

cycle testing by using an engine dynamometer in a laboratory or other environment. This typically consists of one or more test intervals, each defined by a duty cycle, which is a sequence of modes, speeds, and/or torques (or powers) that an engine must follow. If the standard-setting part allows it, you may also simulate field testing with an engine dynamometer in a laboratory or other environment.

(ii) Field testing consists of normal in-use engine operation while an engine is installed in a vehicle, equipment, or vessel rather than following a specific engine duty cycle. The standard-setting part specifies how test intervals are defined for field testing.

(2) The type of testing may also affect what test equipment may be used. You may use "lab-grade" test equipment for any testing. The term "lab-grade" refers to equipment that fully conforms to the applicable specifications of this part. For some testing you may alternatively use "field-grade" equipment. The term "field-grade" refers to equipment that fully conforms to the applicable specifications of subpart J of this part, but does not fully conform to other specifications of this part. You may use "field-grade" equipment for field testing. We also specify in this part and in the standard-setting parts certain cases in which you may use "field-grade" equipment for testing in a laboratory-type environment. (NOTE: Although "field-grade" equipment is generally more portable than "lab-grade" test equipment, portability is not relevant to whether equipment is considered to be "field-grade" or "lab-grade".)

§ 1065.20 Units of measure and overview of calculations.

(a) *System of units.* 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 § 1065.1010. This document is available on the Internet at <http://physics.nist.gov/Pubs/SP811/contents.html>. Note the following exceptions:

(1) We designate rotational frequency, f_n , of an engine's crankshaft in revolutions per minute (rev/min), rather than the SI unit of reciprocal seconds (1/s). This is based on the commonplace use of rev/min in many engine dynamometer laboratories. Also, we use the symbol f_n to identify rotational frequency in rev/min, rather than the SI convention of using n . This

avoids confusion with our usage of the symbol n for a molar quantity.

(2) We designate brake-specific emissions in grams per kilowatt-hour (g/(kW·hr)), rather than the SI unit of grams per megajoule (g/MJ). This is based on the fact that engines are generally subject to emission standards expressed in g/kW·hr. If we specify engine standards in grams per horsepower-hour (g/(hp·hr)) in the standard-setting part, convert units as specified in paragraph (d) of this section.

(3) We designate temperatures in units of degrees Celsius (°C) unless a calculation requires an absolute temperature. In that case, we designate temperatures in units of Kelvin (K). For conversion purposes throughout this part, 0 °C equals 273.15 K.

(b) *Concentrations.* This part does not rely on amounts expressed in parts per million or similar units. Rather, we express such amounts in the following SI units:

(1) For ideal gases, $\mu\text{mol/mol}$, formerly ppm (volume).

(2) For all substances, $\mu\text{m}^3/\text{m}^3$, formerly ppm (volume).

(3) For all substances, mg/kg, formerly ppm (mass).

(c) *Absolute pressure.* Measure absolute pressure directly or calculate it as the sum of atmospheric pressure plus a differential pressure that is referenced to atmospheric pressure.

(d) *Units conversion.* Use the following conventions to convert units:

(1) *Testing.* You may record values and perform calculations with other units. For testing with equipment that involves other units, use the conversion factors from NIST Special Publication 811, as described in paragraph (a) of this section.

(2) *Humidity.* In this part, we identify humidity levels by specifying dew-point, which is the temperature at which pure water begins to condense out of air. Use humidity conversions as described in § 1065.645.

(3) *Emission standards.* If your standard is in g/(hp·hr) units, convert kW to hp before any rounding by using the conversion factor of 1 hp (550 ft·lbf/s) = 0.7456999 kW. Round the final value for comparison to the applicable standard.

(e) *Rounding.* Unless the standard-setting part specifies otherwise, round

only final values, not intermediate values. Round values to the number of significant digits necessary to match the number of decimal places of the applicable standard or specification. For information not related to standards or specifications, use good engineering judgment to record the appropriate number of significant digits.

(f) *Interpretation of ranges.* In this part, we specify ranges such as “±10% of maximum pressure”, “(40 to 50) kPa”, or “(30 ±10) kPa”. Interpret a range as a tolerance unless we explicitly identify it as an accuracy, repeatability, linearity, or noise specification. See §1065.1001 for the definition of Tolerance.

(g) *Scaling of specifications with respect to a standard.* Because this part 1065 is applicable to a wide range of engines and emission standards, some of the specifications in this part are scaled with respect to an engine’s emission standard or maximum power. This ensures that the specification will be adequate to determine compliance, but not overly burdensome by requiring unnecessarily high-precision equipment. Many of these specifications are given with respect to a “flow-weighted mean” that is expected at the standard. Flow-weighted mean is 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 an engine, 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. Refer to §1065.602 for information needed to estimate and calculate flow-weighted means.

EFFECTIVE DATE NOTE: At 73 FR 37292, June 30, 2008, §1065.20 was amended by revising paragraphs (a)(2), (b)(2), (f), and (g), effective July 7, 2008. For the convenience of the user, the revised text is set forth as follows:

§ 1065.20 Units of measure and overview of calculations.

(a) * * *

(2) We designate brake-specific emissions in grams per kilowatt-hour (g/(kW·hr)), rather than the SI unit of grams per megajoule (g/MJ). In addition, we use the symbol hr to identify hour, rather than the SI convention of using h. This is based on the fact that engines are generally subject to emission standards expressed in g/kW·hr. If we specify engine standards in grams per horsepower-hour (g/(hp·hr)) in the standard-setting part, convert units as specified in paragraph (d) of this section.

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(b) * * *

(2) For all substances, cm³/m³, formerly ppm (volume).

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(f) *Interpretation of ranges.* Interpret a range as a tolerance unless we explicitly identify it as an accuracy, repeatability, linearity, or noise specification. See §1065.1001 for the definition of tolerance. In this part, we specify two types of ranges:

(1) Whenever we specify a range by a single value and corresponding limit values above and below that value, target any associated control point to that single value. Examples of this type of range include “± 10% of maximum pressure”, or “(30 ± 10) kPa”.

(2) Whenever we specify a range by the interval between two values, you may target any associated control point to any value within that range. An example of this type of range is “(40 to 50) kPa”.

(g) *Scaling of specifications with respect to an applicable standard.* Because this part 1065 is applicable to a wide range of engines and emission standards, some of the specifications in this part are scaled with respect to an engine’s applicable standard or maximum power. This ensures that the specification will be adequate to determine compliance, but not overly burdensome by requiring unnecessarily high-precision equipment. Many of these specifications are given with respect to a “flow-weighted mean” that is expected at the standard or during testing. Flow-weighted mean is 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 an engine, 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. Refer to §1065.602 for information needed to estimate and calculate flow-weighted means. Wherever a specification is

scaled to a value based upon an applicable standard, interpret the standard to be the family emission limit if the engine is certified under an emission credit program in the standard-setting part.

§ 1065.25 Recordkeeping.

The procedures in this part include various requirements to record data or other information. Refer to the standard-setting part regarding recordkeeping requirements. If the standard-setting part does not specify recordkeeping requirements, store these records in any format and on any media and keep them readily available for one year after you send an associated application for certification, or one year after you generate the data if they do not support an application for certification. You must promptly send us organized, written records in English if we ask for them. We may review them at any time.

Subpart B—Equipment Specifications

§ 1065.101 Overview.

(a) This subpart specifies equipment, other than measurement instruments, related to emission testing. The provisions of this subpart apply for all test-

ing in laboratories. See subpart J of this part to determine which of the provisions of this subpart apply for field testing. This includes three broad categories of equipment—dynamometers, engine fluid systems (such as fuel and intake-air systems), and emission-sampling hardware.

(b) Other related subparts in this part identify measurement instruments (subpart C), describe how to evaluate the performance of these instruments (subpart D), and specify engine fluids and analytical gases (subpart H).

(c) Subpart J of this part describes additional equipment that is specific to field testing.

(d) Figures 1 and 2 of this section illustrate some of the possible configurations of laboratory equipment. These figures are schematics only; we do not require exact conformance to them. Figure 1 of this section illustrates the equipment specified in this subpart and gives some references to sections in this subpart. Figure 2 of this section illustrates some of the possible configurations of a full-flow dilution, constant-volume sampling (CVS) system. Not all possible CVS configurations are shown.