 gives instrument specifications for PM balances and 390 describes the corresponding calibrations and verifications.				
9	202 Data updating, recording, and control.	Not mentioned	Not mentioned	Not mentioned	
	Your test system must be able to update data, record data and control systems related to operator demand, the dynamometer, sampling equipment, and measurement instruments. Use data acquisition and control systems that can record at the specified minimum frequencies, as follows: Table 1 of 202				

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10	205 Performance specifications for measurement instruments.	Not mentioned	Not mentioned	Not mentioned	
	Your test system as a whole must meet all the applicable calibrations, verifications, and test-validation criteria specified. (a) In order to ensure that your instruments will comply with the requirements of this test procedure, we recommend that your instruments meet the specifications in Table 1 of this section for all ranges you use for testing. Retain documentation you receive from instrument manufacturers showing that your instruments meet the specifications in Table 1 of this section				
	(b) You may use a measurement instrument that does not meet the accuracy, repeatability, or noise specifications in Table 1 of 205, as long as you meet the following criteria: (1) Your measurement systems meet all the other required calibration, verification, and validation specifications in subparts D and F of this part, as applicable. (2) The measurement deficiency does not adversely affect your ability to demonstrate compliance with the applicable standards. Table 1 of 205				
	MEASUREMENT OF PARAMETERS AND AMBIENT CONDITIONS				
11	215 Pressure transducers, temperature sensors, and dewpoint sensors.			Not mentioned	
	(a) <u>Application</u> . Use instruments as specified in this section to measure pressure, temperature, and dewpoint.	Temperature sensors mentioned but no details have been given. Pressure transducers and dewpoint sensors not mentioned	Temperature sensors mentioned but no details have been given. Pressure transducers and dewpoint sensors not mentioned		
	(c) <u>Temperature</u> . For PM-balance environments or other precision temperature measurements over a narrow temperature range, we recommend thermistors. For other applications we recommend thermocouples that are not grounded to the thermocouple sheath. You may use other temperature sensors, such				

	as resistive temperature detectors (RTDs).				
	(d) <u>Pressure</u> . Pressure transducers must be located in a temperature-controlled environment, or they must compensate for temperature changes over their expected operating range. Transducer materials must be compatible with the fluid being measured. For atmospheric pressure or other precision pressure measurements, we recommend either capacitance-type, quartz crystal, or laser-interferometer transducers. For other applications, we recommend either strain gage or capacitance-type pressure transducers. You may use other pressure-measurement instruments, such as manometers, where appropriate.				
	(e) <u>Dewpoint</u> . For PM-stabilization environments, we recommend chilled-surface hygrometers, which include chilled mirror detectors and chilled surface acoustic wave (SAW) detectors. For other applications, we recommend thin-film capacitance sensors. You may use other dewpoint sensors, such as a wet-bulb/dry-bulb psychrometer, where appropriate.				
12	230 CHASSIS DYNAMOMETER				
	(a) The dynamometer shall simulate the road load force and inertia specified for the vehicle being tested, and shall determine the distance traveled during each phase of the test procedure. (2)(i) An electric dynamometer that has a single roll with a nominal diameter of 48 inches (1.20 to 1.25 meters).	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 4 CHASSIS DYNAMOMETER Section I 1. Definition of a Chassis Dynamometer with Fixed Load Curve 1.1. Introduction : In the event that total resistance to progress on the road is not reproduced on the chassis dynamometer between speeds of 10 and 120 km/h, it is recommended to use a chassis	Annex 4 - Appendix 2 CHASSIS DYNAMOMETER 1. DEFINITION OF A CHASSIS DYNAMOMETER WITH FIXED LOAD CURVE 1.1. Introduction In the event that the total resistance to progress on the road cannot be reproduced on the chassis dynamometer between speeds of 10 km/h and 120 km/h, it is recommended that a chassis dynamometer having the characteristics defined below should be used. 1.2. Definition	5-4 Setting of chassis dynamometer load The chassis dynamometer load shall be set, after measuring the running resistance of the test vehicle on a test road as specified in Attached Sheet 4, in such a way that the running resistance value of the test vehicle will be reproduced. In this case, the test vehicle and chassis dynamometer shall be warmed up thoroughly by operating the test vehicle continuously on the	

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		<p>dynamometer having the characteristics defined below.</p> <p>1.2. Definition</p> <p>1.2.1. The chassis dynamometer may have one or two rollers. The front roller drives, directly or indirectly, the inertia masses and the power absorption device.</p> <p>1.2.2. The load absorbed by the brake and the chassis dynamometer internal frictional effects from the speed of 0 to 120 km/h is as follows:</p> $F = (a + b * V^2) +/- 0.1 * F80$ <p>(without being negative)</p> <p>where:</p> <p>F = total load absorbed by the chassis dynamometer (N)</p> <p>a = value equivalent to rolling resistance (N)</p> <p>b = value equivalent to coefficient of air resistance (N/(km/h)²)</p> <p>V = speed (km/h)</p> <p>F80 = load at the speed of 80 km/h (N)</p>	<p>1.2.1. The chassis dynamometer may have one or two rollers. The front roller shall drive, directly or indirectly, the inertial masses and the power absorption device.</p> <p>1.2.2. The load absorbed by the brake and the chassis dynamometer internal frictional effects between the speeds of 0 and 120 km/h is as follows:</p> $F = (a + b.V^2) \pm 0.1.F80$ (without being negative) <p>where:</p> <p>F = total load absorbed by the chassis dynamometer (N)</p> <p>a = value equivalent to rolling resistance (N)</p> <p>b = value equivalent to coefficient of air resistance (N/(km/h)²)</p> <p>V = speed (km/h)</p> <p>F80 = load at 80 km/h (N).</p>	<p>chassis dynamometer at a speed of 60 km/h or more.</p>	
	<p>(c) Other dynamometer configurations may be used for testing if it can be demonstrated that the simulated road load power and inertia are equivalent, and if approved in advance by the Administration.</p>				
	<p>(d) An electric dynamometer meeting the requirements of paragraph (b)(2) of this section, or a dynamometer approved as equivalent under paragraph (c) of this section, must be used for all types of emission testing in the following situations.</p> <p>(1)(i) Gasoline vehicles which are part of an engine family which is designated to meet the phase-in of SFTP compliance required under the implementation schedule of table A00-1 of § 86.000-08, or table A00-3, or table A00-5 of</p>				

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	§ 86.000–09. (ii) Diesel LDVs and LDT1s which are part of an engine family which is designated to meet the phase-in of SFTP compliance required under the implementation schedule of table A00–1 of § 86.000–08, or table A00–3, or table A00– 5 of § 86.000–09.				
	FLOW-RELATED MEASUREMENTS				
13	240 Dilution air and diluted exhaust flow meters.	Not mentioned	Not mentioned	Not mentioned	
	(a) <u>Application</u> . Use a diluted exhaust flow meter to determine instantaneous diluted exhaust flow rates or total diluted exhaust flow over a test interval. You may use the difference between a diluted exhaust flow meter and a dilution air meter to calculate raw exhaust flow rates or total raw exhaust flow over a test interval.				
	(b) <u>Component requirements</u> . Note that your overall system for measuring diluted exhaust flow must meet the linearity verification in 307 and the calibration and verifications in 340 and 341. You may use the following meters: (1) For constant-volume sampling (CVS) of the total flow of diluted exhaust, you may use a critical-flow venturi (CFV) or multiple critical-flow venturis arranged in parallel, a positive-displacement pump (PDP), or an ultrasonic flow meter (UFM). Combined with an upstream heat exchanger, either a CFV or a PDP will also function as a passive flow controller in a CVS system. However, you may also combine any flow meter with any active flow control system to maintain proportional sampling of exhaust constituents. You may control the total flow of diluted exhaust, or one or more sample flows, or a combination of these flow controls to maintain proportional sampling. Ensure that any dilute exhaust flow measurement is immune to measurement performance degradation caused by pulsating exhaust flow. (2) For any other dilution system, you may use a laminar flow element, an ultrasonic flow				

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	meter, a subsonic venturi, a critical-flow venturi or multiple critical-flow venturis arranged in parallel, a positive-displacement meter, a thermal-mass meter, an averaging Pitot tube, or a hot-wire anemometer.				
	(c) <u>Flow conditioning</u> . For any type of diluted exhaust flow meter, condition the flow as needed to prevent wakes, eddies, circulating flows, or flow pulsations from affecting the accuracy or repeatability of the meter. For some meters, you may accomplish this by using a sufficient length of straight tubing (such as a length equal to at least 10 pipe diameters) or by using specially designed tubing bends, orifice plates or straightening fins to establish a predictable velocity profile upstream of the meter.				
	d) <u>Exhaust cooling</u> . You may cool diluted exhaust upstream of a dilute-exhaust flow meter, as long as you observe all the following provisions: (1) Do not sample PM downstream of the cooling. (2) If cooling causes exhaust temperatures above 202 °C to decrease to below 180 °C, do not sample NMHC downstream of the cooling for compression-ignition engines. (3) If cooling causes aqueous condensation, do not sample NO _x downstream of the cooling unless the cooler meets the performance verification in 376. (4) If cooling causes aqueous condensation before the flow reaches a flow meter, measure dewpoint, T_{dew} and pressure, p_{total} at the flow meter inlet. Use these values in emission calculations according to 650.				
14	245 Sample flow meter for batch sampling.	Not mentioned	Not mentioned	Not mentioned	
	a) <u>Application</u> . Use a sample flow meter to determine sample flow rates or total flow sampled into a batch sampling system over a test interval.				

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	(b) <u>Component requirements</u> . This may involve a laminar flow element, an ultrasonic flow meter, a subsonic venturi, a critical-flow venturi or multiple critical-flow venturis arranged in parallel, a positive-displacement meter, a thermal-mass meter, an averaging Pitot tube, or a hot-wire anemometer. For the special case where CFVs are used for both the diluted exhaust and sample-flow measurements and their upstream pressures and temperatures remain similar during testing, you do not have to quantify the flow rate of the sample-flow CFV. In this special case, the sample-flow CFV inherently flow-weights the batch sample relative to the diluted exhaust CFV.				
	(c) <u>Flow conditioning</u> . For any type of sample flow meter, condition the flow as needed to prevent wakes, eddies, circulating flows, or flow pulsations from affecting the accuracy or repeatability of the meter. For some meters, you may accomplish this by using a sufficient length of straight tubing (such as a length equal to at least 10 pipe diameters) or by using specially designed tubing bends, orifice plates or straightening fins to establish a predictable velocity profile upstream of the meter.				
15	248 Gas divider.	Gas divider is only mentioned but its application is not given	Gas divider is only mentioned but its application is not given	Gas divider is only mentioned but its application is not given	
	(a) <u>Application</u> . You may use a gas divider to blend calibration gases.	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.5.4. The concentrations specified in Chapter 7 of this part may also be obtained by means of a gas divider, diluting with purified nitrogen or with purified synthetic air. The accuracy of the mixing device shall be such that the concentrations of the diluted calibration gases may be determined within ±	E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 184 Annex 7 4.5.4. The concentrations specified in Chapter 7 of this part may also be obtained by means of a gas divider, diluting with purified nitrogen or with purified synthetic air. The accuracy of the mixing device shall be such that the concentrations of the diluted calibration gases may be determined within ±	(2) The calibration gas may depend on a gas divider. (3) The accuracy of concentration indication of calibration gas shall be within □2% of the indicated concentration. Also, if it depends on a gas divider, it shall be within □2% of divided concentration.	

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		2%.		
	(b) <u>Component requirements.</u> Use a gas divider that blends gases to the specifications of 750 and to the flow-weighted concentrations expected during testing. You may use critical-flow gas dividers, capillary-tube gas dividers, or thermal-mass-meter gas dividers.			
	CO AND CO₂ MEASUREMENTS			
16	250 Nondispersive infra-red analyzer.			Nondispersive infrared analyzer (NDIR) is used for measuring CO ₂ Concentration for Gasoline, LPG and CNG fuel and measuring CO concentration for diesel fuel.
	(a) <u>Application.</u> Use a nondispersive infra-red (NDIR) analyzer to measure CO and CO ₂ concentrations in raw or diluted exhaust for either batch or continuous sampling.	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.3.1.1. Carbon monoxide (CO) and carbon dioxide (CO ₂) analysis. The carbon monoxide and carbon dioxide analysers shall be of the Non-Dispersive Infra Red (NDIR) absorption type.	E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 94 Annex 4 4.3.1.1 Carbon monoxide (CO) and carbon dioxide (CO ₂) analysis: Analysers shall be of the non-dispersive infra-red (NDIR) absorption type.	3-6 CO ₂ emission weight The CO ₂ emission weight shall be determined using the following formulas: CO ₂ mass = Vmix X CO ₂ density X CO ₂ conc /100 CO ₂ conc = CO ₂ e -CO ₂ d(1-1/DF) Where, CO ₂ mass : CO ₂ emission weight g/km CO ₂ density : 1.83 (CO ₂ weight per liter under standard condition)g/l CO ₂ conc : Net concentration of CO ₂ % CO ₂ e : CO ₂ concentration of diluted exhaust gas % CO ₂ d : CO ₂ concentration of dilution air %
	b) <u>Component requirements.</u> You may use an NDIR analyzer that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.			

	HYDROCARBON MEASUREMENTS			
17	260 Flame-ionization detector.	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.3.1.2 Hydrocarbons (HC) analysis - spark-ignition engines: The analyser shall be of the flame ionisation (FID) type calibrated with propane gas expressed equivalent to carbon atoms (C1). 4.3.1.3 Hydrocarbons (HC) analysis - compression-ignition engines: he analyser shall be of the flame ionisation type with detector, valves, pipework, etc., heated to 463 K (190 °C) " 10 K (HFID). It shall be calibrated with propane gas expressed equivalent to carbon atoms (C1).</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 94 Annex 4 Hydrocarbons (HC) analysis - spark-ignition engines: The analyser shall be of the flame ionisation (FID) type calibrated with propane gas expressed equivalent to carbon atoms (C1). Hydrocarbons (HC) analysis - compression-ignition engines: he analyser shall be of the flame ionisation type with detector, valves, pipework, etc., heated to 463 K (190 °C) " 10 K (HFID). It shall be calibrated with propane gas expressed equivalent to carbon atoms (C1).</p>	<p>Heated flame ionization detector (HFID) is used for measuring concentration of THC in Diesel oil fuel.</p>
	<p>(a) <u>Application</u>. Use a flame-ionization detector (FID) analyzer to measure hydrocarbon concentrations in raw or diluted exhaust for either batch or continuous sampling. Determine hydrocarbon concentrations on a carbon number basis of one, C₁. Determine methane and nonmethane hydrocarbon values as described in paragraph (e) of this section. See subpart I of this part for special provisions that apply to measuring hydrocarbons when testing with oxygenated fuels.</p>	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 11 Annexure 1 4.3.1 Hydrocarbon Analyser 4.3.1.1 The atmosphere within the chamber is monitored using a hydrocarbon detector of the flame ionization detector (FID) type. Sample gas must be drawn from the midpoint of one side wall or roof of the chamber and any bypass flow must be returned to the enclosure, preferably to a point immediately downstream of the mixing fan. 4.3.1.2 The hydrocarbon analyzer must have a response time to 90% of final reading of less than 1.5 seconds. Its stability</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 182 Annex 7 4.3.1. Hydrocarbon analyser 4.3.1.1. 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 roof of the chamber and any bypass flow shall be returned to the enclosure, preferably to a point immediately downstream of the mixing fan. 4.3.1.2. The hydrocarbon analyser shall have a response time to 90 per cent of final reading of less than 1.5 seconds. Its</p>	

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		<p>must 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.</p> <p>4.3.1.3 The repeatability for the analyzer expressed as one standard deviation must be better than 1% of full scale deflection at zero and at 80% ± 20% of full scale on all ranges used.</p> <p>4.3.1.4 The operational ranges of the analyzer must be chosen to give best resolution over the measurement, calibration and leak checking procedures.</p>	<p>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.</p> <p>4.3.1.3. 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.</p> <p>4.3.1.4. The operational ranges of the analyser shall be chosen to give best resolution over the measurement, calibration and leak checking procedures.</p>		
	<p>(b) <u>Component requirements.</u> You may use a FID that has compensation algorithms that are functions of other gaseous measurements and the vehicle's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.</p>				
	<p>(c) <u>Heated FID analyzers.</u> For compression-ignition engines, you must use heated FID analyzers that maintain all surfaces that are exposed to emissions at a temperature of (191 ± 11) °C.</p>				
	<p>(d) <u>FID fuel and burner air.</u> Use FID fuel and burner air that meet the specifications of 750. Do not allow the FID fuel and burner air to mix before entering the FID analyzer to ensure that the FID analyzer operates with a diffusion flame and not a premixed flame.</p>				
	<p>(e) <u>Methane.</u> FID analyzers measure total hydrocarbons (THC). To determine nonmethane hydrocarbons (NMHC), quantify methane, CH₄, either with a nonmethane cutter and a FID analyzer as described in 265, or with a gas chromatograph as described in 267. For</p>				

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	a FID analyzer used to determine NMHC, determine its response factor to CH ₄ , RF_{CH_4} , as described in 360. Note that NMHC-related calculations are described in 660.				
18	265 Nonmethane cutter.		Not mentioned	Not mentioned	
	(a) <u>Application</u> . You may use a nonmethane cutter to measure CH ₄ with a FID analyzer. A nonmethane cutter oxidizes all nonmethane hydrocarbons to CO ₂ and H ₂ O. You may use a nonmethane cutter for raw or diluted exhaust for batch or continuous sampling.	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XV Appendix 4 3.3.4.2 Non-Methane Cutter (NMC) Method The determination of the non-methane fraction shall be performed with a heated NMC operated in line with an FID as per section 3.3.3 of this appendix by subtraction of the methane from the hydrocarbons.			
	(b) <u>System performance</u> . Determine nonmethane-cutter performance as described in 365 and use the results to calculate NMHC emission in.660.				
	(c) <u>Configuration</u> . Configure the nonmethane cutter with a bypass line if it is needed for the verification described in 365.				
	(d) <u>Optimization</u> . Optimize a nonmethane cutter to maximize the penetration of CH ₄ and the oxidation of all other hydrocarbons. You may humidify a sample and you may dilute a sample with purified air or upstream of the nonmethane cutter to optimize its performance. You must account for any sample humidification and dilution in emission calculations.				
19	267 Gas chromatograph.				
	(a) <u>Application</u> . You may use a gas chromatograph to measure CH ₄ concentrations of diluted exhaust for batch sampling.	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XV Appendix 4		Selective combustion methane analyzer (NMC-FID) or gas chromatograph	

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		<p>3.3.4.1 Gas Chromatographic (GC) Method Non-methane hydrocarbons shall be determined by subtraction of the methane analysed with a Gas Chromatograph (GC) conditioned at 423 K (150 °C) from the hydrocarbons measured according to section 3.3.3 of this appendix.</p>		spectrometer (GC-FID) is used for measuring CH ₄ concentration for Gasoline, LPG and CNG fuels.	
	NO_x AND N₂O MEASUREMENTS				
20	270 Chemiluminescent detector.				
	(a) <u>Application</u> . You may use a chemiluminescent detector (CLD) to measure NO _x concentration in raw or diluted exhaust for batch or continuous sampling. We generally accept a CLD for NO _x measurement, even though it measures only NO and NO ₂ , when coupled with an NO ₂ -to-NO converter, since conventional engines and aftertreatment systems do not emit significant amounts of NO _x species other than NO and NO ₂ . Measure other NO _x species if required by the standard-setting part.	<p>MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.3.1.4.Nitrogen oxide (NO_x) analysis. The nitrogen oxide analyser shall be of the Chemiluminescent (CLA) type or by NDUVR (non-dispersive ultraviolet resonance absorption) type analyzer, both with an NO_x – NO converter.</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 95 Annex 4 Nitrogen oxide (NO_x) analysis: The analyser shall be either of the chemi-luminescent (CLA) or of the non-dispersive ultra-violet resonance absorption (NDUVR) type, both with an NO_x-NO converter.</p>	Chemiluminescent detector is used to measure NO _x concentration for Gasoline, LPG and CNG fuels.	
	(b) <u>Component requirements</u> . You may use a heated or unheated CLD, and you may use a CLD that operates at atmospheric pressure or under a vacuum. You may use a CLD that has compensation algorithms that are functions of other gaseous measurements and the vehicle's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.				
	(c) <u>NO₂-to-NO converter</u> . Place upstream of the CLD an internal or external NO ₂ -to-NO converter that meets the verification in 378. Configure the converter with a bypass line if it is needed to facilitate this verification.				
	(d) <u>Humidity effects</u> . You must maintain all CLD temperatures to prevent aqueous				

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	<p>condensation. If you remove humidity from a sample upstream of a CLD, use one of the following configurations: 1) Connect a CLD downstream of any dryer or chiller that is downstream of an NO₂-to-NO converter that meets the verification in 378.</p> <p>(2) Connect a CLD downstream of any dryer or thermal chiller that meets the verification in §376.</p>				
	<p>(e) <u>Response time</u>. You may use a heated CLD to improve CLD response time.</p>				
21	<p>272 Nondispersive ultraviolet analyzer.</p>				
	<p>(a) <u>Application</u>. You may use a nondispersive ultraviolet (NDUV) analyzer to measure NO_x concentration in raw or diluted exhaust for batch or continuous sampling. We generally accept an NDUV for NO_x measurement, even though it measures only NO and NO₂, since conventional engines and aftertreatment systems do not emit significant amounts of other NO_x species. Measure other NO_x species if required by the standard-setting part.</p>			<p>Attached Sheet 2</p> <p>ANALYZER (RELATED TO 5)</p> <p>1. Analyzer-</p> <p>Except for the measurements given in Attached Sheet 7, measurements of exhaust emission concentration shall be in accordance with the following.</p> <p>(1) Exhaust emission concentrations shall be measured for the exhaust emission components, posted in the middle column of Table 1, corresponding to the fuel used given in the left column of the same Table, by the analyzer given in the right column of the table. Table 1</p> <p>(2) Heating temperature of the sampling channel of THC in the heated flame</p>	

				<p>ionization detector (HFID) shall be 463 ± 10 K ($190 \pm 10^\circ\text{C}$).</p> <p>(3) The analyzers shall have the following accuracies.</p> <p>a) As for the response speed, when calibration gas is flowed, the time to reach 90% of the indicated value of the concentration of the calibration gas concerned shall be 3.0 seconds or less (except when using GC-FID).</p> <p>b) As for safety, in all ranges used, the fluctuation of the indicated value within 80% shall be within 2% of the full scale for 15 minutes after the analyzer reached the indicated value (except when using GC-FID).</p> <p>c) As for reproducibility, in all ranges used, the standard deviation</p>	
	(b) <u>Component requirements</u> . You may use a NDUV analyzer that has compensation algorithms that are functions of other gaseous measurements and the vehicle's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.				
	(c) <u>NO₂-to-NO converter</u> . If your NDUV analyzer measures only NO, place upstream of the NDUV analyzer an internal or external NO ₂ -to-NO converter that meets the verification in 378. Configure the converter with a bypass to facilitate this verification.				
	(d) <u>Humidity effects</u> . You must maintain NDUV temperature to prevent aqueous condensation, unless you use one of the following				

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	configurations: (1) Connect an NDUV downstream of any dryer or chiller that is downstream of an NO ₂ -to-NO converter that meets the verification in 378. (2) Connect an NDUV downstream of any dryer or thermal chiller that meets the verification in 376.			
22	275 N₂O measurement devices.			35 NOx emission weight
	(a) <u>General component requirements.</u>	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.3.1.4.Nitrogen oxide (NOx) analysis. The nitrogen oxide analyser shall be of the Chemiluminescent (CLA) type or by NDUVR (non-dispersive ultraviolet resonance absorption) type analyzer, both with an NOX – NO converter.	E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 95 Annex 4 Nitrogen oxide (NOx) analysis: The analyser shall be either of the chemi-luminescent (CLA) or of the non-dispersive ultra-violet resonance absorption (NDUVR) type, both with an NOx-NO converter.	
	(b) <u>Instrument types.</u> You may use any of the following analyzers to measure N ₂ O: (1) <u>Nondispersive infra-red (NDIR) analyzer.</u> You may use an NDIR analyzer that has compensation algorithms that are functions of other gaseous measurements and the vehicle's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias. (2) <u>Fourier transform infra-red (FTIR) analyzer.</u> You may use an FTIR analyzer that has compensation algorithms that are functions of other gaseous measurements and the vehicle's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias. Use appropriate analytical procedures for interpretation of infrared spectra. (3) <u>Photoacoustic analyzer.</u> You may use a photoacoustic analyzer that has compensation algorithms that are functions of other gaseous measurements. The target value for any			(1) The water vapor pressure in air shall be calculated by a psychrometer using the following formula: e= e's-0.5(T2-T1)Pa/755 where e = Water vapor pressure in air kPa e's= Saturated water vapor pressure at T2 (referred to Table) kPa T1 = Mean absolute temperature of measured dry-bulb temperature in the test room at the start and end of mode operation K T2 = Mean absolute temperature of measured wet-bulb temperature in the test room

	<p>compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias. Use an optical wheel configuration that gives analytical priority to measurement of the least stable components in the sample. Select a sample integration time of at least 5 seconds. Take into account sample chamber and sample line volumes when determining flush times for your instrument.</p> <p>(4) <u>Gas chromatograph analyzer.</u> You may use a gas chromatograph with an electron-capture detector (GC-ECD) to measure N₂O concentrations of diluted exhaust for batch sampling.</p> <p>(i) You may use a packed or porous layer open tubular (PLOT) column phase of suitable polarity and length to achieve adequate resolution of the N₂O peak for analysis. Examples of acceptable columns are a PLOT column consisting of bonded polystyrene-divinylbenzene or a Porapack Q packed column. Take the column temperature profile and carrier gas selection into consideration when setting up your method to achieve adequate N₂O peak resolution.</p> <p>(ii) Zero your instrument and correct for drift. You do not need to follow the specific procedures in 530 and 550(b) that would otherwise apply. For example, you may perform a span gas measurement before and after sample analysis without zeroing. Use the average area counts of the pre-span and post-span measurements to generate a response factor (area counts/span gas concentration), which you then multiply by the area counts from your sample to generate the sample concentration.</p>			<p>at the start and end of mode operation K Pa = Atmospheric pressure of the test room kPa</p>	
	<p>(c) <u>Interference validation.</u> Perform interference validation for NDIR, FTIR, and photoacoustic analyzers using the procedures of 375. Interference validation is not required for GC-ECD. Certain interference gases can positively interfere with NDIR, FTIR, and photoacoustic analyzers by causing a response similar to N₂O. When running the interference verification for these analyzers, use interference gases as</p>			<p>The NO_x emission weight shall be determined using the following formulas: $\text{NOxmass} = \text{Vmix} \times \text{NOx density} \times \text{NOxconc} \times \text{KH} \times 10^{-6}$</p>	

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	<p>follows: (1) The interference gases for NDIR analyzers are CO, CO₂, H₂O, CH₄ and SO₂. Note that interference species, with the exception of H₂O, are dependent on the N₂O infrared absorption band chosen by the instrument manufacturer and should be determined independently for each analyzer. (2) Use accepted measurement practices to determine interference gases for FTIR. Note that interference species, with the exception of H₂O, are dependent on the N₂O infrared absorption band chosen by the instrument manufacturer and should be determined independently for each analyzer. (3) The interference gases for photoacoustic analyzers are CO, CO₂, and H₂O or as recommended by the analyzer manufacturer.</p>			<p>NOxconc = NOxe – Nox(1-1/DF) NOxmass = NOx emission weight g/km NOxdensity = 1.91 (NOx mass per liter under standard condition, assuming that the whole amount of NOx is NO₂) g/l NOxconc = Net concentration of NOx ppm NOxe = NOx concentration of diluted exhaust gas ppm NOxd = NOx concentration of dilution air ppm</p>	
	O₂ MEASUREMENTS				
23	280 Paramagnetic and magnetopneumatic O₂ detection analyzers.	Not mentioned	Not mentioned	Not mentioned	
	(a) <u>Application</u> . You may use a paramagnetic detection (PMD) or magnetopneumatic detection (MPD) analyzer to measure O ₂ concentration in raw or diluted exhaust for batch or continuous sampling.				

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) Component requirements. You may use a PMD or MPD that has compensation algorithms that are functions of other gaseous measurements and the vehicle's known or assumed fuel properties. The target value for any compensation algorithm is 0.0 % (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.				
	PM MEASUREMENTS				
24	290 PM gravimetric balance.			PM gravimetric balance not mentioned. Attached Sheet 9 METHOD OF MEASURING PM AND CALCULATING THE EMISSION AMOUNT (RELATED TO 8.)	
	(a) <u>Application.</u> Use a balance to weigh net PM on a sample medium for laboratory testing.	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XIV Chapter 3 4.3.1.5.Particulates: Gravimetric determination of the particulates collected. These particulates are in each case collected by two series mounted filters in the sample gas flow. The quantity of particulates collected by each pair of filters shall be as follows: • Vep: Flow through filters. • Vmix: Flow through tunnel. • M: Particulate mass (g/km) • Mlimit: Limit mass of particulates (limit mass in force, g/km) • m: Mass of particulates collected by filters (g) • d: Actual distance corresponding to the operating cycle (km)	E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 95 Annex 4 Particulates - Gravimetric determination of the particulates collected: These particulates shall in each case be collected by two series-mounted filters in the sample gas flow. The quantity of particulates collected by each pair of filters shall be as follows: $M = \frac{V_{mix}}{V_{ep} \cdot d} \cdot m \rightarrow m = M \cdot d \cdot \frac{V_{ep}}{V_{mix}}$ where: Vep : flow through filters; Vmix : flow through tunnel; M : particulate mass (g/km); Mlimit : limit mass of particulates (limit mass in force, g/km); m : mass of particulates collected by	1. Measurement Method for PM The measurement for PM shall be carried out either by the full flow single-stage dilution method (hereinafter referred to as the "single-stage dilution method") in which, after the full flow of the dilution air and exhaust gas are mixed, part of the diluted exhaust gas is diverted and passed through the PM collecting system, or by the full flow double-stage dilution method (hereinafter referred to as the "double-stage dilution method") in which part of the diluted exhaust gas is diluted again and passed through the PM	

		$M = \frac{(V_{mix} * m)}{(V_{ep} * d)} \quad \text{or}$ $m = \frac{(M * d * V_{ep})}{V_{mix}}$ <ul style="list-style-type: none"> • The particulate sample rate (Vep / Vmix) will be adjusted so that for M = Mlimit 1 ≤ m ≤ 5 mg (when 47mm diameter filters are used). • The filter surface consists of a material that is hydrophobic and inert towards the components of exhaust gas (fluorocarbon coated glass fibre filters or equivalent) 	<p>filters (g); d : distance corresponding to the operating cycle km). The particulates sample rate (Vep/Vmix) shall be adjusted so that for M = Mlimit, 1 # m # 5 mg (when 47 mm diameter filters are used). The filter surface shall consist of a material that is hydrophobic and inert towards the components of the exhaust gas (fluorocarbon coated glass fibre filters or equivalent).</p>	<p>collecting system.</p> <p>1–1 In the case of single-stage dilution method</p> <p>In the case of the single-stage dilution method, PM is collected as follows: The diluted exhaust gas inside the main dilution tunnel is passed through the filter holder incorporating the PM collecting filter from the PM sampling probe. The diluted exhaust gas is sucked by the sampling suction pump and the sample flow rate shall be measured by means of the sample flow rate meter.</p> <p>1–2 In the case of double-stage dilution method</p> <p>In the case of the double-stage dilution method, PM is collected as follows: The diluted exhaust gas inside the main dilution tunnel is introduced into the secondary dilution tunnel from the sampling transfer tube. There, the full flow of the secondary diluted exhaust gas that has been diluted by air again is passed through the filter holder incorporating the PM collecting filter from the PM sampling probe. Furthermore, the flow rate of the secondary diluted exhaust gas sucked by the sampling suction pump shall be measured by means of</p>	
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				the sample flow rate meter.	
	(b) <u>Component requirements</u> . If the balance uses internal calibration weights for routine spanning and linearity verifications, the calibration weights must meet the specifications in 790.				
	c) <u>Pan design</u> . Use a balance pan designed to minimize the effect of corner loading of the balance, as follows: (1) Use a pan that centers the PM sample media (such as a filter) on the weighing pan. For example, use a pan in the shape of a cross that has upswept tips that center the PM sample media on the pan. (2) Use a pan that positions the PM sample as low as possible.				
	(d) <u>Balance configuration</u> . Configure the balance for optimum settling time and stability at your location.				
	Calibrations and Verifications				
25	301 Overview and general provisions.				
	(a) This subpart describes required and recommended calibrations and verifications of measurement systems. See section 200 for specifications that apply to individual instruments.	<p>APPENDIX 5 CALIBRATION PROCEDURE MoRTH / CMVR / TAP-115/116 (Issue 4) Part XV APPENDIX 5</p> <p>1 Calibration of the analytical instruments: 1.1 Introduction Each analyser shall be calibrated as often as necessary to fulfill the accuracy requirements of this part. The calibration method that shall be used is described in this section for the analysers indicated in chapter III, appendix 4, section 3 and</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 151 Annex 4 – Appendix 6 Annex 4 - Appendix 6 METHOD OF CALIBRATING THE EQUIPMENT</p> <p>1. ESTABLISHMENT OF THE CALIBRATION CURVE 1.1. Each normally used operating range is calibrated in accordance with the requirements of paragraph 4.3.3. of Annex 4 by the following procedure: 1.2. The analyser calibration curve is established by at least five calibration points spaced as uniformly as possible. The nominal concentration of the calibration gas</p>	<p>Attached Sheet 3</p> <p>CALIBRATIO N GAS, ETC. (RELATED TO 5)</p> <p>1. Calibration Gas, Fuel Gas, and Ozone Generating Gas</p> <p>(1) Components of calibration gas, fuel gas,</p>	

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		<p>chapter V, section 1 of this part. 1.2 Calibration gases The shelf life of all calibration gases must be respected. The expiration date of the calibration gases stated by the manufacturer shall be recorded. 1.2.1 Pure gases: The required purity of the gases is defined by the contamination limits given below. The following gases must be available for operation: Purified nitrogen (Contamination \leq 1 ppm C1, \leq 1 ppm CO, \leq 400 ppm CO₂, \leq 0,1 ppm NO) Purified oxygen (Purity > 99,5 % vol O₂) Hydrogen-helium mixture (40 \pm 2 % hydrogen, balance helium) (Contamination \leq 1 ppm C1, \leq 400 ppm CO₂) Purified synthetic air (Contamination \leq 1 ppm C1, \leq 1 ppm CO, \leq 400 ppm CO₂, \leq 0,1 ppm NO) (Oxygen content between 18-21 % vol.) Purified propane or CO for the CVS verification</p>	<p>of the highest concentration shall be not less than 80 per cent of the full scale. 1.3. The calibration curve is calculated by the least squares method. If the resulting polynomial degree is greater than 3, the number of calibration points shall be at least equal to this polynomial degree plus 2. 1.4. The calibration curve shall not differ by more than " 2 per cent from the nominal value of each calibration gas.</p>	<p>and ozone generating gas shall be as given in Table 1, corresponding to the components of exhaust emission</p>	
	<p>(b) You must generally use complete measurement systems when performing calibrations or verification. For example, this would generally involve evaluating instruments based on values recorded with the complete system you use for recording test data, including analog-to-digital converters. For some calibrations and verifications, we may specify that you disconnect part of the measurement system to introduce a simulated signal.</p>		<p>1.5. Trace of the calibration curve From the trace of the calibration curve and the calibration points, it is possible to verify that the calibration has been carried out correctly. The different characteristic parameters of the analyser shall be indicated, particularly: the scale, the sensitivity, the zero point, the date of carrying out the calibration. 1.6. If it can be shown to the satisfaction of the technical service that alternative technology (e.g. computer, electronically controlled</p>	<p>(2) The calibration gas may depend on a gas divider. (3) The accuracy of concentration indication of calibration gas shall be within \pm2% of the indicated concentration. Also, if it depends on a gas divider, it shall be within \pm2% of divided concentration. (4) The concentration of calibration gas used for span adjustment of the</p>	

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			range switch, etc.) can give equivalent accuracy, then these alternatives may be used.	analyzer shall be approximately 70% or more, but 100% or less, of the full scale of the analyzer. (5) The concentration of calibration gas of THC (FID, HFID) and CH4 (NMC-FID, GC-FID) shall be expressed in equivalent carbon concentration ppmC, which shall represent values of concentration of C3H8 or CH4 in ppm multiplied by 3.	
	(c) If we do not specify a calibration or verification for a portion of a measurement system, calibrate that portion of your system and verify its performance at a frequency consistent with recommendations from the measurement-system manufacturer.		1.7. Verification of the calibration 1.7.1. Each normally used operating range shall be checked prior to each analysis in accordance with the following: 1.7.2. The calibration shall be checked by using a zero gas and a span gas whose nominal value is within 80-95 per cent of the supposed value to be analysed.		
	(d) Use NIST-traceable standards to the tolerances we specify for calibrations and verifications. Where we specify the need to use NIST-traceable standards, you may alternatively ask for our approval to use international standards that are not NIST-traceable.		1.7.3. If, for the two points considered, the value found does not differ by more than " 5 per cent of the full scale from the theoretical value, the adjustment parameters may be modified. Should this not be the case, a new calibration curve shall be established in accordance with paragraph 1 of this appendix. 1.7.4. After testing, zero gas and the same span gas are used for re-checking. The analysis is considered acceptable if the difference between the two measuring results is less than 2 per cent.		
26	303 Summary of required calibration and verifications	Not mentioned	Not mentioned	Not mentioned	

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	The following table summarizes the required and recommended calibrations and verifications described in this subpart and indicates when these have to be performed: Table 1 of 303				
27	305 Verifications for accuracy, repeatability, and noise.	Nothing is mentioned about general accuracy and repeatability of all the components	Nothing is mentioned about general accuracy and repeatability of all the components	511 Accuracies of measuring devices	
	(a) This section describes how to determine the accuracy, repeatability, and noise of an instrument. Table 1 of 205 specifies recommended values for individual instruments.	MoRTH / CMVR / TAP-115/116 (Issue 4) Part XV 3.1.1 Accuracy The analyser shall not deviate from the nominal calibration point by more than $\pm 2\%$ of the reading over the whole measurement range except zero, or $\pm 0,3\%$ of full scale whichever is larger. The accuracy shall be determined according to the calibration requirements laid down in section 1.6 of appendix 5 of this chapter. Note: For the purpose of this part, accuracy is defined as the deviation of the analyser reading from the nominal calibration values using a calibration gas (= true value).	E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 95 Annex 4 4.3.1.2. Accuracy The analysers shall have a measuring range compatible with the accuracy required to measure the concentrations of the exhaust gas sample pollutants, disregarding the true value for the calibration gases. For concentrations of less than 100 ppm the measurement error shall not exceed " 2 ppm. The ambient air sample shall be measured on the same analyser with an appropriate range. The microgram balance used to determine the weight of all filters shall have accuracy of 5 g (standard deviation) and readability of 1 μ g.	Accuracies of measuring devices shall be in accordance with the following. (1) The accuracy of the thermometer shall be within ± 1 K . (2) The accuracy of the barometer shall be within ± 0.1 kPa. (3) The accuracy of the anemometer shall be within ± 1 m/s. (4) The accuracy of the speedometer shall be within ± 0.5 km/h. (5) The accuracy of the device for measuring coasting time shall be within ± 0.1 second. (6) The accuracy of the wheel torque meter shall be within $\pm 2\%$ of the full scale.	
	(b) We do not require you to verify instrument accuracy, repeatability, or noise. However, it may be useful to consider these verifications to define a specification for a new instrument, to verify the performance of a new instrument upon delivery, or to troubleshoot an existing instrument.	3.1.2 Precision The precision, defined as 2,5 times the standard deviation of 10 repetitive responses to a given calibration or span gas, has to be not greater than $\pm 1\%$ of full scale concentration for each range used above 155 ppm (or ppmC) or $\pm 2\%$ of each range used below 155 ppm (or ppmC). 3.1.3 Noise The analyser peak-to-peak		(7) The analyzer shall have the accuracy specified in Attached Sheet 2. (8) The accuracy of the constant volume sampler (hereinafter referred to as "CVS system") shall be within $\pm 2\%$ of measured flow volume. (9) The accuracy of the sample flowmeter of the diluted exhaust gas	

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		<p>response to zero and calibration or span gases over any 10 second period shall not exceed 2 % of full scale on all ranges used.</p> <p>3.1.4 Zero Drift Zero response is defined as the mean response, including noise, to a zero gas during a 30 seconds time interval. The drift of the zero response during a one hour period shall be less than 2 % of full scale on the lowest range used.</p>		<p>(referring to the mixture of the exhaust gas and dilution air of the necessary amount for the exhaust gas analysis. Hereinafter the same.) shall be within $\pm 2\%$ of measured flow volume. (10) The PM measuring device shall have the accuracy specified in Attached Sheet 9.</p>	
	<p>(c) In this section we use the letter “y” to denote a generic measured quantity, the superscript over-bar to denote an arithmetic mean (such as \bar{y}), and the subscript “ref” to denote the reference quantity being measured.</p>	<p>3.1.5 Span Drift Span response is defined as the mean response, including noise, to a span gas during a 30 seconds time interval. The drift of the span response during a one hour period shall be less than 2 % of full scale on the lowest range used.</p>			
	<p>(d) Conduct these verifications as follows: (1) Prepare an instrument so it operates at its specified temperatures, pressures, and flows. Perform any instrument linearization or calibration procedures prescribed by the instrument manufacturer. (2) Zero the instrument as you would before an emission test by introducing a zero signal. Depending on the instrument, this may be a zero-concentration gas, a reference signal, a set of reference thermodynamic conditions, or some combination of these. For gas analyzers, use a zero gas that meets the specifications of 750. (3) Span the instrument as you would before an emission test by introducing a span signal. Depending on the instrument, this may be a span-concentration gas, a reference signal, a set of reference thermodynamic conditions, or some combination of these. For gas analyzers, use a span gas that meets the specifications of 750. (4) Use the instrument to quantify a NIST-traceable reference quantity, y_{ref}. For gas analyzers the reference gas must meet the</p>	<p>3.1.6 Rise time The rise time of the analyser installed in the measurement system shall not exceed 3,5s. Note: Only evaluating the response time of the analyser alone will not clearly define the suitability of the total system for transient testing. Volumes and especially dead volumes through out the system will not only effect the transportation time from the probe to the analyser, but also effect the rise time. Also transport times inside of an analyser would be defined as analyser response time, like the converter or water traps inside NOX analysers. The determination of the total system response time is described in section 1.5 of appendix 5 of this chapter.</p>			

<p>specifications of 750. Select a reference quantity near the mean value expected during testing. For all gas analyzers, use a quantity near the flow-weighted mean concentration expected at the standard. For noise verification, use the same zero gas from</p>				
<p>paragraph (d)(2) of this section as the reference quantity. Use stabilization times equivalent to those used during regular testing.</p> <p>(5) Sample and record values for 30 seconds (you may select a longer sampling period if the recording update frequency is less than 0.5 Hz), record the arithmetic mean, \bar{y}_i and record the standard deviation, σ_i of the recorded values. Refer to 602 for an example of calculating arithmetic mean and standard deviation.</p> <p>(6) If the reference quantity is not absolutely constant, which might be the case with a reference flow, sample and record values of y_{ref} for 30 seconds and record the arithmetic mean of the values, \bar{y}_{ref}. Refer to §602 for an example of calculating arithmetic mean.</p> <p>(7) Subtract the reference value, y_{ref} (or \bar{y}_{ref}), from the arithmetic mean, \bar{y}_i. Record this value as the error, e_i.</p> <p>(8) Repeat the steps specified in paragraphs (d)(2) through (7) of this section until you have ten arithmetic means ($\bar{y}_1, \bar{y}_2, \bar{y}_i, \dots, \bar{y}_{10}$), ten standard deviations, ($\sigma_1, \sigma_2, \sigma_i, \dots, \sigma_{10}$), and ten errors ($e_1, e_2, e_i, \dots, e_{10}$).</p> <p>(9) Use the following values to quantify your measurements:</p> <p>(i) <u>Accuracy</u>. Instrument accuracy is the absolute difference between the reference quantity, y_{ref} (or \bar{y}_{ref}), and the arithmetic mean of the ten \bar{y}_i values, \bar{y}. Refer to the example of an accuracy calculation in 602.</p> <p>(ii) <u>Repeatability</u>. Repeatability is two times the standard deviation of the ten errors (that is,</p>				

	<p>repeatability = 2σ). Refer to the example of a standard-deviation calculation in 602.</p> <p>(iii) <u>Noise</u>. Noise is two times the root-mean-square of the ten standard deviations (that is, noise = $2 \cdot rms_{\sigma}$) when the reference signal is a zero-quantity signal. Refer to the example of a root-mean-square calculation in 602.</p>				
28	307 Linearity verification.	Not mentioned	Not mentioned	Not mentioned	
	<p>(a) <u>Scope and frequency</u>. Perform a linearity verification on each measurement system listed in Table 1 of this section at least as frequently as indicated in the table, consistent with measurement system manufacturer recommendations. Note that this linearity verification replaces requirements we previously referred to as “calibrations”. The intent of a linearity verification is to determine that a measurement system responds proportionally over the measurement range of interest. A linearity verification generally consists of introducing a series of at least 10 reference values to a measurement system. The measurement system quantifies each reference value. The measured values are then collectively compared to the reference values by using a least squares linear regression and the linearity criteria specified in Table 1 of this section.</p>				
	<p>(b) <u>Performance requirements</u>. If a measurement system does not meet the applicable linearity criteria in Table 1 of this section, correct the deficiency by re-calibrating, servicing, or replacing components as needed. Repeat the linearity verification after correcting the deficiency to ensure that the measurement system meets the linearity criteria. Before you may use a measurement system that does not meet linearity criteria, you must demonstrate to us that the deficiency does not adversely affect your ability to demonstrate compliance with the applicable standards.</p>				
	<p>(c) <u>Procedure</u>. Use the following linearity</p>				

<p>verification protocol, or use accepted measurement practices to develop a different protocol that satisfies the intent of this section, as described in paragraph (a) of this section:</p> <p>(1) In this paragraph (c), we use the letter “y” to denote a generic measured quantity, the superscript over-bar to denote an arithmetic mean (such as \bar{y}), and the subscript “ref” to denote the known or reference quantity being measured.</p> <p>(2) Precede the linearity verification with any adjustment or periodic calibration of the measurement system as required. Operate a measurement system at its specified temperatures, pressures, and flows.</p> <p>(3) Zero the instrument as you would before an emission test by introducing a zero signal. Depending on the instrument, this may be a zero-concentration gas, a reference signal, a set of reference thermodynamic conditions, or some combination of these. For gas analyzers, use a zero gas that meets the specifications of 750 and introduce it directly at the analyzer port.</p> <p>(4) Span the instrument as you would before an emission test by introducing a span signal. Depending on the instrument, this may be a span-concentration gas, a reference signal, a set of reference thermodynamic conditions, or some combination of these. For gas analyzers, use a span gas that meets the specifications of 750 and introduce it directly at the analyzer port.</p> <p>(5) After spanning the instrument, check zero with the same signal you used in paragraph (c)(3) of this section. Based on the zero reading, determine whether or not to rezero and or re-span the instrument before proceeding to the next step.</p> <p>(6) For all measured quantities, use instrument manufacturer recommendations and accepted measurement practices to select reference values, y_{refi}, that cover a range of values that encompasses the maximum values expected during emission testing. We recommend selecting a zero reference signal as one of the reference values of the linearity verification.</p>				
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<p>For pressure, temperature, dewpoint, and GC-ECD linearity verifications, we recommend at least three reference values. For all other linearity verifications select at least ten reference values.</p> <p>(7) Use instrument manufacturer recommendations and accepted measurement practices to select the order in which you will introduce the series of reference values. For example you may select the reference values randomly to avoid correlation with previous measurements, you may select reference values in ascending or descending order to avoid long settling times of reference signals, or as another example you may select values to ascend and then descend which might incorporate the effects of any instrument hysteresis into the linearity verification.</p> <p>(8) Generate reference quantities as described in paragraph (d) of this section. For gas analyzers, use gas concentrations known to be within the specifications of 750 and introduce them directly at the analyzer port.</p> <p>(9) Introduce a reference signal to the measurement instrument.</p> <p>(10) Allow time for the instrument to stabilize while it measures the reference value. Stabilization time may include time to purge an instrument and time to account for its response.</p> <p>(11) At a recording frequency of at least f Hz, specified in Table 1 of 205, measure the reference value for 30 seconds (you may select a longer sampling period if the recording update frequency is less than 0.5 Hz) and record the arithmetic mean of the recorded values, \bar{y}_i.</p> <p>Refer to §602 for an example of calculating an arithmetic mean.</p> <p>(12) Repeat steps in paragraphs (c)(9) though (11) of this section until all reference quantities are measured.</p> <p>(13) Use the arithmetic means, \bar{y}_i, and reference values, y_{refi}, to calculate least-squares linear regression parameters and statistical values to compare to the minimum performance criteria specified in Table 1 of this section. Use the calculations described in 602.</p>				
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<p>Using accepted measurement practices, you may weight the results of individual data pairs (i.e. (y_{refi}, \bar{y}_i)), in the linear regression calculations.</p>				
<p>(d) <u>Reference signals</u>. This paragraph (d) describes recommended methods for generating reference values for the linearity-verification protocol in paragraph (c) of this section. Use reference values that simulate actual values, or introduce an actual value and measure it with a reference-measurement system. In the latter case, the reference value is the value reported by the reference-measurement system. Reference values and reference-measurement systems must be NIST-traceable. We recommend using calibration reference quantities that are NIST-traceable within 0.5 % uncertainty, if not specified otherwise in other sections of this part Use the following recommended methods to generate reference values or use accepted measurement practices to select a different reference: 1) <u>Dynamometer</u>. (a) Load cell calibration weight sets shall be certified traceable to international standards authority recognized as equivalent to NIST. Individual weights shall have an uncertainty of less than 0.05% of their labeled value. Individual weights shall weigh not more than 50 pounds, shall be corrosion resistant, and shall be permanently stamped with a unique serial number. Any other device whose physical attributes affect the forces applied to the load cell shall also be permanently marked with a unique device number. No physical alteration of any certified weight or device shall be made subsequent to certification. (b) The dynamometer shall use an independent method or auxiliary piece of equipment for verifying the accuracy and precision of the speed measurement process, displays on each dynamometer, and both rolls as a synchronous pair. This method shall be useable during all steady speeds and accelerations. For example, a process that acquires speed data from a frequency standard at constant or varied</p>				

<p>rates that is independent of the encoder.</p> <p>(c) The dynamometer shall use an independent international standards authority traceable method or auxiliary piece of equipment to verify that the mechanical roll speed matches the dynamometer displayed speed (i.e. photo-tachometer with reflective tape, etc.).</p> <p><u>(2) Flow rates—dilution air, diluted exhaust, raw exhaust, or sample flow.</u> Use a reference flow meter with a means of generating flows of the nature encountered during normal testing. Use the reference meter's response as the reference values.</p> <p>(i) <u>Reference flow meters.</u> Because the flow range requirements for these various flows are large, we allow a variety of reference meters. For example, for diluted exhaust flow for a full-flow dilution system, we recommend a reference subsonic venturi flow meter with a restrictor valve and a blower to simulate flow rates. For inlet air, dilution air, diluted exhaust for partial-flow dilution, raw exhaust, or sample flow, we allow reference meters such as critical flow orifices, critical flow venturis, laminar flow elements, master mass flow standards, or Roots meters. Make sure the reference meter has been calibrated by a qualified calibration laboratory and its calibration is NIST-traceable. If you use the difference of two flow measurements to determine a net flow rate, you may calibrate and use one of the measurements as a reference for the other.</p> <p>(ii) <u>Reference flow values.</u> Sample and record reference values of \dot{n}_{ref} for 30 seconds and use the arithmetic mean of the values, $\bar{\dot{n}}_{ref}$, as the reference value. Refer to 602 for an example of calculating arithmetic mean.</p> <p><u>(3) Gas division.</u> Use one of the two reference signals:</p> <p>(i) At the outlet of the gas-division system, connect a gas analyzer that meets the linearity verification described in this section that has not been linearized with the gas divider being verified. For example, verify the linearity of an analyzer using a series of reference analytical</p>				
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<p>gases directly from compressed gas cylinders that meet the specifications of 750. We recommend using a FID analyzer or a PMD or MPD O₂ analyzer because of their inherent linearity. Operate this analyzer consistent with how you would operate it during an emission test. Connect a span gas to the gas-divider inlet. Use the gas-division system to divide the span gas with purified air or nitrogen. Select gas divisions that you typically use. Use a selected gas division as the measured value. Use the analyzer response divided by the span gas concentration as the reference gas-division value. Sample and record reference values of x_{ref} for 30 seconds and use the arithmetic mean of the values, \bar{x}_{ref}, as the reference value.</p> <p>Refer to 602 for an example of calculating arithmetic mean.</p> <p>(ii) Using accepted measurement practices and gas divider manufacturer recommendations, use one or more reference flow meters to measure the flow rates of the gas divider and verify the gas-division value.</p> <p>(4) <u>Continuous constituent concentration</u>. For reference values, use a series of gas cylinders of known gas concentration or use a gas-division system that is known to be linear with a span gas. Gas cylinders, gas-division systems, and span gases that you use for reference values must meet the specifications of 750.</p> <p>(5) <u>Temperature</u>. You may perform the linearity verification for temperature measurement systems with thermocouples, RTDs, and thermistors by removing the sensor from the system and using a simulator in its place. Use a NIST-traceable simulator that is independently calibrated and, as appropriate, cold-junction compensated. The simulator uncertainty scaled to temperature must be less than 0.5 % of T_{max}. If you use this option, you must use sensors that the supplier states are accurate to better than 0.5 % of T_{max} compared with their standard calibration curve.</p>				
<p>(e) <u>Measurement systems that require linearity verification</u>. Table 1 of this section indicates</p>				

<p>measurement systems that require linearity verifications, subject to the following provisions:</p> <p>(1) Perform a linearity verification more frequently based on the instrument manufacturer's recommendation or accepted measurement practice.</p> <p>(2) The expression "x_{min}" refers to the reference value used during the linearity verification that is closest to zero. This is the value used to calculate the first tolerance in Table 1 of this section using the intercept, a_0. Note that this value may be zero, positive, or negative depending on the reference values. For example, if the reference values chosen to validate a pressure transducer vary from -10 to -1 kPa, x_{min} is -1 kPa. If the reference values used to validate a temperature device vary from 290 to 390 K, x_{min} is 290 K.</p> <p>(3) The expression "max" generally refers to the absolute value of the reference value used during the linearity verification that is furthest from zero. This is the value used to scale the first and third tolerances in Table 1 of this section using a_0 and <i>SEE</i>. For example, if the reference values chosen to validate a pressure transducer vary from -10 to -1 kPa, then p_{max} is +10 kPa. If the reference values used to validate a temperature device vary from 290 to 390 K, then T_{max} is 390 K. For gas dividers where "max" is expressed as, x_{max}/x_{span}; x_{max} is the maximum gas concentration used during the verification, x_{span} is the undivided, undiluted, span gas concentration, and the resulting ratio is the maximum divider point reference value used during the verification (typically 1). The following are special cases where "max" refers to a different value:</p> <p>(i) For linearity verification with a PM balance, m_{max} refers to the typical mass of a PM filter.</p> <p>(4) The specified ranges are inclusive. For example, a specified range of 0.98-1.02 for a_1 means $0.98 \leq a_1 \leq 1.02$.</p> <p>(5) These linearity verifications are optional for systems that pass the flow-rate verification for diluted exhaust as described in 341 (the propane check) or for systems that agree within ± 2 % based on a chemical balance of carbon or oxygen of the intake air, fuel, and exhaust.</p>				
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<p>(6) You must meet the a_1 criteria for these quantities only if the absolute value of the quantity is required, as opposed to a signal that is only linearly proportional to the actual value.</p> <p>(7) Linearity checks are required for the following temperature measurements:</p> <p>(i) The following temperature measurements always require linearity checks:</p> <p>(A) Dilution air for PM sampling, including CVS, double-dilution, and partial-flow systems.</p> <p>(B) PM sample, if applicable.</p> <p>(C) Chiller sample, for gaseous sampling systems that use thermal chillers to dry samples and use chiller temperature to calculate the dewpoint at the outlet of the chiller. For your testing, if you choose to use a high alarm temperature setpoint for the chiller temperature as a constant value in the amount of water calculations in 645, you may use accepted measurement practices to verify the accuracy of the high alarm temperature setpoint in lieu of the linearity verification on the chiller temperature. We recommend that you input a reference simulated temperature signal below the alarm trip point, increase this signal until the high alarm trips, and verify that the alarm trip point value is no less than 2.0 °C below the reference value at the trip point.</p> <p>(8) Linearity checks are required for the following pressure measurements:</p> <p>(i) The following pressure measurements always require linearity checks:</p> <p>(A) Barometer.</p> <p>(B) CVS inlet gage pressure.</p> <p>(C) Pressure gauges used for determining flow.</p> <p>(D) Sample dryer, for gaseous sampling systems that use either osmotic-membrane or thermal chillers to dry samples. For your testing, if you choose to use a low alarm pressure setpoint for the sample dryer pressure as a constant value in the amount of water calculations in 645, you may use accepted measurement practices to verify the accuracy of the low alarm pressure setpoint in lieu of the linearity verification on the sample dryer pressure. We recommend that you input a</p>				
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	reference pressure signal above the alarm trip point, decrease this signal until the low alarm trips, and verify that the trip point value is no more than 4.0 kPa above the reference value at the trip point. Table 1 of 307				
29	308 Continuous gas analyzer system-response and updating-recording verification—for gas analyzers not continuously compensated for other gas species.			Not mentioned	
	<p>) <u>Scope and frequency.</u> This section describes a verification procedure for system response and updating-recording frequency for continuous gas analyzers that output a gas species mole fraction (i.e., concentration) using a single gas detector, i.e., gas analyzers not continuously compensated for other gas species measured with multiple gas detectors. See 309 for verification procedures that apply to continuous gas analyzers that are continuously compensated for other gas species measured with multiple gas detectors. Perform this verification to determine the system response of the continuous gas analyzer and its sampling system. This verification is required for continuous gas analyzers used for transient or ramped-modal testing. You need not perform this verification for batch gas analyzer systems or for continuous gas analyzer systems that are used only for discrete-mode testing. Perform this verification after initial installation (i.e., test cell commissioning) and after any modifications to the system that would change system response. For example, perform this verification if you add a significant volume to the transfer lines by increasing their length or adding a filter; or if you reduce the frequency at which the gas analyzer updates its output or the frequency at which you sample and record gas-analyzer concentrations.</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 199 Annex 7 – Appendix 1 3. CHECKING OF FID HYDROCARBON ANALYZER 3.1. Detector response optimisation The FID shall be adjusted as specified by the instrument manufacturer. Propane in air should be used to optimise the response on the most common operating range. 3.2. Calibration of the HC analyser The analyser should be calibrated using propane in air and purified synthetic air. See paragraph 4.5.2. of Annex 4 (Calibration and span gases). Establish a calibration curve as described in paragraphs 4.1. to 4.5. of this appendix. 3.3. Oxygen interference check and recommended limits The response factor (Rf) for a particular hydrocarbon species is the ratio of the FID C1 reading to the gas cylinder concentration, expressed as ppm C1. The concentration of the test gas shall be at a level to give a response of approximately 80 per cent of full-scale deflection, for the operating range. The concentration shall be known, to an</p>	<p>E/ECE/324 Rev.1/Add.82/Rev.3 E/ECE/TRANS/505 Regulation No. 83 page 199 Annex 7 – Appendix 1 3. CHECKING OF FID HYDROCARBON ANALYZER 3.1. Detector response optimisation The FID shall be adjusted as specified by the instrument manufacturer. Propane in air should be used to optimise the response on the most common operating range. 3.2. Calibration of the HC analyser The analyser should be calibrated using propane in air and purified synthetic air. See paragraph 4.5.2. of Annex 4 (Calibration and span gases). Establish a calibration curve as described in paragraphs 4.1. to 4.5. of this appendix. 3.3. Oxygen interference check and recommended limits The response factor (Rf) for a particular hydrocarbon species is the ratio of the FID C1 reading to the gas cylinder concentration, expressed as ppm C1. The concentration of the test gas shall be at a level 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</p>		

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		<p>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 a temperature between 293 K and 303 K (20 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 is 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: $0.95 \leq Rf \leq 1.05$.</p>	<p>in volume. In addition the gas cylinder shall be preconditioned for 24 hours at a temperature between 293 K and 303 K (20 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 is 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: $0.95 \leq Rf \leq 1.05$.</p>		
	<p>(b) <u>Measurement principles</u>. This test verifies that the updating and recording frequencies match the overall system response to a rapid change in the value of concentrations at the sample probe. Gas analyzers and their sampling systems must be optimized such that their overall response to a rapid change in concentration is updated and recorded at an appropriate frequency to prevent loss of information. This test also verifies that the measurement system meets a minimum response time. You may use the results of this test to determine transformation time, t_{50}, for the purposes of time alignment of continuous data in accordance with 650(c)(2)(i). You may also use an alternate procedure to determine t_{50} in accordance with accepted measurement practices. Note that any such procedure for determining t_{50} must account for both transport delay and analyzer response time.</p>	<p>4. CALIBRATION OF THE HYDROCARBON ANALYZER 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 to 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</p>	<p>4. CALIBRATION OF THE HYDROCARBON ANALYZER 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 to 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</p>		

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		<p>3.2. above, 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 other relevant data such as:</p> <p>(a) date of calibration, span and zero potentiometer readings (where applicable),</p> <p>(b) nominal scale,</p> <p>(c) reference data of each calibration gas used,</p> <p>(d) the actual and indicated value of each calibration gas used together with</p> <p>(e) FID fuel and type,</p> <p>(f) FID air pressure.</p> <p>4.5. If it can be shown to the satisfaction of the technical service that alternative technology (e.g. computer, electronically controlled range switch) can give equivalent accuracy, then those alternatives may be used.</p>	<p>3.2. above, 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 other relevant data such as:</p> <p>(a) date of calibration, span and zero potentiometer readings (where applicable),</p> <p>(b) nominal scale,</p> <p>(c) reference data of each calibration gas used,</p> <p>(d) the actual and indicated value of each calibration gas used together with</p> <p>(e) FID fuel and type,</p> <p>(f) FID air pressure.</p> <p>4.5. If it can be shown to the satisfaction of the technical service that alternative technology (e.g. computer, electronically controlled range switch) can give equivalent accuracy, then those alternatives may be used.</p>		
	<p>(c) <u>System requirements</u>. Demonstrate that each continuous analyzer has adequate update and recording frequencies and has a minimum rise time and a minimum fall time during a rapid change in gas concentration. You must meet one of the following criteria:</p> <p>(1) The product of the mean rise time, t_{10-90}, and the frequency at which the system records an updated concentration must be at least 5, and the product of the mean fall time, t_{90-10}, and the frequency at which the system records an updated concentration must be at least 5. If the recording frequency is different than the analyzer's output update frequency, you must use the lower of these two frequencies for this verification, which is referred to as the updating-recording frequency. This verification applies to the nominal updating and recording frequencies. This criterion makes no</p>				

	<p>assumption regarding the frequency content of changes in emission concentrations during emission testing; therefore, it is valid for any testing. Also, the mean rise time must be at or below 10 seconds and the mean fall time must be at or below 10 seconds.</p> <p>(2) The frequency at which the system records an updated concentration must be at least 5 Hz. This criterion assumes that the frequency content of significant changes in emission concentrations during emission testing do not exceed 1 Hz. Also, the mean rise time must be at or below 10 seconds and the mean fall time must be at or below 10 seconds.</p> <p>(3) You may use other criteria if we approve the criteria in advance.</p>				
	<p>(d) <u>Procedure</u>. Use the following procedure to verify the response of each continuous gas analyzer:</p> <p>(1) <u>Instrument setup</u>. Follow the analyzer manufacturer's start-up and operating instructions. Adjust the measurement system as needed to optimize performance. Run this verification with the analyzer operating in the same manner you will use for emission testing. If the analyzer shares its sampling system with other analyzers, and if gas flow to the other analyzers will affect the system response time, then start up and operate the other analyzers while running this verification test. You may run this verification test on multiple analyzers sharing the same sampling system at the same time. If you use any analog or real-time digital filters during emission testing, you must operate those filters in the same manner during this verification. (2) <u>Equipment setup</u>. We recommend using minimal lengths of gas transfer lines between all connections and fast-acting three-way valves (2 inlets, 1 outlet) to control the flow of zero and blended span gases to the sample system's probe inlet or a tee near the outlet of the probe. Normally the gas flow rate is higher than the probe sample flow rate and the excess is overflowed out the inlet of the probe. If the gas flow rate is lower than the probe flow rate, the gas concentrations must be adjusted to account for the dilution</p>				

<p>from ambient air drawn into the probe. Select span gases for the species being measured. You may use binary or multi-gas span gases. You may use a gas blending or mixing device to blend span gases. A gas blending or mixing device is recommended when blending span gases diluted in N₂ with span gases diluted in air. You may use a multi-gas span gas, such as NO-CO-CO₂-C₃H₈-CH₄, to verify multiple analyzers at the same time. If you use standard binary span gases, you must run separate response tests for each analyzer. In designing your experimental setup, avoid pressure pulsations due to stopping the flow through the gas-blending device.</p> <p>(3) <u>Data collection.</u> (i) Start the flow of zero gas. (ii) Allow for stabilization, accounting for transport delays and the slowest analyzer's full response. (iii) Start recording data. For this verification you must record data at a frequency greater than or equal to that of the updating-recording frequency used during emission testing. You may not use interpolation or filtering to alter the recorded values. (iv) Switch the flow to allow the blended span gases to flow to the analyzer. If you intend to use the data from this test to determine t_{50} for time alignment, record this time as t_0. (v) Allow for transport delays and the slowest analyzer's full response. (vi) Switch the flow to allow zero gas to flow to the analyzer. If you intend to use the data from this test to determine t_{50} for time alignment, record this time as t_{100}. (vii) Allow for transport delays and the slowest analyzer's full response. (viii) Repeat the steps in paragraphs (d)(3)(iv) through (vii) of this section to record seven full cycles, ending with zero gas flowing to the analyzers. (ix) Stop recording.</p>				
<p>(e) <u>Performance evaluation.</u> (1) If you choose to demonstrate compliance with paragraph (c)(1) of this section, use the data from paragraph (d)(3) of this section to calculate the</p>				

	<p>mean rise time, t_{10-90}, and mean fall time, t_{90-10}, for each of the analyzers being verified. You may use interpolation between recorded values to determine rise and fall times. If the recording frequency used during emission testing is different from the analyzer's output update frequency, you must use the lower of these two frequencies for this verification. Multiply these times (in seconds) by their respective updating-recording frequencies in Hertz (1/second). The resulting product must be at least 5 for both rise time and fall time. If either value is less than 5, increase the updating-recording frequency, or adjust the flows or design of the sampling system to increase the rise time and fall time as needed. You may also configure analog or digital filters before recording to increase rise and fall times. In no case may the mean rise time or mean fall time be greater than 10 seconds.</p> <p>(2) If a measurement system fails the criterion in paragraph (e)(1) of this section, ensure that signals from the system are updated and recorded at a frequency of at least 5 Hz. In no case may the mean rise time or mean fall time be greater than 10 seconds.</p> <p>(3) If a measurement system fails the criteria in paragraphs (e)(1) and (2) of this section, you may use the measurement system only if the deficiency does not adversely affect your ability to show compliance with the applicable standards.</p>				
	<p>f) <u>Transformation time, t_{50}, determination.</u> If you choose to determine t_{50} for purposes of time alignment using data generated in paragraph (d)(3) of this section, calculate the mean t_{0-50} and the mean t_{100-50} from the recorded data. Average these two values to determine the final t_{50} for the purposes of time alignment in accordance with 650(c)(2)(i).</p>				
30	<p>309 Continuous gas analyzer system-response and updating-recording verification—for gas analyzers continuously compensated for other gas species.</p>	Not mentioned	Not mentioned	Not mentioned	
	<p>(a) <u>Scope and frequency.</u> This section describes a verification procedure for system</p>				

<p>response and updating-recording frequency for continuous gas analyzers that output a single gas species mole fraction (i.e., concentration) based on a continuous combination of multiple gas species measured with multiple detectors (i.e., gas analyzers continuously compensated for other gas species). See 308 for verification procedures that apply to continuous gas analyzers that are not continuously compensated for other gas species or that use only one detector for gaseous species. Perform this verification to determine the system response of the continuous gas analyzer and its sampling system. This verification is required for continuous gas analyzers used for transient or ramped-modal testing. You need not perform this verification for batch gas analyzers or for continuous gas analyzers that are used only for discrete-mode testing. For this check we consider water vapor a gaseous constituent. This verification does not apply to any processing of individual analyzer signals that are time aligned to their t_{50} times and were verified according to §308. For example, this verification does not apply to correction for water removed from the sample done in post- processing according to 659 and it does not apply to NMHC determination from THC and CH₄ according to 660. Perform this verification after initial installation (i.e., test cell commissioning) and after any modifications to the system that would change the system response.</p>				
<p>(b) <u>Measurement principles</u>. This procedure verifies that the updating and recording frequencies match the overall system response to a rapid change in the value of concentrations at the sample probe. It indirectly verifies the time-alignment and uniform response of all the continuous gas detectors used to generate a continuously combined/compensated concentration measurement signal. Gas analyzer systems must be optimized such that their overall response to rapid change in concentration is updated and recorded at an appropriate frequency to prevent loss of</p>				

<p>information. This test also verifies that the measurement system meets a minimum response time. For this procedure, ensure that all compensation algorithms and humidity corrections are turned on. You may use the results of this test to determine transformation time, t_{50}, for the purposes of time alignment of continuous data in accordance with 650(c)(2)(i). You may also use an alternate procedure to determine t_{50} consistent with accepted measurement practices. Note that any such procedure for determining t_{50} must account for both transport delay and analyzer response time.</p>				
<p>(c) System requirements. Demonstrate that each continuously combined/compensated concentration measurement has adequate updating and recording frequencies and has a minimum rise time and a minimum fall time during a system response to a rapid change in multiple gas concentrations, including H₂O concentration if H₂O compensation is applied. You must meet one of the following criteria: (1) The product of the mean rise time, t_{10-90}, and the frequency at which the system records an updated concentration must be at least 5, and the product of the mean fall time, t_{90-10}, and the frequency at which the system records an updated concentration must be at least 5. If the recording frequency is different than the update frequency of the continuously combined/compensated signal, you must use the lower of these two frequencies for this verification. This criterion makes no assumption regarding the frequency content of changes in emission concentrations during emission testing; therefore, it is valid for any testing. Also, the mean rise time must be at or below 10 seconds and the mean fall time must be at or below 10 seconds. (2) The frequency at which the system records an updated concentration must be at least 5 Hz. This criterion assumes that the frequency content of significant changes in emission concentrations during emission testing do not</p>				

	<p>exceed 1 Hz. Also, the mean rise time must be at or below 10 seconds and the mean fall time must be at or below 10 seconds. (3) You may use other criteria if we approve them in advance.</p>				
	<p>(d) <u>Procedure</u>. Use the following procedure to verify the response of each continuously compensated analyzer (verify the combined signal, not each individual continuously combined concentration signal): (1) <u>Instrument setup</u>. Follow the analyzer manufacturer's start-up and operating instructions. Adjust the measurement system as needed to optimize performance. Run this verification with the analyzer operating in the same manner you will use for emission testing. If the analyzer shares its sampling system with other analyzers, and if gas flow to the other analyzers will affect the system response time, then start up and operate the other analyzers while running this verification test. You may run this verification test on multiple analyzers sharing the same sampling system at the same time. If you use any analog or real-time digital filters during emission testing, you must operate those filters in the same manner during this verification. (2) <u>Equipment setup</u>. We recommend using minimal lengths of gas transfer lines between all connections and fast-acting three-way valves (2 inlets, 1 outlet) to control the flow of zero and blended span gases to the sample system's probe inlet or a tee near the outlet of the probe. Normally the gas flow rate is higher than the probe sample flow rate and the excess is overflowed out the inlet of the probe. If the gas flow rate is lower than the probe flow rate, the gas concentrations must be adjusted to account for the dilution from ambient air drawn into the probe. Select span gases for the species being continuously combined, other than H₂O. Select concentrations of compensating species that will yield concentrations of these species at the analyzer inlet that covers the range of concentrations expected during testing. You may use binary or multi-gas span gases. You may use a gas blending or mixing device to blend span gases.</p>				

<p>A gas blending or mixing device is recommended when blending span gases diluted in N₂ with span gases diluted in air. You may use a multi-gas span gas, such as NO-CO-CO₂-C₃H₈-CH₄, to verify multiple analyzers at the same time. In designing your experimental setup, avoid pressure pulsations due to stopping the flow through the gas blending device. If H₂O correction is applicable, then span gases must be humidified before entering the analyzer; however, you may not humidify NO₂ span gas by passing it through a sealed humidification vessel that contains water. You must humidify NO₂ span gas with another moist gas stream. We recommend humidifying your NO-CO-CO₂-C₃H₈-CH₄, balance N₂ blended gas by flowing the gas mixture through a sealed vessel that humidifies the gas by bubbling it through distilled water and then mixing the gas with dry NO₂ gas, balance purified synthetic air. If your system does not use a sample dryer to remove water from the sample gas, you must humidify your span gas to the highest sample H₂O content that you estimate during emission sampling. If your system uses a sample dryer during testing, it must pass the sample dryer verification check in 342, and you must humidify your span gas to an H₂O content greater than or equal to the level determined in 145(e)(2). If you are humidifying span gases without NO₂, use accepted measurement practices to ensure that the wall temperatures in the transfer lines, fittings, and valves from the humidifying system to the probe are above the dewpoint required for the target H₂O content. If you are humidifying span gases with NO₂, use accepted measurement practices to ensure that there is no condensation in the transfer lines, fittings, or valves from the point where humidified gas is mixed with NO₂ span gas to the probe. We recommend that you design your setup so that the wall temperatures in the transfer lines, fittings, and valves from the humidifying system to the probe are at least 5 °C above the local sample gas dewpoint. Operate the measurement and sample handling system as you do for emission testing. Make</p>				
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<p>no modifications to the sample handling system to reduce the risk of condensation. Flow humidified gas through the sampling system before this check to allow stabilization of the measurement system's sampling handling system to occur, as it would for an emission test.</p> <p>(3) <u>Data collection.</u> (i) Start the flow of zero gas. (ii) Allow for stabilization, accounting for transport delays and the slowest analyzer's full response. (iii) Start recording data. For this verification you must record data at a frequency greater than or equal to that of the updating-recording frequency used during emission testing. You may not use interpolation or filtering to alter the recorded values. (iv) Switch the flow to allow the blended span gases to flow to the analyzer. If you intend to use the data from this test to determine t_{50} for time alignment, record this time as t_0. (v) Allow for transport delays and the slowest analyzer's full response. (vi) Switch the flow to allow zero gas to flow to the analyzer. If you intend to use the data from this test to determine t_{50} for time alignment, record this time as t_{100}. (vii) Allow for transport delays and the slowest analyzer's full response. (viii) Repeat the steps in paragraphs (d)(3)(iv) through (vii) of this section to record seven full cycles, ending with zero gas flowing to the analyzers. (ix) Stop recording.</p>				
<p>(e) <u>Performance evaluations.</u> (1) If you choose to demonstrate compliance with paragraph (c)(1) of this section, use the data from paragraph (d)(3) of this section to calculate the mean rise time, t_{10-90}, and mean fall time, t_{90-10}, for the continuously combined signal from each analyzer being verified. You may use interpolation between recorded values to determine rise and fall times. If the recording frequency used during emission testing is different from the analyzer's output update frequency, you must use the lower of these two frequencies for this verification. Multiply these</p>				

	<p>times (in seconds) by their respective updating-recording frequencies in Hz (1/second). The resulting product must be at least 5 for both rise time and fall time. If either value is less than 5, increase the updating-recording frequency or adjust the flows or design of the sampling system to increase the rise time and fall time as needed. You may also configure analog or digital filters before recording to increase rise and fall times. In no case may the mean rise time or mean fall time be greater than 10 seconds.</p> <p>(2) If a measurement system fails the criterion in paragraph (e)(1) of this section, ensure that signals from the system are updated and recorded at a frequency of at least 5 Hz. In no case may the mean rise time or mean fall time be greater than 10 seconds.</p> <p>(3) If a measurement system fails the criteria in paragraphs (e)(1) and (2) of this section, you may use the measurement system only if the deficiency does not adversely affect your ability to show compliance with the applicable standards.</p>				
	<p>f) <u>Transformation time, t_{50}, determination.</u> If you choose to determine t_{50} for purposes of time alignment using data generated in paragraph (d)(3) of this section, calculate the mean t_{0-50} and the mean t_{100-50} from the recorded data. Average these two values to determine the final t_{50} for the purposes of time alignment in accordance with 650(c)(2)(i).</p>				
31	310 Dynamometer				
32	<p>315 Pressure, temperature, and dewpoint calibration</p> <p>(a) Calibrate instruments for measuring pressure, temperature, and dewpoint upon initial installation. Follow the instrument manufacturer's instructions and use accepted measurement practices to repeat the calibration, as follows:</p> <p>(1) <u>Pressure.</u> We recommend temperature-compensated, digital-pneumatic, or deadweight pressure calibrators, with data-logging capabilities to minimize transcription errors. We recommend using calibration reference quantities that are NIST-traceable within 0.5 %</p>	Not mentioned	Not mentioned	Not mentioned	

<p>uncertainty. (2) <u>Temperature</u>. We recommend digital dry-block or stirred-liquid temperature calibrators, with data logging capabilities to minimize transcription errors. We recommend using calibration reference quantities that are NIST-traceable within 0.5 % uncertainty. You may perform the linearity verification for temperature measurement systems with thermocouples, RTDs, and thermistors by removing the sensor from the system and using a simulator in its place. Use a NIST-traceable simulator that is independently calibrated and, as appropriate, cold-junction compensated. The simulator uncertainty scaled to temperature must be less than 0.5 % of T_{max}. If you use this option, you must use sensors that the supplier states are accurate to better than 0.5 % of T_{max} compared with their standard calibration curve. (3) <u>Dewpoint</u>. We recommend a minimum of three different temperature-equilibrated and temperature-monitored calibration salt solutions in containers that seal completely around the dewpoint sensor. We recommend using calibration reference quantities that are NIST-traceable within 0.5 % uncertainty.</p>			
<p>(b) You may remove system components for off-site calibration. We recommend specifying calibration reference quantities that are NIST-traceable within 0.5 % uncertainty.</p>			

Tables of WLTP

Table 1 of 170—Gaseous Batch Sampling Container Materials

Emissions	Engines	
	Compression-ignition	All other engines
CO, CO ₂ , O ₂ , CH ₄ , C ₂ H ₆ , C ₃ H ₈ , NO, NO ₂ ¹	Tedlar™ ² , Kynar™ ² , Teflon™ ³ , or 300 series stainless steel ³	Tedlar™ ² , Kynar™ ² , Teflon™ ³ , or 300 series stainless steel ³
THC, NMHC	Teflon™ ⁴ or 300 series stainless steel ⁴	Tedlar™ ² , Kynar™ ² , Teflon™ ³ , or 300 series stainless steel ³

Figure 1 of §1065.170—PM filter cassette specifications.

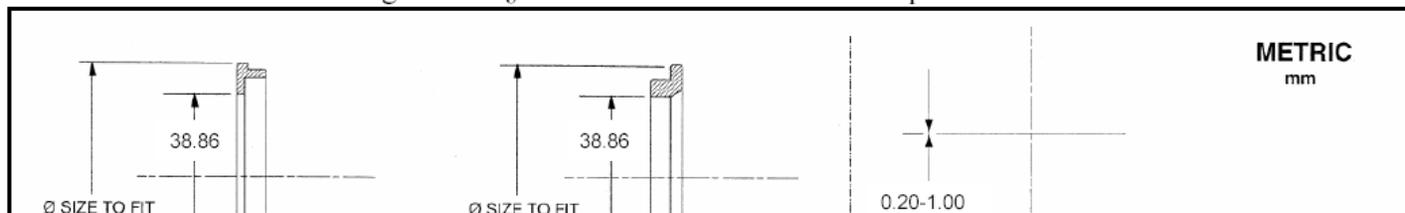


Table 1 of 190—Dewpoint tolerance
as a function of % PM change and % sulfuric acid PM

Expected sulfuric acid fraction of PM	±0.5 % PM mass change	±1.0 % PM mass change	±2.0 % PM mass change
5 %	±3.0 °C	±6.0 °C	±12 °C
50 %	±0.30 °C	±0.60 °C	±1.2 °C
100 %	±0.15 °C	±0.30 °C	±0.60 °C

Table 1 of 202—Data recording and control minimum frequencies

Measured Values	Minimum	Minimum
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	Command and Control Frequency	Recording Frequency
Dynamometer	40 Hz	10 Hz
Continuous concentrations of raw or dilute analyzers	N/A	1 Hz
Batch concentrations of raw or dilute analyzers	N/A	1 mean value per test interval
Diluted exhaust flow rate from a CVS with a heat exchanger upstream of the flow measurement	N/A	1 Hz
Diluted exhaust flow rate from a CVS without a heat exchanger upstream of the flow measurement	5 Hz	1 Hz means
Intake-air or raw-exhaust flow rate	N/A	1 Hz means
Dilution air if actively controlled	5 Hz	1 Hz means
Sample flow from a CVS that has a heat exchanger	1 Hz	1 Hz
Sample flow from a CVS does not have a heat exchanger	5 Hz	1 Hz mean

Table 1 of 205–Recommended performance specifications for measurement instruments

Measurement Instrument	Measured quantity symbol	Complete System Rise time (t_{10-90}) and Fall time (t_{90-10}) ^a	Recording update frequency	Accuracy ^b	Repeatability ^b	Noise ^b
General pressure transducer (not a part of another instrument)	p	5 s	1 Hz	2.0 % of pt. or 1.0 % of max.	1.0 % of pt. or 0.50 % of max.	0.1 % of max
Atmospheric pressure meter used for PM-stabilization and balance environments	p_{atmos}	50 s	5 times per hour	50 Pa	25 Pa	5 Pa
General purpose atmospheric pressure meter	p_{atmos}	50 s	5 times per hour	250 Pa	100Pa	50 Pa

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Temperature sensor for PM-stabilization and balance environments	T	50 s	0.1 Hz	0.25 K	0.1 K	0.1 K
Other temperature sensor (not a part of another instrument)	T	10 s	0.5 Hz	0.4 % of pt. K or 0.2 % of max. K	0.2 % of pt. K or 0.1 % of max. K	0.1 % of max
Dewpoint sensor for intake air, PM-stabilization and balance environments	T_{dew}	50 s	0.1 Hz	0.25 K	0.1 K	0.02 K
Other dewpoint sensor	T_{dew}	50 s	0.1 Hz	1 K	0.5 K	0.1 K
Fuel flow meter (Fuel totalizer)	\dot{m}	5 s (N/A)	1 Hz (N/A)	2.0 % of pt. or 1.5 % of max.	1.0 % of pt. or 0.75 % of max.	0.5 % of max.
Total diluted exhaust meter (CVS) (With heat exchanger before meter)	\dot{n}	1 s (5 s)	1 Hz means (1 Hz)	2.0 % of pt. or 1.5 % of max.	1.0 % of pt. or 0.75 % of max.	1.0 % of max.
Dilution air, inlet air, exhaust, and sample flow meters	\dot{n}	1 s	1 Hz means of 5 Hz samples	2.5 % of pt. or 1.5 % of max.	1.25 % of pt. or 0.75 % of max.	1.0 % of max.
Continuous gas analyzer	x	5 s	1 Hz	2.0 % of pt. or 2.0 % of meas.	1.0 % of pt. or 1.0 % of meas.	1.0 % of max.
Batch gas analyzer	x	N/A	N/A	2.0 % of pt. or 2.0 % of meas.	1.0 % of pt. or 1.0 % of meas.	1.0 % of max.
Gravimetric PM balance	m_{PM}	N/A	N/A	See §790	0.5 μ g	N/A

^a The performance specifications identified in the table apply separately for rise time and fall time.

^b Accuracy, repeatability, and noise are all determined with the same collected data, as described in §305, and based on absolute values. “pt.” refers to the overall flow-weighted mean value expected at the standard; “max.” refers to the peak value expected at the standard over any test interval, not the maximum of the instrument’s range; “meas” refers to the actual flow-weighted mean measured over any test interval.

Table 1 of 303–Summary of required calibration and verifications

Type of calibration or verification	Minimum frequency ^a
305: Accuracy, repeatability and noise	Accuracy: Not required, but recommended for initial installation. Repeatability: Not required, but recommended for initial installation. Noise: Not required, but recommended for initial installation.
307: Linearity verification	Dynamometer: Upon initial installation, within 370 days before testing and after major maintenance. Clean gas and diluted exhaust flows: Upon initial installation, within 370 days before testing and after major maintenance, unless flow is verified by propane check or by carbon or oxygen balance. Raw exhaust flow: Upon initial installation, within 185 days before testing and after major maintenance, unless flow is verified by propane check or by carbon or oxygen

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	<p>balance. Gas dividers: Upon initial installation, within 370 days before testing, and after major maintenance. Gas analyzers: Upon initial installation, within 35 days before testing and after major maintenance. FTIR and photoacoustic analyzers: Upon initial installation, within 370 days before testing and after major maintenance. GC-ECD: Upon initial installation and after major maintenance. PM balance: Upon initial installation, within 370 days before testing and after major maintenance. Pressure, temperature, and dewpoint: Upon initial installation, within 370 days before testing and after major maintenance.</p>
308: Continuous gas analyzer system response and updating-recording verification—for gas analyzers not continuously compensated for other gas species	Upon initial installation or after system modification that would affect response.
309: Continuous gas analyzer system-response and updating-recording verification—for gas analyzers continuously compensated for other gas species	Upon initial installation or after system modification that would affect response.
310: Dynamometer	<p>Full transducer calibrations traceable to a recognized standards organization upon initial installation, within 370 days before testing, and after major maintenance. Dynamometer Parasitic loss: Upon initial installation and weekly. Dynamometer speed verifications: Upon initial installation and monthly. Dynamometer load curve coastdown: Upon initial installation and weekly.</p>
315: Pressure, temperature, dewpoint	Upon initial installation and after major maintenance.
330: Exhaust flow	Upon initial installation and after major maintenance.
340: Diluted exhaust flow (CVS)	Upon initial installation and after major maintenance.
341: CVS and batch sampler verification ^b	Upon initial installation, within 35 days before testing, and after major maintenance.
342 Sample dryer verification	<p>For thermal chillers: upon installation and after major maintenance. For osmotic membranes; upon installation, within 35 days of testing, and after major maintenance.</p>
345: Vacuum leak	Within 8 hours before the start of the first test interval of each duty-cycle sequence, and after maintenance such as pre-filter changes.
350: CO ₂ NDIR H ₂ O interference	Upon initial installation and after major maintenance.
355: CO NDIR CO ₂ and H ₂ O interference	Upon initial installation, within 370 days before testing and after major maintenance.
360: FID calibration THC FID optimization, and THC FID verification.	<p>Calibrate all FID analyzers: upon initial installation and after major maintenance. Optimize and determine CH₄ response for THC FID analyzers: upon initial installation and after major maintenance. Verify CH₄ response for THC FID analyzers: upon initial installation, within 185 days before testing, and after major maintenance.</p>
362: Raw exhaust FID O ₂ interference	<p>For all FID analyzers: upon initial installation, and after major maintenance. For THC FID analyzers: upon initial installation, after major maintenance, and after FID optimization according to 360.</p>
365: Nonmethane cutter penetration	Upon initial installation, within 185 days before testing, and after major maintenance.
370: CLD CO ₂ and H ₂ O quench	Upon initial installation and after major maintenance.
372: NDUV HC and H ₂ O interference	Upon initial installation and after major maintenance.
375: N ₂ O analyzer interference	Upon initial installation and after major maintenance.

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376: Chiller NO ₂ penetration	Upon initial installation and after major maintenance.
378: NO ₂ -to-NO converter conversion	Upon initial installation, within 35 days before testing, and after major maintenance.
390: PM balance and weighing	Independent verification: upon initial installation, within 370 days before testing, and after major maintenance. Zero, span, and reference sample verifications: within 12 hours of weighing, and after major maintenance.

Table 1 of §307–Measurement systems that require linearity verifications

Measurement system	Quantity	Minimum verification frequency	Linearity criteria			
			$ x_{\min}(a_1-1)+a_0 $	a_1	SEE	r^2
Dynamometer	f_n	Within 370 days before testing	$\leq 0.05\% \cdot f_{n\max}$	0.98-1.02	$\leq 2\% \cdot f_{n\max}$	≥ 0.990
Dilution air flow rate	\dot{n}	Within 370 days before testing	$\leq 1\% \cdot \dot{n}_{\max}$	0.98-1.02	$\leq 2\% \cdot \dot{n}_{\max}$	≥ 0.990
Diluted exhaust flow rate	\dot{n}	Within 370 days before testing	$\leq 1\% \cdot \dot{n}_{\max}$	0.98-1.02	$\leq 2\% \cdot \dot{n}_{\max}$	≥ 0.990
Raw exhaust flow rate	\dot{n}	Within 185 days before testing	$\leq 1\% \cdot \dot{n}_{\max}$	0.98-1.02	$\leq 2\% \cdot \dot{n}_{\max}$	≥ 0.990
Batch sampler flow rates	\dot{n}	Within 370 days before testing	$\leq 1\% \cdot \dot{n}_{\max}$	0.98-1.02	$\leq 2\% \cdot \dot{n}_{\max}$	≥ 0.990
Gas dividers	x/x_{span}	Within 370 days before testing	$\leq 0.5\% \cdot x_{\max}/x_{\text{span}}$	0.98-1.02	$\leq 2\% \cdot x_{\max}/x_{\text{span}}$	≥ 0.990
Gas analyzers for laboratory testing	x	Within 35 days before testing	$\leq 0.5\% \cdot x_{\max}$	0.99-1.01	$\leq 1\% \cdot x_{\max}$	≥ 0.998
Gas analyzers for field testing	x	Within 35 days before testing	$\leq 1\% \cdot x_{\max}$	0.99-1.01	$\leq 1\% \cdot x_{\max}$	≥ 0.998
PM balance	m	Within 370 days before testing	$\leq 1\% \cdot m_{\max}$	0.99-1.01	$\leq 1\% \cdot m_{\max}$	≥ 0.998
Pressures	p	Within 370 days before testing	$\leq 1\% \cdot p_{\max}$	0.99-1.01	$\leq 1\% \cdot p_{\max}$	≥ 0.998

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Dewpoint for intake air, PM-stabilization and balance environments	T_{dew}	Within 370 days before testing	$\leq 0.5 \% \cdot T_{dewmax}$	0.99-1.01	$\leq 0.5 \% \cdot T_{dewmax}$	≥ 0.998
Other dewpoint measurements	T_{dew}	Within 370 days before testing	$\leq 1 \% \cdot T_{dewmax}$	0.99-1.01	$\leq 1 \% \cdot T_{dewmax}$	≥ 0.998
Analog-to-digital conversion of temperature signals	T	Within 370 days before testing	$\leq 1 \% \cdot T_{max}$	0.99-1.01	$\leq 1 \% \cdot T_{max}$	≥ 0.998

Tables Of Japan

Table 1 Components of calibration of gas

Exhaust emission components	Type of gas		Gas components	
CO	Calibration gas	In zero adjustment	N ₂	High-purity N ₂ (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower)
		In span adjustment	CO, N ₂ balance	

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THC (FID,	Calibration gas	In zero adjustment	Air	High-purity air (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower, oxygen content: 18 to 21 vol%)
HFID)		In span adjustment	C ₃ H ₈ , air balance	
	Fuel gas		H ₂ : 40±2%, balance gas: He (HC: 1ppmC equivalent or lower, CO ₂ : 400ppm or lower)	
HC (NDIR)	Calibration gas	In zero adjustment	N ₂	High-purity N ₂ (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower)
		In span adjustment	C ₆ H ₁₄ , N ₂ balance (If propane/hexane sensitivity coefficient of the analyzer is known, C ₃ H ₈ , N ₂ balance)	
	Calibration gas	In zero adjustment	N ₂	High-purity N ₂ (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower)
		In span adjustment	NO, N ₂ balance	
NOx	Ozone generating gas		Oxygen (purity 99.5 vol% or more) or high-purity air (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower, oxygen content: 18 to 21 vol%) * Based on the principle of ozone generator.	

Exhaust emission components	Type of gas		Gas components	
	Calibration gas	In zero adjustment	Air	High-purity air (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower, oxygen content: 18 to 21 vol%)
			CH ₄ , air balance (in case of GC-FID)	
CH ₄		In span adjustment	C ₃ H ₈ , air balance (In case of NMC-FID)	
	Fuel gas		H ₂ : 40±2%, balance gas: He (HC: 1ppmC equivalent or lower, CO ₂ : 400ppm or lower)	
	Gas for calculating methane efficiency		CH ₄ , air balance	
	Gas for calculating ethane efficiency		C ₂ H ₆ , air balance	
CO ₂	Calibration gas	In zero adjustment	N ₂	High-purity N ₂ (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower)
		In span adjustment	CO, N ₂ balance	

**Table 1
Analyzer**

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Fuel	Exhaust emission component	Analyzer
	CO	Nondispersive infrared analyzer (NDIR)
Gasoline LPG CNG	THC	Hydrogen flame ionization detector (FID)
	CH ₄	Selective combustion methane analyzer (NMC-FID) or gas chromatograph spectrometer (GC-FID)
	NO _x	Chemiluminescence detector (CLD)
	CO ₂	Nondispersive infrared analyzer (NDIR)
	CO	Nondispersive infrared analyzer (NDIR)
	THC	Heated flame ionization detector (HFID)
Diesel oil	CH ₄	Selective combustion methane analyzer (NMC-FID) or gas chromatograph spectrometer (GC-FID)
	NO _x	Chemiluminescence detector (CLD)
	CO ₂	Nondispersive infrared analyzer (NDIR)

Tables and figures of EEC

Figure 5/1

Diagram of a variable-dilution system for measuring exhaust gas emissions

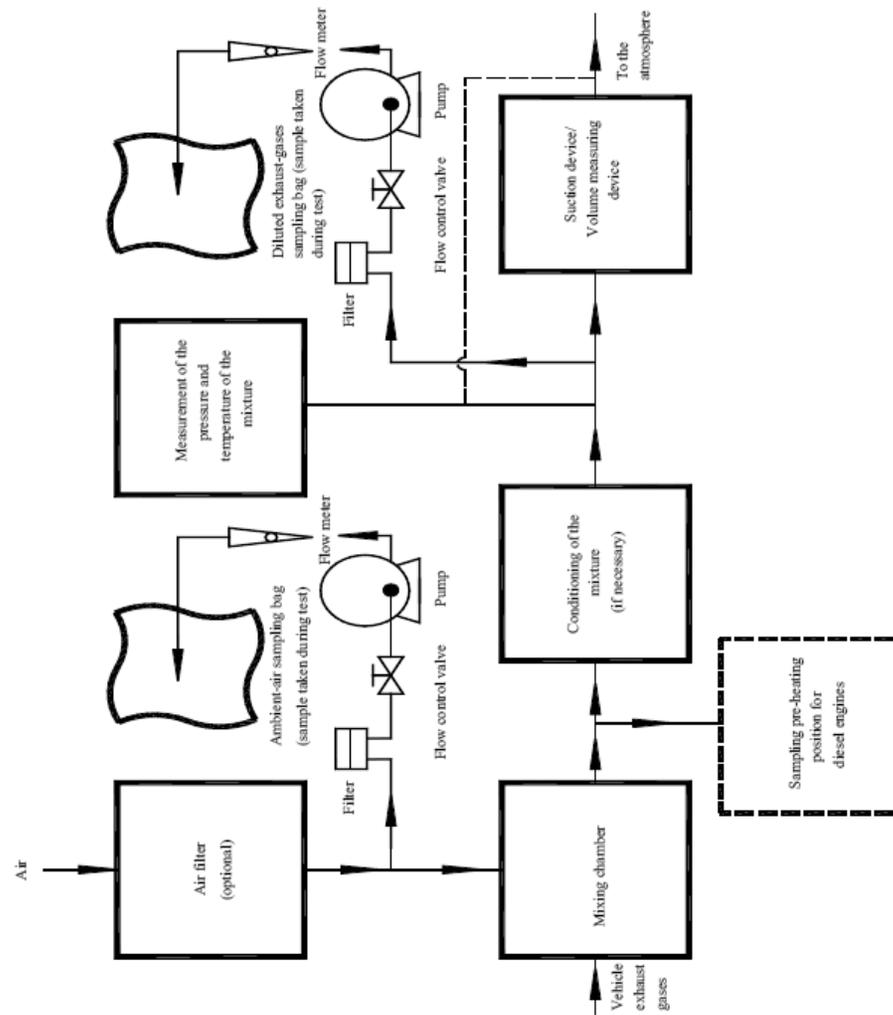


Figure 5/2

Particulate sampling probe configuration

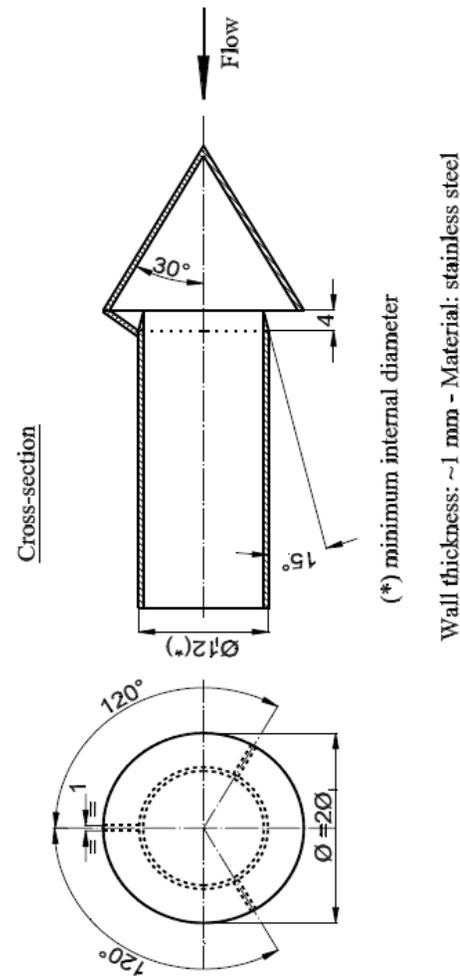
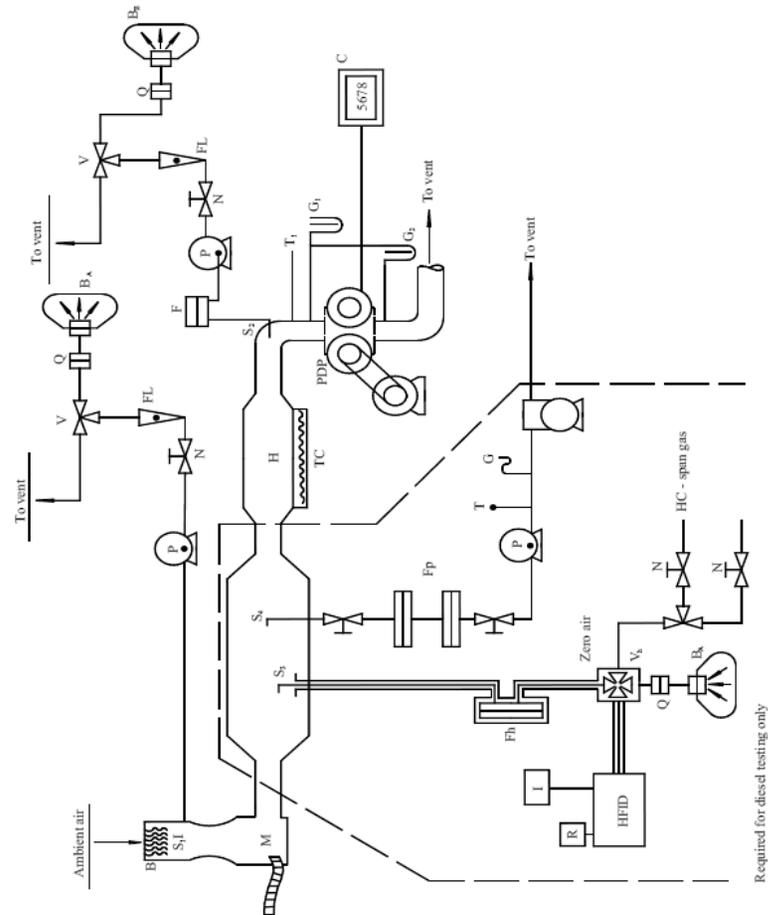


Figure 5/3

Constant volume sampler with positive displacement pump (PDP-CVS)



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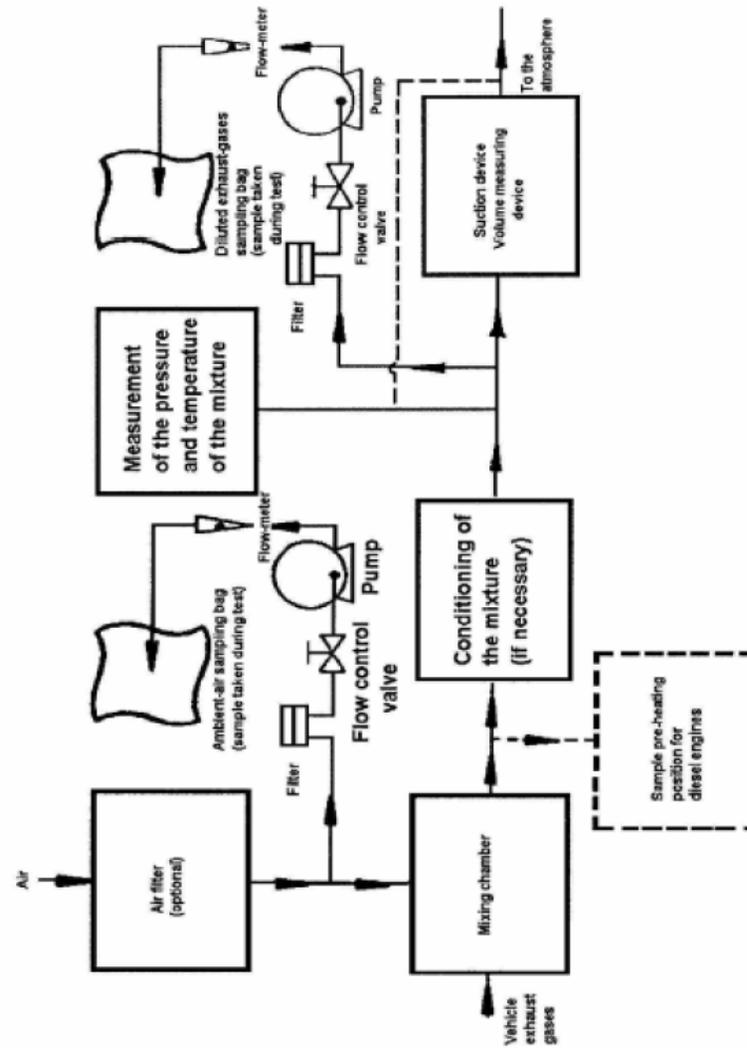


Figure 7 : Diagram of variable-dilution system for measuring exhaust-gas emissions

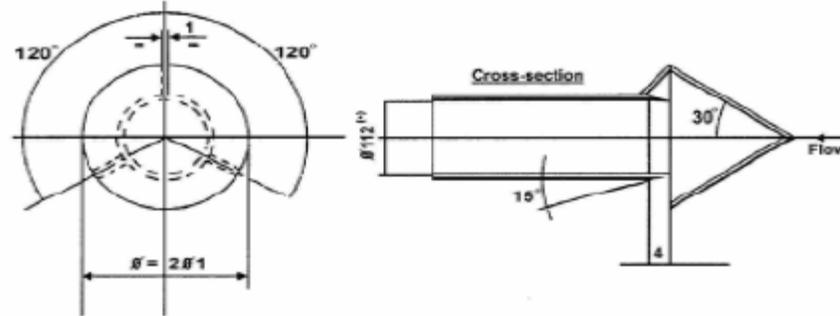


Figure 8 : Particulate Sampling Probe Configuration

(*) Minimum internal diameter

Wall thickness : ~1 mm; Material : Stainless Steel

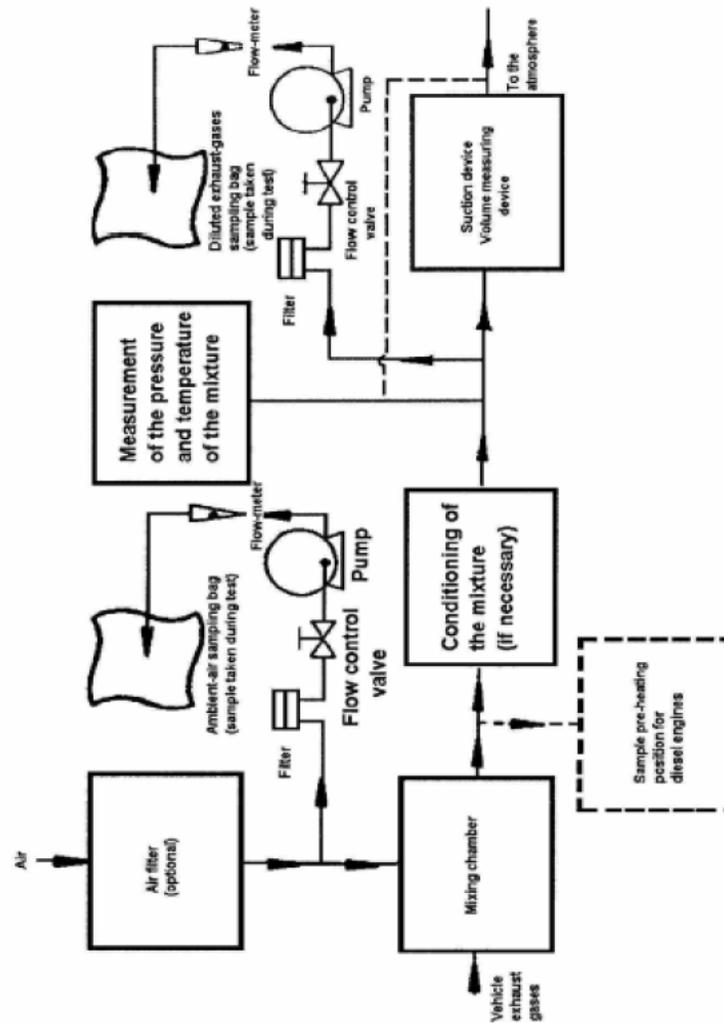


Figure 7 : Diagram of variable-dilution system for measuring exhaust-gas emissions

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FLOW-RELATED MEASUREMENTS					
Exhaust flow calibration					
33	Calibrate upon initial installation using subsonic venturi or ultrasonic flow meter. Traceable within 0.5 % uncertainty	Each analyser shall be calibrated as often as necessary and in any case in the month before type approval testing and at least once every six months for verifying conformity of production.		For proper calibration the main dilution tunnel shall be a straight pipe. The temperature of the test room shall be kept at 298 ±5 K (25 ±5°C) and the relative humidity shall be in the range of 30% to 75%.	
Diluted exhaust flow Constant volume sampling (CVS) calibration					
34	Calibrate CVS temperature and pressure instruments. Calibrate at permanent position. Repeat calibration if there is a change in upstream or downstream of the flow meter. Calibration traceable within ±1 % uncertainty	A CVS system that has multiple speeds shall be calibrated on each speed used. The calibrated flow rate should be given in m ³ /min at pump inlet, absolute pressure and temperature. Temperature stability shall be maintained during the calibration. Gradual changes of ± 1K in temperature are acceptable.		CVS system shall have a heat exchanger. The accuracy of the constant volume sampler shall be within ±2% of measured flow volume. Set the equivalent inertia weight within a range between the said standard value and the said standard value +10%.	
35	Calibrate a CVS flow meter using a reference flow meter such as a subsonic venturi flow meter, a long-radius ASME/NIST flow nozzle, a smooth approach orifice, a laminar flow element, a set of critical flow venturi, or an ultrasonic flow meter. Do not use an upstream screen or other restriction that could affect the flow	Calibrated by using an accurate flow meter and a restricting device. CVS pump run for 20 minutes before starting the calibration. Various types of flow meter may be used, e.g. calibrated venturi, laminar flow meter, calibrated turbine meter.		The inner surface of the main dilution tunnel shall be smooth. The tolerable difference between the static pressure at the exhaust pipe outlet of the test vehicle running at a constant speed of 70 ±2 km/h and the static pressure at the connection when the exhaust pipe outlet is connected to the exhaust gas sampling port of the CVS system shall be within ±0.10 kPa.	
Positive-displacement pump (PDP)					
36	Calibrate a positive-displacement pump (PDP) to determine a flow-versus-PDP speed equation. Leaks between the calibration flow meter and the PDP must be less than 0.3 % of the total flow.	Positive Displacement Pump (PDP). All connections between the flow meter and the CVS pump shall be free of any leakage.		The sampling suction pump shall be mounted on the PM filter holder. Sampling transfer tube may be within ±5% in relation to the set flow rate.	
37	Constant temperature at the PDP inlet within ±2 % of the mean absolute inlet temperature and at least maintain 3 min to stabilize the system. Verify the calibration by performing a CVS verification (i.e., propane check)	The calculated values from the equation should be within ± 0.5 % of the measured value		Inlet gas temperature of the positive displacement pump (PDP) type CVS system shall be within ±6 K (±6°C) in relation to the mean measured value.	
Critical Flow Venturi (CFV)					
38	Calibrate a critical flow venturi (CFV) to	Gas flow is a function of inlet pressure		Venturi inlet gas temperature of the	

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	verify its discharge coefficient. Maintain a constant temperature at the CFV inlet within ± 2 % of the mean absolute inlet temperature.	and temperature. The manufacturer's recommended procedure shall be followed for calibrating electronic portions of the CFV.		critical flow venturi (CFV) type CVS system shall be within ± 11 K ($\pm 11^\circ\text{C}$) in relation to the mean measured value.	
39	Leaks between the calibration flow meter and the CFV must be less than 0.3 % of the total flow. Operate the CFV for at least 3 min to stabilize the system	Any leaks between the flow measuring device and the critical flow venturi will seriously affect the accuracy of the calibration. If the standard deviation exceeds 0.3 % of the average, corrective action shall be taken.			
	Subsonic Venturi Calibration (SSV)				
40	Calibrate a subsonic venturi (SSV) to determine its calibration coefficient. Leaks between the calibration flow meter and the SSV must be less than 0.3 % of the total flow. When the SSV operates, maintain a constant temperature at the SSV inlet within ± 2 % of the mean absolute inlet temperature. Operate the SSV for at least 3 min to stabilize the system. Continue operating the SSV and record the mean of at least 30 seconds. Use the SSV only between the minimum and maximum calibrated flow rates			The nozzle of the CFV type CVS system shall have been cleaned thoroughly. The width of fluctuation of the venturi inlet gas temperature of the subsonic speed venturi (SSV) type CVS system shall be within ± 11 K ($\pm 11^\circ\text{C}$) in relation to the mean measured value.	Venturi calibration is not provided in TAP, ECE documents
	CVS and batch sampler verification (propane check)				
41	A propane check is to determine if there is a discrepancy in measured values of diluted exhaust flow. Any deviation exceeding ± 2 % operates the CVS at a higher flow rate. Determine the reference cylinder's mass of C_3H_8 within ± 0.5 % of the amount of C_3H_8 that you expect to use. If the overflow HC concentration exceeds $2 \pm$ mol/mol, do not proceed until contamination is eliminated.				CVS batch sampler is not discussed by TAP, ECE, Japan documents
	Sample dryer verification.				
42	If you use a sample dryer to remove water from the sample gas, verify the performance upon installation. Inlet of the sampling system at a temperature at least 5°C above the local humidified gas dew point.				Sampler dryer is not discussed by TAP, ECE, Japan documents
	Vacuum-side leak verification				
43	Perform the vacuum-side leak verification upon initial installation. After stabilizing, verify that the flow through the vacuum-side of the sampling system is less than 0.5 % of				Vacuum side leak is not discussed by TAP, ECE, Japan documents

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	normal flow rate. Use repeatability of 0.5% or better. Verify the measured overflow span gas concentration is within $\pm 0.5\%$. To perform leak test the vacuum-side volume of your sampling system to within $\pm 10\%$ of its true volume.				
CO AND CO2 MEASUREMENTS					
	H₂O interference verification for CO₂ /CO Non dispersive infra red (NDIR) analyzers				
44	If you measure CO ₂ /CO using an NDIR analyzer, verify the amount of H ₂ O interference after initial analyzer installation and after major maintenance. A CO ₂ NDIR analyzer must have an H ₂ O interference that is within (0.0 \pm 0.2) mmol/mol.	The NDIR analyzer shall be tuned, where appropriate, and the flame combustion of the FID analyzer is optimized. Using purified dry air (or nitrogen), the CO and NOx analysers shall be set at zero; dry air shall be purified for the HC analyser.		The analyzer to be used shall be warmed up prior to the test, following the method recommended by the manufacturer of the device.	
45	The wall temperature should be at least 5 °C above the local sample gas dew point.	A minimum of two hours shall be allowed for warming up the infra-red NDIR analyzer.			
46	Record 30 seconds of sampled data calculate the arithmetic mean of this data. The analyzer meets the interference verification if this value is within (0 \pm 0.2) mmol/mol.	The calibration curves of the analysers should be verified by checking at least at five calibration points. The nominal concentration of the calibration gas shall be at least equal to 80% of the full scale.		When the concentration of the CO, etc. in the measured dilution air becomes negative, the concentration of the CO, etc. in the dilution air shall be regarded as zero.	
47	NDIR analyzer always affects your brake-specific emission results within $\pm 0.5\%$ of each of the applicable standards.	The nominal value of the span calibration gas used shall remain within $\pm 2\%$ of the calibration curve.			
HYDROCARBON MEASUREMENTS					
	Flame Ionization detector (FID) optimization and verification <u>FID calibrated with the Non methane cutter (NMC)</u> <u>FID calibrated with propane, bypassing the NMC.</u> <u>FID calibrated with methane, bypassing the NMC.</u>				
48	Optimize the response to various hydrocarbons after initial analyzer installation. Verify the methane (CH ₄) response within 185 days before testing.	The FID shall be adjusted as specified by the instrument manufacturer. Propane in air shall be used to optimize the response, on the most common operating range.			
49	For a FID that measures THC, calibrate using C ₃ H ₈ calibration gases. For a FID that	The concentration of the test gas shall be at a level to give a response of			

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	measures CH ₄ , calibrate using CH ₄ calibration gases. Regardless of the calibration gas composition, calibrate on a carbon number basis of one (C ₁). For example, if you use a C ₃ H ₈ span gas of concentration 200 mol/mol, span the FID to respond with a value of 600±mol/mol. Calculate the arithmetic mean of the data points.	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 & 303 K (20 °C and 30 °C). Response factors are to be determined during service and major service intervals.			
NO_x AND N₂O MEASUREMENTS					
	chemiluminescent (CLD) CO₂ and H₂O quench verification				
50	A CLD analyzer must have a combined H ₂ O and CO ₂ quench of ±2 % or less, though prefer ±1 % or less. Calculate the arithmetic mean concentration and use it in the quench verification. The analyzers are at least 5 °C above the local sample gas dew point. If the sum of the H ₂ O quench plus the CO ₂ quench is less than -2 % or greater than +2 %, take corrective action by repairing or replacing the analyzer. CLD analyzer always affects your brake-specific NO _x emission results within no more than ±1.0 % of the applicable NO _x standard.	Calibrate the CLA analyser in the most common operating range using zero and span gas. The efficiency of the converter shall not be less than 95%. Via a T-fitting, oxygen or synthetic air is added continuously to the gas flow until the concentration indicated is about 10 % less than the indicated calibration concentration			NOX is not discussed in, Japan regulation
	NDUV analyzer HC and H₂O interference verification.				
51	If you measure NO _x using an NDUV analyzer, verify the amount of H ₂ O and hydrocarbon interference after installation. A NO _x NDUV analyzer must have combined H ₂ O and HC interference within ±2 % of the flow-weighted mean concentration of NO _x though preferably within ±1 %.				NDUV is not discussed in TAP, ECE, Japan regulation
	Interference verification for N₂O analyzers.				
52	Analyzers must have combined interference that is within (0.0 ± 1.0) ±mol/mol. We strongly recommend a lower interference that is within (0.0 ± 0.5) mol/mol.				Interference is not discussed in TAP, ECE, Japan regulation
	Chiller NO₂ penetration				
53	A chiller removes water, which can otherwise interfere with a NO _x measurement. A chiller must allow for measuring at least 95 % of				Chiller is not discussed in TAP, ECE, Japan regulation

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	the total NO ₂ .				
	NO₂-to-NO converter conversion verification				
54	An NO ₂ -to-NO converter must allow for measuring at least 95 % of the total NO ₂ at the maximum expected concentration of NO ₂ . If the result is less than 95 %, repair or replace the NO ₂ -to-NO converter.				NO converter is not discussed in TAP, ECE, Japan regulation
Particulate matter (PM) MEASUREMENTS					
	PM balance verifications and weighing process verification				
55	Independent verification of PM balances performance within 370 days before weighing any filter. Zero and span the balance within 12 h before weighing any filter. A weighing session may be as short as desired, as but no longer than 80 hours. Consider references stabilized if they have been in the PM-stabilization environment for a minimum of 30 min, and the PM-stabilization environment for at least the preceding 60 min.			The flow velocity of the diluted exhaust gas passing through the PM collecting filter shall be 35 cm/s or more and 100 cm/s or less. In this case, the increase of the pressure loss by the PM collecting filter at the end of the measurement from that at the start of the measurement shall not exceed 25 kPa. The temperature of the diluted exhaust gas immediately before the PM collecting filter shall be 325 K (52 °C) (464 K (191 °C) in the case of the measurement of the exhaust gas.	PM is not discussed in TAP, ECE document
56	Successive mass determinations of each reference PM sample media (e.g., filter) must return the same value within ±10 g or ±10 % of the net PM mass expected at the standard (if known), whichever is higher.			The temperature of the weighing room shall be kept at 295 ±3 K (22 ±3°C). The humidity of the weighing room shall be 45 ±8%. Airborne dust inside the weighing room shall be kept to a minimum. The readable limit of the weighing balance shall be 0.1 µg or less, and the standard deviation shall be 0.25 µg or less.	
PERFORMING EMISSION TESTS					
	Sequences of fueling, parking, and operating test conditions.				
57	Idle modes less than one minute in length shall be run with automatic transmissions and the wheels braked; The upper/lower limit is 2 mph (3.2 km/ h) higher than the highest point on the trace within 1 second of the given time.	The first idling period at the beginning of the urban cycle (Part One) shall consist of 6 seconds of idling in neutral with the clutch engaged and 5 seconds in first gear with the clutch disengaged.	The vehicle shall be started up by the means provided for normal use to the driver. The first cycle starts on the initiation of the vehicle start-up procedure.	During the idling operation, the accelerator pedal shall not be operated.	
58	Speed variations greater than the tolerances	Time tolerances of ± 1 second shall be	In case of special gear shifting	In cases where the engine revolution	

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	(such as may occur during gear changes or braking spikes) are acceptable, provided they occur for less than 2 seconds on any occasion.	allowed. A tolerance of ± 2 km/h shall be allowed between the indicated speed and the theoretical speed during acceleration, during steady speed and during deceleration.	strategy, according to the manufacturer's instructions, as incorporated in the drivers' handbook of production vehicles and indicated by a technical gear shift instrument (for drivers' information).	speed of the motor vehicle concerned exceeds 90% of the engine speed at which the engine produces the maximum output during the operation of the test motor vehicle, it is permissible to use the shift gear 1 position higher than the shift gear that is being used at this time.	
59	To determine road load power, test weight, and inertial weight class, follow SAE J2263, track road load determination and SAE J2264 dyno road load determination.	It shall have been run-in either as per manufacturer's specification or at least 3000 km before the test.	Sampling shall begin (BS) before or at the initiation of the vehicle start up procedure and end on conclusion of the final idling period in the extra-urban cycle (Part Two, end of sampling (ES))	The vehicle condition setting before the running according to the JC08H-mode method. The test motor vehicle shall be driven on the chassis dynamometer from the 1032nd second to the 1204th second of the JC08-mode.	
	Vehicle Preparation				
60	Fuel tanks shall be filled to a minimum of 75% of service pressure for natural gas-fueled vehicles or a minimum of 75% of available fill volume for liquefied petroleum gas-fueled vehicles.	The reference fuel as prescribed in the applicable Gazette notification shall be used.	During soak, the electrical energy/power storage device shall be charged: With the on board charger if fitted; With an external charger recommended by the manufacturer, using the normal overnight charging procedure.	The vehicle condition before the running according to the JC08C-mode	
61	Gasoline- and methanol-fueled vehicles shall be soaked for at least 6 hours after being refueled. Petroleum fueled diesel vehicles and gaseous fueled vehicles shall be soaked for at least 1 hour after being refueled. In the case of repeat testing on a flexible-fueled vehicle, in which the test fuel is changed, separate preconditioning procedure shall be used.	The vehicle soaking shall be carried out for at least 6 hours and continue until the engine oil temperature and coolant, if any, are within ± 2 K of the temperature of the room.	The vehicle shall be kept in a room in which the temperature remains relatively constant between 293 and 303 K (20 °C and 30 °C). This conditioning shall be carried out for at least six hours and continue until the engine oil temperature and coolant, if any, are within ± 2 K of the temperature of the room, and the electrical energy/power storage device is fully charged	Soak the vehicle with the engine stopped for at least 6 hours, but less than 36 hours, in a room at 298 ± 5 K (25 ± 5 °C) after running the test vehicle on the chassis dynamometer. The vehicle condition setting before the running according to the JC08H-mode method.	
	Fuel dispensing spit back procedure				
62	The vehicle is fueled at a rate of 10 gal/min to test for fuel spit back emissions. Ambient temperature levels encountered by the test vehicle shall be not less than 68 °F or more than 86 ° F. Measure and record the mass of the bag to be used for collecting spit back emissions to the nearest 0.01 gram. The vehicle shall be soaked at 80 ± 6 °F (27 ± 3 °C)	The test vehicle must be exposed to one cycle of ambient temperature with a maximum deviation of ± 2 K at any time. The measuring chamber must be purged for several minutes immediately before the test until a stable background is obtainable. The chamber mixing fan(s) must also be switched on		The room temperature shall be approximately uniform, and no adjustment or maintenance shall be performed on the test vehicle while it is left standing. Also, when moving the test vehicle after setting the condition, the engine concerned shall not be operated.	

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	for a minimum of six hours.	at this time.			
	Vehicle and canister preconditioning; refueling test				
63	purging the canister(s) with at least 1200 canister bed volumes of ambient air (with humidity controlled to 50}25 grains of water vapor per pound of dry air) maintained at a nominal flow rate of 0.8 cfm	Temperature sensor to enable the temperature in the fuel tank when filled to 40% of its capacity, The vehicle is taken into the test area where the ambient temperature is between 293 K and 303 K (20 and 30 °C)			Canister purging is not discussed by Japan documents
64	For canister purge, conduct additional driving on a dynamometer, within one hour of completion of the hot start exhaust test, by operating the test vehicle through one UDDS, a 2 minute idle, two NYCCs, another 2 minute idle, another UDDS, and then another 2 minute idle. Fifteen seconds after the engine starts, place the transmission in gear. Twenty seconds after the engine starts, begin the initial vehicle acceleration of the driving schedule.	The ageing of the canister(s) has to be verified. This may be done by demonstrating that it has accumulated a minimum of 3000 km. The canister is connected to a fuel tank, possibly an external one, filled with reference fuel, to 40% volume of the fuel tank(s). The fuel temperature in the fuel tank must be between 283 K (10 °C) and 287 K (14 °C) The (external) fuel tank is heated from 288 K to 318 K (15 °C to 45 °C) (1 °C increase every 9 minutes). If the canister reaches breakthrough before the temperature reaches 318 K (45 °C), the heat source must be turned off. Then the canister is weighed.			
	Canister purging: non-integrated systems.				
65	Within one hour of completion of canister loading to breakthrough, the fuel tank(s) shall be further filled to 95 percent of nominal tank capacity determined to the nearest one-tenth of a U.S. gallon (0.38 liter)	Within one hour of being refueled the vehicle must be placed, with the engine shut off, in the evaporative emission enclosure. The fuel tank temperature sensor is connected to the temperature recording system.			Canister purging is not discussed by Japan documents
66	Vehicle driving on a chassis dynamometer shall consist of repeated drives with the UDDS until 85 percent of fuel tank capacity has been consumed. For vehicles equipped with dual fuel tanks, fuel switching from the first tank to the second tank shall occur at the 10 percent volume of the first tank regardless of the point in the UDDS cycle at which this occurs.	Mono-fuel vehicle means a vehicle that is designed primarily for permanent running on LPG or NG, but may also have a petrol system for emergency purposes for starting only, where the petrol tank does not contain more than 15 liters of petrol.			
	Test track procedure				
67	If the distance from the emission laboratory to the test track is less than 5 miles (8.05				Test track procedure is not discussed by TAP,

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	km) the vehicle may be driven to the test track at a speed not to exceed 25 mph. If the distance is greater than 5 miles (8.05 km) the vehicle shall be moved to the test track with the engine off.				ECE, Japan documents
	Other refueling emission tests				
68	Within 60 minutes of completion of refueling emissions canister stabilization the vehicle fuel tank(s) shall be drained. The testing sequence includes an approved preconditioning cycle, a 10 minute soak with the engine turned off.	The exhaust gases contained in the bag shall be analysed as soon as possible and in any event not later than 20 minutes after the end of the test cycle. The spent particulate filters must be taken to the chamber no later than 1 hour.			Other refueling test procedure is not discussed by TAP, ECE, Japan documents
69	DYNAMOMETER PROCEDURE				
70	The dynamometer run consists of [two] tests, a "cold" start test, after a minimum [12]-hour and a maximum [36]-hour soak, and a "hot" start test following the "cold" start by [10] minutes. A minimum of [three] particulate samples are collected on filters for weighing; Parallel bag samples of dilution air are analyzed for THC, CO, CO ₂ , CH ₄ , NOX, and N ₂ O. Ethanol and carbonyls are analyzed if applicable.	The dynamometer must be capable of simulating road load with fixed load curve, with adjustable load curve. In the case of a dynamometer with a fixed load curve the accuracy of the load setting at 80 km/h shall be ± 5 percent. In the case of a dynamometer with an adjustable load curve, the accuracy of matching dynamometer load to road load shall be within 5 per cent at 90, 80, 60, 50, 40, 30 km/h and 10 per cent at 20 km/h.	The blower speed shall be within the operating range of 10 km/h to at least 50 km/h. The linear velocity of the air at the blower outlet shall be within ±5 km/h of the corresponding roller speed within the range of 10 km/h to 50 km/h. At the range over 50 km/h, the linear velocity of the air shall be within ±10 km/h of the corresponding roller speed. At roller speeds of less than 10 km/h, air velocity may be zero.	The test vehicle and chassis dynamometer shall be warmed up thoroughly by operating the test vehicle continuously on the chassis dynamometer at a speed of 60 km/h or more. The tolerable difference between the static pressure at the exhaust pipe outlet of the test vehicle running at a constant speed of 70 ±2 km/h and the static pressure at the connection when the exhaust pipe outlet is connected to the exhaust gas sampling port of the CVS system shall be within ±0.10 kPa.	
71	The fan shall be squarely positioned within 12 inches (30.5 centimeters) of the vehicle. The drive wheel tires are to be inflated to the manufacturer recommended pressure.	the following data shall be found within the limits of precision given: Barometric pressure (corrected (PB) ± 0.03 kPa Ambient temperature (T) ± 0.2 K Air temperature at LFE (ETI) ± 0.15 K Pressure depression upstream of LFE (EPI) ± 0.01 kPa Pressure drop across the LFE matrix (EDP) ± 0.0015 kPa Air temperature at CVS pump inlet (PTI) ± 0.2 K Air temperature at CVS pump outlet (PTO) ± 0.2 K Pressure depression at CVS pump inlet (PPI) ± 0.22 kPa Pressure head at CVS-pump outlet (PPO) ± 0.22 kPa	For circular blower outlets, the outlet shall be divided into 8 equal arcs by vertical, horizontal and 45° lines. The measurement points lie on the radial centre line of each arc (22.5°) at a radius of two thirds of the total	The temperature of the test room shall be kept at 298 ±5 K (25 ±5°C), and the relative humidity shall be in the range of 30% to 75%. The temperature measuring point shall be close to the cooling fan. The concentrations of CO, THC, NMHC, CH ₄ , NOx and CO ₂ in test room shall be stable.	
	Pre-test checks				
72	Verify the amount of non-methane contamination in the exhaust and	During the test the exhaust gases shall be diluted with air and a proportional		As for the response speed, when calibration gas is flowed, the time to	

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	background HC sampling systems within 8 hours before the start.	sample collected in one or more bags. The contents of the bags will be analysed at the end of the test. The total volume of the diluted exhaust shall be measured.		reach 90% of the indicated value of the concentration of the calibration gas concerned shall be 3.0 seconds or less. As for reproducibility, in all ranges used, the standard deviation at 80 ±20% of zero and full scale shall be within 1% of the full scale.	
	Emission Test Sequence				
73					
74	Zero the analyzers and obtain a stable zero reading. Span gases should have concentrations equal to 75 to 100 percent of full scale. Zero HFID analyzer and obtain a stable zero reading. Introduce span gas and set instrument gains. Span gas should have concentration equal to 75 to 100 percent of full scale.	Correction of the diluted exhaust gas volume to standard conditions. Interior surface temperatures must not be less than 278 K (5 °C) nor more than 320 K (55 °C) at any time during the diurnal emission test.		Heating temperature of the sampling channel of THC in the heated flame ionization detector (HFID) shall be 463 ±10 K (190 ±10°C).	
	Engine starting and restarting				
75	The transmission shall be placed in gear 15 seconds after the engine is started. If the vehicle does not start after the manufacturer's recommended cranking time (or 10 continuous seconds).				Engine starting is not discussed by TAP, ECE, Japan documents
	Validation of proportional flow control for batch sampling				
76	Total flow rate for CVS sampling, was constant within ±2.5 % of its respective mean or target flow rate.	A CVS system that has multiple speeds shall be calibrated on each speed used.			
77	For critical-flow venturi, record venturi-inlet conditions or their 1 Hz means. Demonstrate that the flow density at the venturi inlet was constant within ±2.5 % of the mean. Demonstrate that the flow density at the pump inlet was constant within ±2.5 % of the mean or target density over each test interval. For a CVS pump, you may demonstrate this by showing that the absolute temperature at the pump inlet was constant within ±2 % of the mean or target absolute temperature over each test interval.	Measurements for flow calibration of the critical flow venturi are required and the following data shall be found within the limits of precision given: Barometric pressure (corrected) (PB) ± 0.03 kPa. LFE air temperature flow meter (ETI) ± 0.15 K Pressure depression up-stream of LFE (EPI) ± 0.01 kPa Pressure drop across (EDP) LFE matrix ± 0.0015 kPa Air Flow (Qs) ± 0.5 % CFV inlet depression (PPI) ± 0.02 kPa Temperature at venturi inlet ± 0.2 K			Flow control is not discussed by Japan documents
	Gas analyzer range validation, drift validation, and drift correction				
78	For batch sampling, re-analyze the sample using the lowest analyzer range that results	Measurements error must not exceed ± 2% (intrinsic error of analyser)			Gas analyzer validation is not discussed by

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	in a maximum instrument response below 100 %. If the analyzer again operates above 100 % of its range, repeat the test using the next higher range.	disregarding the true value for the calibration gases.			Japan documents
	PM sampling media (e.g., filters) preconditioning and tare weighing				
79	Consider an unused sample medium stabilized as long as it has been in the PM-stabilization environment for a minimum of 30 min. Correct the mass of the substitution weight for buoyancy if the density of the substitution weight is less than 2.0 g/cm ³ .	Means components of exhaust gas, which are removed from the diluted exhaust gas at a maximum temperature of 52°C (325 K) by means of filters. The microgram balance used to determine the weight of all filters must have an accuracy of 5 µg and readability of 1 µg.		The collecting filter shall be soaked in the weighing room for at least 24 hours. The collecting filter shall have 99% or higher efficiency of collecting dioctyl phthalate (DOP) with a particle diameter of 0.3 µm in the range of gas surface velocity of 35 cm/s or more, but 100 cm/s or less. The diameter of the collecting filter shall be 47 mm (the effective diameter of 37 mm) or more.	
	PM sample post-conditioning and total weighing				
80	If you expect a higher PM concentration or do not know what PM concentration to expect, expose the filter to the stabilization environment for at least 60 minutes before weighing. Note that 400 µg on sample media (e.g., filters) is an approximate net mass of 0.07 g/kW·hr for a hot-start test with compression-ignition engines or 50 mg/mile for light-duty vehicles.	The temperature of the chamber (or room) in which particulate filters are conditioned and weighed shall be maintained to within 295 +/- 3 K (22°C +/-3°C) during all filters conditioning and weighing. The spent particulate filters must be taken to the chamber no later than 1 hour after conclusion of the test on the exhaust gases and must be conditioned for between 2 & 36 hours and then be weighed.		The collecting filter that has been used for collecting PM shall be soaked in the weighing room for 1 to 80 hours immediately.	
81	601 General Overview	Not Available	Not Available	Not Available	No such provision in ECE/TAP
82	602 Statistics	Not Available	Not Available	Not Available	There is a dedicated section in WLTP for explanation of statistical formulae. No such provision

SNo	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
					available in ECE/TAP
83	630 International Gravity Formula	Not Available	Not Available	Not Available	No such provision available in ECE/TAP
84	640 Flowmeter Calibration Calculations	TAP, Part XIV, Chapter 7 (Entire)	Page133, Annex4, Appendix5	Pg 60, Clause3-2-1	Similarities in methodology: PDP Vol/rev, PDP Slip Correction, Flow through CFV. A lot of mathematical expressions and derivations are given in WLTP document which may not be required and may be omitted. (Not available in TAP/ECE)
85	642 Molar Based Calculations	Not Available	Not Available	Pg 63, Clause 3-2-3	All flow calculations have been defined as Molar based. Also Subsonic venturi has been

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					considered and detailed calculations for Reynold's number had been shown in the WLP document. In case of Japan, the expression for flow calculation through subsonic venture has been defined.
86	644 Vaccum Decay Leak Rate	Not Available	Not Available	Not Available	No such provision available in ECE/TAP
87	645 Amount of Water in an Ideal Gas	Chap 8, Clause 5, Pg 100	Page 166, Clause 1.4	Pg 69, Clause 3-5	There are three approaches in the WLTP document: The first one uses a lot of Mathematical Detail. A logarithmic eqn for showing the

SNo	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
					<p>relation between the Saturated Vapor Pressure and Saturation Temperature is defined. The 2nd approach measures the dew point and arrives at the saturation vapour pressure for calculation of Humidity. The 3rd approach is based on RH measurement. TAP / ECE use the 3rd approach and give a simple expression for calculation of abs humidity. The Japan approach is similar but gives a table of</p>

SNo	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
					saturation vapor pressure. It gives a steam table for vapor pressure calculation for calculation of absolute humidity.
88	650 Emission Calculations	Not Available	Not Available	Not Available	Emission Calculations have weighting factors for Cold Start / Stabilized Phase and Hot Start / Stabilized Phase. Calculations of for Variable Flow and Constant Flow Systems and in addition batch Systems
89	655 Chemical Balance of Fuel, Intake air and Exhaust	Not Available	Not Available	Not Available	Equations for calculating mole fractions of various constituents (i.e CO, NOX etc) so

SNo	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
					as to determine the flow of intake air exhaust gases and fuel.
90	659 Removed Water Correction	Not Available	Not Available	Not Available	This is compensation for water removal, removed upstream of flow measurement or concentration measurement
91	660 THC, NMHC and CH4 determination	Not Available	Not Available	Page 67, Clause 3-4-2	NMHC norm is specified in ECE, but measurement equipment is not specified.
92	665 THCE and NMHCE determination.	Not Available	Not Available	Not Available	This provision is for Oxygenated Hydrocarbons
93	667 Dilution air BG emission correction	Chap 8, Clause 4, Pg 100	Page 165, Clause 1.3	Page 59, Clause 3-1	Methodology in WLTP document is totally different what is followed in ECE /TAP for BG

SNo	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
					emission correction
94	670 Nox Intake air Humidity and Temperature Corrections			Pg 69, Clause 3-5	Major difference in the methodology for calculation of Humidity Correction. Also different expressions for SI and CI engines in WLTP, while expression is same in TAP / EU
95	672 Dift Correction	Not Available	Not Available	Not Available	Analyzer Drift Correction is to be done. No such Provision available in TAP /ECE
96	675 CLD quench verification calculations	Not Available	Not Available	Not Available	This is similar to interference check of water / CO2 or CO2 analyzer. In case of WLTP, this is the CLD analyzer for

SNo	WLTP –DTP Test procedure	Indian (TAP Issue 4)	EU (715/2008/EC)	Japanese (Attachment 42)	Remarks
					NOx is checked for H2O quench
97	690 Buoyancy Correction for PM sample media	Not Available	Not Available	Pg 83, Clause no.5	No such provision available in TAP / ECE. Available in Japan Regulation. This is related to the buoyancy of the filter media for collection of PM. As different materials are allowed, so buoyancy correction must be done for PM calculation.
98	Mass Based Calculations.	Chapter 8 (Entire Chap)	Page 163, Annex4, Appendix 8	Page 66, Clause 3-3, 3-4, 3-5 and 3-6	The methodology is similar to TAP / ECE, though the calculations formulae are different. (For ex: DF is calculation formula is different)

Analytical Gases and Other Calibration Standards					
99	750 Analytical Gases Other then specified can be used provided it would not affect vehicle ability to meet norms	Only specified gases can be used for calibration and operation:	Only specified gases can be used for calibration and operation	Only specified gases can be used	
100	a (i) 2 % contamination, measured relative to the flow-weighted mean concentration expected at the standard	The true concentration of a calibration gas shall be within ± 2% of the stated Figure.	The true concentration of a calibration gas shall be within ± 2 per cent of the stated figure.	The accuracy of concentration indication of calibration gas shall be Within ±2% of the indicated concentration.	2% Whether it is ±2% or ± 1%
101	Purified Synthetic Air ¹ THC ≤ 0.05 μmol/mol, CO ≤ 1 μmol/mol, CO ₂ ≤ 10 μmol/mol, O ₂ 0.205 to 0.215 mol/mol, NO _x ≤ 0.02 μmol/mol, N ₂ O ² ≤ 0.05 μmol/mol	Purified synthetic air (purity ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO ₂ , ≤ 0.1 ppm NO); oxygen content between 18% & 21% vol.	purified synthetic air: (purity: ± 1 ppm C, ± 1 ppm CO, ± 400 ppm CO ₂ , ± 0.1 ppm NO); oxygen content between 18 and 21 per cent volume;	Purified synthetic air (HC ≤ 1 ppm C, CO ≤ 1 ppm, CO ₂ ≤ 400 ppm, NO ≤ 0.1 ppm); oxygen content between 18% & 21% vol.	
102	Purified N ₂ ¹ THC ≤ 0.05 μmol/mol, CO ≤ 1 μmol/mol, CO ₂ ≤ 10 μmol/mol, O ₂ ≤ 2 μmol/mol, NO _x ≤ 0.02 μmol/mol, N ₂ O ² ≤ 0.05 μmol/mol	Purified nitrogen (purity ≤ 1 ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO ₂ , ≤ 0.1 ppm NO)	purified nitrogen: (purity: ± 1 ppm C, ± 1 ppm CO, ± 400 ppm CO ₂ , ± 0.1 ppm NO);	High-purity N ₂ (HC: 1 ppm C equivalent or lower, CO: 1 ppm or lower, CO ₂ : 400 ppm or lower, NO: 0.1 ppm or lower)	
103	FID fuel. Use FID fuel with a stated H ₂ concentration of (0.39	Purified hydrogen (and mixture containing	purified hydrogen (and mixture containing	H ₂ : 40±2% (HC ≤ 1 ppm	H ₂ : 40±2% (HC

	to 0.41) mol/mol, balance He, and a stated total hydrocarbon concentration of 0.05 μmol/mol or less.	hydrogen) (Purity ≤ 1ppm C, ≤ 400 ppm CO ₂).	helium): (purity ± 1 ppm C, ±400 ppm CO ₂).	C, ≤ 400 ppm CO ₂ .	≤ 0.05 ppm C, ≤ 400 ppm CO ₂).
104	<u>FID burner air</u> . Use FID burner air that meets the specifications of purified air above paragraph and for field trail ambient air can be used.	Same as Sr No. 3	Same as Sr No. 3	Same as Sr No. 3	Field Trial not available in ECE, India & Japan
105	<u>FID zero gas</u> . Zero flame-ionization detectors with purified gas that meets the specifications in paragraph (a)(1) of this section, except that the purified gas O ₂ concentration may be any value. Note that FID zero balance gases may be any combination of purified air and purified nitrogen. We recommend FID analyzer zero gases that contain approximately the expected flow-weighted mean concentration of O ₂ in the exhaust sample during testing.	Same as Sr No. 3	Same as Sr No. 3	Same as Sr No. 3	
106	<u>FID propane span gas</u> We recommend FID analyzer span gases that contain approximately the flow-weighted mean concentration of O ₂ expected during testing. If the expected O ₂ concentration in the exhaust sample is zero, we recommend using a balance gas of purified nitrogen.	C ₃ H ₈ and purified synthetic air, as in Sr no.3 above	C ₃ H ₈ and purified synthetic air, as in Sr no.3 above	C ₃ H ₈ , air balance	C ₃ H ₈ and purified synthetic air, as in Sr no.3 above

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107		Purified oxygen (purity \leq 99.5 per cent Vol O ₂)	Purified oxygen (purity \leq 99.5 per cent Vol O ₂)	Oxygen (purity 99.5 vol% or more) or high-purity air (HC: 1ppmC equivalent or lower, CO: 1ppm or lower, CO ₂ : 400ppm or lower, NO: 0.1ppm or lower, oxygen content: 18 to 21 vol%)	For CLA analyzer (Ozone Generating Gas)
108	<u>FID methane span gas</u> Note that FID span balance gases may be any combination of purified air and purified nitrogen. We recommend FID analyzer span gases that contain approximately the expected flow-weighted mean concentration of O ₂ in the exhaust sample during testing. If the expected O ₂ concentration in the exhaust sample is zero, we recommend using a balance gas of purified nitrogen.	Not specified	Not specified	CH ₄ , air balance (in case of GC-FID) C ₃ H ₈ , air balance (In case of NMC-FID)	
109	<u>Gas Mixtures</u> (i) CH ₄ , balance purified synthetic air and/or N ₂ (as applicable). (ii) C ₂ H ₆ , balance purified synthetic air and/or N ₂ (as applicable). (iii) C ₃ H ₈ , balance purified synthetic air and/or N ₂ (as applicable).	(i) C ₃ H ₈ , balance purified synthetic air (ii) CO, balance purified N ₂ .	i) C ₈ H ₈ and purified synthetic air ii) CO and purified nitrogen; iii) CO ₂ and purified nitrogen; iv) NO and purified nitrogen. (The amount of NO ₂ contained in this calibration gas	i) C ₃ H ₈ , air balance for FID & HFID ii) C ₆ H ₁₄ , N ₂ balance (If propane/hexane sensitivity coefficient of the analyzer is known, C ₃ H ₈ , N ₂ balance)	

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	<p>applicable).</p> <p>(iv) CO, balance purified N₂.</p> <p>(v) CO₂, balance purified N₂.</p> <p>(vi) NO, balance purified N₂.</p> <p>(vii) NO₂, balance purified synthetic air.</p> <p>(viii) O₂, balance purified N₂.</p> <p>(ix) C₃H₈, CO, CO₂, NO, balance purified N₂.</p> <p>(x) C₃H₈, CH₄, CO, CO₂, NO, balance purified N₂.</p> <p>(xi) N₂O, balance purified synthetic air.</p>	<p>(iii) CO₂, balance purified N₂.</p> <p>(iv) NO, balance purified N₂</p>	<p>shall not exceed 5 per cent of the NO content.)</p>	<p>iii) NO, N₂ balance</p> <p>iv) CH₄, air balance (in case of GC-FID)</p> <p>v) C₃H₈, air balance (In case of NMC-FID)</p> <p>vi) CH₄, air balance for calculating CH₄ Efficiency</p> <p>vii) C₂H₆, air balance for calculating C₂H₆ Efficiency</p> <p>viii) CO₂, N₂ balance</p> <p>ix) CO, N₂ balance</p>	
110	<p>(4) You may use gases for species other than those listed in paragraph (a)(3) of this section (such as methanol in air, which you may use to determine response factors), as long as they are traceable to within ±3.0 % of the NIST-accepted value or other similar standards we approve, and meet the stability requirements</p>	N.A.	N.A.	N.A.	
111	<p>5) You may generate your own calibration gases using a precision blending device, such as a gas divider, to dilute gases with purified N₂ or purified</p>	<p>The concentrations specified in Chapter 7 of this part may also be obtained by means of a gas divider, diluting with purified</p>	<p>The concentrations specified in Appendix 6 to this annex may also be obtained by means of a gas divider, diluting with purified</p>	<p>if it depends on a gas divider, it shall be within ±2% of divided Concentration.</p>	

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	synthetic air. If your gas dividers meet the specifications in 248.	nitrogen or with purified synthetic air. The accuracy of the mixing device shall be such that the concentrations of the diluted calibration gases may be determined within $\pm 2\%$.	N ₂ or with purified synthetic air. The accuracy of the mixing device shall be such that the concentrations of the diluted calibration gases may be determined to within ± 2 per cent.		
112	(b) Record the concentration of any calibration gas standard and its expiration date specified by the gas supplier. 1) Do not use any calibration gas standard after its expiration date, except as allowed by paragraph (2) of this section 2) Calibration gases may be relabeled and used after their expiration date as follows: (i) Alcohol/carbonyl calibration gases used to determine response factors according to subpart I of this part may be relabeled as specified in subpart I of this part. (ii) Other gases may be relabeled and used after the expiration date only if we approve it in advance.	Not specified	Not specified	NA	
113	c) Transfer gases from their source to analyzers using	Not specified	Not specified	NA	

	components that are dedicated to controlling and transferring only those gases.				
114	d) To maintain stability and purity of gas standards, use accepted measurement practices and follow the gas standard supplier's recommendations for storing and handling zero, span, and calibration gases.	Not specified	Not specified	NA	
115	790 Mass standards. (a) <u>PM balance calibration weights.</u> Use PM balance calibration weights that are certified as NIST-traceable within 0.1 % uncertainty. Calibration weights may be certified by any calibration lab that maintains NIST-traceability. Make sure your lowest calibration weight has no greater than ten times the mass of an unused PM-sample medium.	Not Defined	Not Defined	Not Defined	
	Testing with Oxygenated Fuels				
116	§805 Sampling system (a) Dilute vehicle exhaust, and use batch sampling to collect	NA	NA	NA	

	proportional flow-weighted dilute samples of the applicable alcohols and carbonyls. You may not use raw sampling for alcohols and carbonyls.				
117	(b) You may collect background samples for correcting dilution air for background concentrations of alcohols and carbonyls. You collect one background over an entire exhaust emission test, rather than for each individual test phase for this purpose.	NA	NA	NA	
118	(c) Maintain sample temperatures and dilution rates within the dilution system, probes, and sample lines high enough to prevent aqueous condensation up to the point where a sample is collected to prevent loss of the alcohols and carbonyls by dissolution in condensed water. Use accepted measurement practices to ensure that surface reactions of alcohols and carbonyls do not occur, as surface decomposition of methanol has been shown to occur at temperatures greater than 120 °C in exhaust from	NA	NA	NA	

	methanol-fueled vehicles.				
119	(d) You may bubble a sample of the exhaust through water to collect alcohols for later analysis. You may also use a photo-acoustic analyzer to quantify ethanol and methanol in an exhaust sample.	NA	NA	NA	
120	(e) Sample the exhaust through cartridges impregnated with 2, 4-dinitrophenylhydrazine to collect carbonyls for later analysis. If the standard specifies a duty cycle that has multiple test intervals (such as multiple engine starts or an engine-off soak phase), you may proportionally collect a single carbonyl sample for the entire duty cycle. For example, if the standard-setting part specifies a six-to-one weighting of hot-start to cold-start emissions, you may collect a single carbonyl sample for the entire duty cycle by using a hot-start sample flow rate that is six times the cold-start sample flow rate.	NA	NA	NA	
121	(f) You may sample alcohols or carbonyls using "California Non-Methane Organic Gas Test Procedures". If you use this	NA	NA	NA	

	method, follow its calculations to determine the mass of the alcohol/carbonyl in the exhaust sample, but follow subpart G of this part for all other calculations.				
122	<p>§845 Response factor determination</p> <p>Since FID analyzers generally have an incomplete response to alcohols and carbonyls, determine each FID analyzer's alcohol/carbonyl response factor (such as RF_{MeOH}) after FID optimization to subtract those responses from the FID reading. You are not required to determine the response factor for a compound unless you will subtract its response to compensate for a response. Formaldehyde response is assumed to be zero and does not need to be determined. Use the most recent alcohol/carbonyl response factors to compensate for alcohol/carbonyl response.</p>	NA	NA	NA	
123	<p>(a) Determine the alcohol/carbonyl response factors as follows:</p> <p>1. Select a C_3H_8 span gas that</p>	NA		NA	

<p>meets the specifications of 750 and record concentration</p> <p>2. Select or prepare an alcohol/carbonyl calibration gas that meets the specifications of 750 and record concentration</p> <p>3) Start and operate the FID analyzer according to the manufacturer's instructions</p> <p>5) Zero the FID</p> <p>6) Span the FID with the C₃H₈ span gas selected above</p> <p>7) Introduce at the inlet of the FID analyzer the alcohol/carbonyl calibration gas that you selected under paragraph (2)</p> <p>8) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the analyzer and to account for its response.</p> <p>9) While the analyzer measures the alcohol/carbonyl concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of these values.</p> <p>10) Divide the mean measured concentration by the recorded span concentration of the alcohol/carbonyl calibration gas. The result is the FID analyzer's response factor for alcohol/carbonyl, RF_{MeOH}.</p>				
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124	b) Alcohol/carbonyl calibration gases must remain within $\pm 2\%$ of the labeled concentration. You must demonstrate the stability based on a quarterly measurement procedure with a precision of $\pm 2\%$ percent or another method that we approve. Your measurement procedure may incorporate multiple measurements. If the true concentration of the gas changes deviates by more than $\pm 2\%$, but less than $\pm 10\%$, the gas may be relabeled with the new concentration.	NA	NA	NA	
125	850 Calculations. Use the calculations specified in 665 to determine THCE or NMHCE.	NA	NA	NA	
126	Subpart K—Definitions and Other Reference Information				
	§1001 Definitions. <u>300 series stainless steel</u> means any stainless steel alloy with a Unified Numbering System for Metals and Alloys number designated from S30100 to S39000. For all instances in this part where we specify 300 series stainless steel, such parts must also have a smooth inner-wall construction. We recommend an average roughness, R_a , no greater than 4 μm .	Not Mentioned	Not Mentioned	Not Mentioned	
	<u>Accuracy</u> means the absolute				

<p>difference between a reference quantity and the arithmetic mean of ten mean measurements of that quantity. Determine instrument accuracy, repeatability, and noise from the same data set. We specify a procedure for determining accuracy in §305.</p>				
<p><u>Adjustable parameter</u> means any device, system, or element of design that someone can adjust (including those which are difficult to access) and that, if adjusted, may affect emissions or vehicle performance during emission testing or normal in-use operation. This includes, but is not limited to, parameters related to injection timing and fueling rate. In some cases, this may exclude a parameter that is difficult to access if it cannot be adjusted to affect emissions without significantly degrading vehicle performance, or if it will not be adjusted in a way that affects emissions during in-use operation.</p>				
<p><u>Aerodynamic diameter</u> means the diameter of a spherical water droplet that settles at the same constant velocity as the particle being sampled.</p>				
<p><u>After treatment</u> means relating to</p>				

<p>a catalytic converter, particulate filter, or any other system, component, or technology mounted downstream of the exhaust valve (or exhaust port) whose design function is to decrease emissions in the vehicle exhaust before it is exhausted to the environment. Exhaust-gas recirculation (EGR) and turbochargers are not after treatment.</p>				
<p><u>Allowed procedures</u> means procedures that we specify.</p>				
<p><u>Applicable standard</u> means an emission standard to which an vehicle is subject.</p>				
<p><u>Aqueous condensation</u> means the precipitation of water-containing constituents from a gas phase to a liquid phase. Aqueous condensation is a function of humidity, pressure, temperature, and concentrations of other constituents such as sulfuric acid. These parameters vary as a function of vehicle intake-air humidity, dilution-air humidity, vehicle air-to-fuel ratio, and fuel composition—including the amount of hydrogen and sulfur in the fuel.</p>				
<p><u>Atmospheric pressure</u> means the wet, absolute, atmospheric static pressure. Note that if you</p>				

<p>measure atmospheric pressure in a duct, you must ensure that there are negligible pressure losses between the atmosphere and your measurement location, and you must account for changes in the duct's static pressure resulting from the flow.</p>				
<p><u>Auto-ranging</u> means a gas analyzer function that automatically changes the analyzer digital resolution to a larger range of concentrations as the concentration approaches 100 % of the analyzer's current range. Auto-ranging does not mean changing an analog amplifier gain within an analyzer.</p>				
<p><u>Auxiliary emission-control device</u> means any element of design that senses temperature, motive speed, engine RPM, transmission gear, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission-control system.</p>				
<p><u>C₁ equivalent (or basis)</u> means a convention of expressing HC concentrations based on the total number of carbon atoms present, such that the C₁ equivalent of a molar HC concentration equals</p>				

<p>the molar concentration multiplied by the mean number of carbon atoms in each HC molecule. For example, the C₁ equivalent of 10 μmol/mol of propane (C₃H₈) is 30 μmol/mol. C₁ equivalent molar values may be denoted as “ppmC” in the standard-setting part.</p>				
<p><u>Calibration</u> means the process of setting a measurement system’s response so that its output agrees with a range of reference signals. Contrast with “verification”.</p> <p><u>Calibration gas</u> means a purified gas mixture used to calibrate gas analyzers. Calibration gases must meet the specifications of §750. Note that calibration gases and span gases are qualitatively the same, but differ in terms of their primary function. Various performance verification checks for gas analyzers and sample handling components might refer to either calibration gases or span gases.</p>				
<p><u>Certification</u> means relating to the process of obtaining a certificate of conformity for a vehicle that complies with the emission standards and requirements in the standard-setting part.</p>				

<p><u>Compression-ignition</u> means relating to a type of reciprocating, internal-combustion engine that is not a spark-ignition engine.</p>	<p>Compression Ignition Engine: Means an engine, which works on the compression ignition Principle (e.g. diesel engine).</p>			
<p><u>Confidence interval</u> means the range associated with a probability that a quantity will be considered statistically equivalent to a reference quantity.</p>				
<p><u>Dewpoint</u> means a measure of humidity stated as the equilibrium temperature at which water condenses under a given pressure from moist air with a given absolute humidity. Dewpoint is specified as a temperature in °C or K, and is valid only for the pressure at which it is measured. See §645 to determine water vapor mole fractions from dewpoints using the pressure at which the dewpoint is measured.</p>				
<p><u>Dilution ratio (DR)</u> means the amount of diluted exhaust per amount of undiluted exhaust.</p>				
<p><u>Drift</u> means the difference between a zero or calibration signal and the respective value reported by a measurement instrument immediately after it was used in an emission test, as long as you zeroed and spanned</p>				

	the instrument just before the test.				
	<u>Electronic control module</u> means a vehicle's electronic device that uses data from vehicle sensors to control vehicle parameters.				
	<u>Emission-control system</u> means any device, system, or element of design that controls or reduces the emissions of regulated pollutants from a vehicle.				
	<u>Exhaust-gas recirculation</u> means a technology that reduces emissions by routing exhaust gases that had been exhausted from the combustion chamber(s) back into the engine to be mixed with incoming air before or during combustion. The use of valve timing to increase the amount of residual exhaust gas in the combustion chamber(s) that is mixed with incoming air before or during combustion is not considered exhaust-gas recirculation for the purposes of this part.				
	<u>Fall time, t_{90-10}</u> , means the time interval of a measurement instrument's response after any step decrease to the input between the following points: (1) The point at which the response has fallen 10% of the total amount it will fall in				

<p>response to the step change. (2) The point at which the response has fallen 90% of the total amount it will fall in response to the step change.</p>				
<p><u>Flow-weighted mean</u> means the mean of a quantity after it is weighted proportional to a corresponding flow rate. For example, if a gas concentration is measured continuously from the raw exhaust of a vehicle, its flow-weighted mean concentration is the sum of the products of each recorded concentration times its respective exhaust flow rate, divided by the sum of the recorded flow rates. As another example, the bag concentration from a CVS system is the same as the flow-weighted mean concentration, because the CVS system itself flow-weights the bag concentration.</p>				
<p><u>Fuel type</u> means a general category of fuels such as gasoline or LPG. There can be multiple grades within a single type of fuel, such as all-season and winter-grade gasoline.</p>				
<p><u>Accepted measurement practices</u> means judgments made consistent with generally accepted scientific and</p>				

<p>engineering principles and all available relevant information. See 40 CFR 1068.5 for the administrative process we use to evaluate accepted measurement practices.</p>				
<p><u>HEPA filter</u> means high-efficiency particulate air filters that are rated to achieve a minimum initial particle-removal efficiency of 99.97 % using ASTM F1471-93 (incorporated by reference in §1010).</p>				
<p><u>Hydraulic diameter</u> means the diameter of a circle whose area is equal to the area of a noncircular cross section of tubing, including its wall thickness. The wall thickness is included only for the purpose of facilitating a simplified and nonintrusive measurement.</p>				
<p><u>Hydrocarbon (HC)</u> means THC, THCE, NMHC, or NMHCE, as applicable. Hydrocarbon generally means the hydrocarbon group on which the emission standards are based for each type of fuel and vehicle.</p>				
<p><u>Identification number</u> means a unique specification (for example, a model number/serial number combination) that allows someone to distinguish a particular vehicle from other</p>				

similar vehicles.				
<p><u>Linearity</u> means the degree to which measured values agree with respective reference values. Linearity is quantified using a linear regression of pairs of measured values and reference values over a range of values expected or observed during testing. Perfect linearity would result in an intercept, a_0, equal to zero, a slope, a_1, of one, a coefficient of determination, r^2, of one, and a standard error of the estimate, SEE, of zero. The term "linearity" is not used in this part to refer to the shape of a measurement instrument's unprocessed response curve, such as a curve relating emission concentration to voltage output. A properly performing instrument with a nonlinear response curve will meet linearity specifications.</p>				
<p><u>NIST-accepted</u> means relating to a value that has been assigned or named by NIST.</p>				
<p><u>NIST-traceable</u> means relating to a standard value that can be related to NIST-stated references through an unbroken chain of comparisons, all having stated uncertainties, as specified in NIST Technical Note 1297</p>				

<p>(incorporated by reference in §1010). Allowable uncertainty limits specified for NIST-traceability refer to the propagated uncertainty specified by NIST. You may ask to use other internationally recognized standards that are equivalent to NIST standards.</p>				
<p><u>Noise</u> means the precision of 30 seconds of updated recorded values from a measurement instrument as it quantifies a zero or reference value. Determine instrument noise, repeatability, and accuracy from the same data set. We specify a procedure for determining noise in §305.</p> <p><u>Nonmethane hydrocarbons (NMHC)</u> means the sum of all hydrocarbon species except methane. Refer to §660 for NMHC determination.</p>				
<p><u>Nonmethane hydrocarbon equivalent (NMHCE)</u> means the sum of the carbon mass contributions of non-oxygenated nonmethane hydrocarbons, alcohols and aldehydes, or other organic compounds that are measured separately as contained in a gas sample, expressed as exhaust nonmethane hydrocarbon from petroleum-fueled vehicles. The</p>				

	hydrogen-to-carbon ratio of the equivalent hydrocarbon is 1.85:1.				
	<u>Oxides of nitrogen</u> means NO and NO ₂ as measured by the procedures specified in §270. Oxides of nitrogen are expressed quantitatively as if the NO is in the form of NO ₂ , such that you use an effective molar mass for all oxides of nitrogen equivalent to that of NO ₂ .				
	<u>Oxygenated fuels</u> means fuels composed of oxygen-containing compounds, such as ethanol or methanol. Testing vehicles that use oxygenated fuels generally requires the use of the sampling methods in subpart I of this part. However, you should read the standard-setting part and subpart I of this part to determine appropriate sampling methods.				
	<u>Partial pressure</u> means the pressure, <i>p</i> , attributable to a single gas in a gas mixture. For an ideal gas, the partial pressure divided by the total pressure is equal to the constituent's molar concentration, <i>x</i> .				
	<u>Percent (%)</u> means a representation of exactly 0.01 (with infinite precision).				
	<u>Portable emission measurement system (PEMS)</u> means a				

<p>measurement system consisting of portable equipment that can be used to generate brake-specific emission measurements during field testing or laboratory testing</p>				
<p><u>Procedures</u> means all aspects of vehicle testing, including the equipment specifications, calibrations, calculations and other protocols and specifications needed to measure emissions, unless we specify otherwise.</p>				
<p><u>Proving ring</u> is a device used to measure static force based on the linear relationship between stress and strain in an elastic material. It is typically a steel alloy ring, and you measure the deflection (strain) of its diameter when a static force (stress) is applied across its diameter.</p>				
<p><u>PTFE</u> means polytetrafluoroethylene, commonly known as Teflon™.</p>				
<p><u>Recommend</u> has the meaning given in 201.</p>				
<p><u>Regression statistics</u> means any of the regression statistics specified in §602.</p>				
<p><u>Regulated pollutant</u> means an exhaust constituent for which an emission standard or a reporting requirement applies</p>				

	<p><u>Repeatability</u> means the precision of ten mean measurements of a reference quantity. Determine instrument repeatability, accuracy, and noise from the same data set. We specify a procedure for determining repeatability in 305.</p>				
	<p><u>Rise time, t_{10-90}</u>, means the time interval of a measurement instrument's response after any step increase to the input between the following points: (1) The point at which the response has risen 10% of the total amount it will rise in response to the step change. (2) The point at which the response has risen 90% of the total amount it will rise in response to the step change.</p>				
	<p><u>Roughness (or average roughness, R_a)</u> means the size of finely distributed vertical surface deviations from a smooth surface, as determined when traversing a surface. It is an integral of the absolute value of the roughness profile measured over an evaluation length.</p>				
	<p><u>Round</u> means to round numbers according to NIST SP 811 (incorporated by reference in §1010), unless otherwise specified.</p>				

<p><u>Scheduled maintenance</u> means adjusting, repairing, removing, disassembling, cleaning, or replacing components or systems periodically to keep a part or system from failing, malfunctioning, or wearing prematurely. It also may mean actions you expect are necessary to correct an overt indication of failure or malfunction for which periodic maintenance is not appropriate.</p>				
<p><u>Shared atmospheric pressure meter</u> means an atmospheric pressure meter whose output is used as the atmospheric pressure for an entire test facility that has more than one dynamometer test cell.</p>				
<p><u>Shared humidity measurement</u> means a humidity measurement that is used as the humidity for an entire test facility that has more than one dynamometer test cell.</p>				
<p><u>Span</u> means to adjust an instrument so that it gives a proper response to a calibration standard that represents between 75 % and 100 % of the maximum value in the instrument range or expected range of use.</p>				
<p><u>Span gas</u> means a</p>				

<p>purified gas mixture used to span gas analyzers. Span gases must meet the specifications of §750. Note that calibration gases and span gases are qualitatively the same, but differ in terms of their primary function. Various performance verification checks for gas analyzers and sample handling components might refer to either calibration gases or span gases.</p>				
<p><u>Spark-ignition</u> means relating to a gasoline-fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark-ignition engines usually use a throttle to regulate intake air flow to control power during normal operation.</p>				
<p><u>Standard deviation</u> has the meaning given in §602. Note this is the standard deviation for a non-biased sample.</p>				
<p><u>Stoichiometric</u> means relating to the particular ratio of air and fuel such that if the fuel were fully oxidized, there would be no remaining fuel or oxygen. For example, stoichiometric combustion in a gasoline-fueled</p>				

<p>engine typically occurs at an air-to-fuel mass ratio of about 14.7:1.</p>				
<p><u>Storage medium</u> means a particulate filter, sample bag, or any other storage device used for batch sampling.</p>				
<p><u>Tolerance</u> means the interval in which at least 95 % of a set of recorded values of a certain quantity must lie. Use the specified recording frequencies and time intervals to determine if a quantity is within the applicable tolerance. The concept of tolerance is intended to address random variability. You may not take advantage of the tolerance specification to incorporate a bias into a measurement.</p>				
<p><u>Total hydrocarbon (THC)</u> means the combined mass of organic compounds measured by the specified procedure for measuring total hydrocarbon, expressed as a hydrocarbon with a hydrogen-to-carbon mass ratio of 1.85:1.</p>				
<p><u>Total hydrocarbon equivalent (THCE)</u> means the sum of the carbon mass contributions of non-oxygenated hydrocarbons, alcohols and aldehydes, or other organic compounds that are</p>				

<p>measured separately as contained in a gas sample, expressed as exhaust hydrocarbon from petroleum-fueled engines. The hydrogen-to-carbon ratio of the equivalent hydrocarbon is 1.85:1.</p>				
<p><u>Transformation time, t_{50}</u> means the overall system response time to any step change in input, generally the average of the time to reach 50% response to a step increase, t_{0-50}, or to a step decrease, t_{100-50}.</p>				
<p><u>Uncertainty</u> means uncertainty with respect to NIST-traceability. See the definition of NIST-traceable in this section.</p>				
<p><u>Vehicle</u> means any vehicle, vessel, or type of equipment using engines to which this part applies. For purposes of this part, the term “vehicle” may include nonmotive machines or equipment such as a pump or generator.</p>				
<p><u>Verification</u> means to evaluate whether or not a measurement system’s outputs agree with a range of applied reference signals to within one or more predetermined thresholds for acceptance. Contrast with “calibration”.</p>				
<p><u>Zero</u> means to adjust an</p>				

	instrument so it gives a zero response to a zero calibration standard, such as purified nitrogen or purified air for measuring concentrations of emission constituents.				
	<u>Zero gas</u> means a gas that yields a zero response in an analyzer. This may either be purified nitrogen, purified air, a combination of purified air and purified nitrogen. For field testing, <u>zero gas</u> may include ambient air.				
127	§1005 Symbols, abbreviations, acronyms, and units of measure.				
	The procedures in this part generally follow the International System of Units (SI), as detailed in NIST Special Publication 811, 1995 Edition, “Guide for the Use of the International System, of Units (SI),” which we incorporate by reference in §1010.				
	(a) <u>Symbols for quantities.</u>				
	(b) <u>Symbols for chemical species.</u>				
	(c) <u>Prefixes.</u>				
	(d) <u>Superscripts.</u>				
	(e) <u>Subscripts.</u>				
	(f) <u>Constants.</u> (1) This part uses the following constants for the composition of dry air				

	2. This part uses the following molar masses or effective molar masses of chemical species: 3) This part uses the following molar gas constant for ideal gases 4) This part uses the following ratios of specific heats for dilution air and diluted exhaust				
	(g) <u>Other acronyms and abbreviations</u>				
128	§1010 Reference materials				
	(a) <u>ASTM material</u> .				
	(b) <u>ISO material</u>				
	(c) <u>NIST material</u> .				
	(d) <u>SAE material</u>				
	(e) <u>California Air Resources Board material</u>				