

§ 1065.415

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(d) If your test engine has a major mechanical failure that requires you to take it apart, you may no longer use it as a test engine.

§ 1065.415 Durability demonstration.

If the standard-setting part requires durability testing, you must accumulate service in a way that represents how you expect the engine to operate in use. You may accumulate service hours using an accelerated schedule, such as through continuous operation.

(a) *Maintenance.* The following limits apply to the maintenance that we allow you to do on test engine:

(1) You may perform scheduled maintenance that you recommend to operators, but only if it is consistent with the standard-setting part's restrictions.

(2) You may perform additional maintenance only if we approve it in advance, as specified in § 1065.410(b).

(3) If your test engine has a major mechanical failure that requires you to take it apart, you may no longer use it as a test engine.

(b) *Emission measurements.* You must measure emissions following two main requirements:

(1) Perform emission tests to determine deterioration factors consistent with good engineering judgment. Evenly space any tests between the first and last test points throughout the durability period.

(2) Perform emission tests following the provisions of this part and the standard-setting part.

Subpart F—Running an Emission Test

§ 1065.501 Overview of the engine dynamometer test procedures.

(a) The engine dynamometer test procedure measures brake-specific emissions of hydrocarbons (total and nonmethane, as applicable), carbon monoxide, and oxides of nitrogen. To perform this test procedure, you first dilute exhaust emissions with ambient air and collect a continuous proportional sample for analysis, then analyze the composite samples (either in bags after the test or continuously during the test). The general test procedure consists of a test cycle made of

one or more segments (check the standard-setting part for specific cycles):

(1) Either a cold-start cycle (where you measure emissions) or a warm-up cycle (where you do not measure emissions).

(2) A hot-start transient test (some test cycles may omit engine starting from the "hot-start" cycle).

(3) A steady-state test.

(b) Measure power using the dynamometer's feedback signals for torque and speed. The power measurement produces a brake kilowatt-hour value that allows you to calculate brake-specific emissions (see Subpart G of this part).

(c) Prepare engines for testing consistent with § 1065.10(c)(1) and according to the following provisions:

(1) When you test an engine or operate it for service accumulation, use the complete engine with all emission-control devices installed and functioning.

(2) Install the fan for any air-cooled engine (if applicable).

(3) You may install accessories such as an oil cooler, alternators, and air compressors or simulate their loading if they are typical of in-use operation. Apply this loading during all testing operations, including mapping.

(4) You may install a production-type starter on the engine.

(5) Cool the engine in a way that will maintain its operating temperatures including the intake air, oil, water temperatures about the same as they would be during normal operation. You may use auxiliary fans if necessary. You may use rust inhibitors and lubrication additives, up to the levels that the additive manufacturer recommends. You may also use antifreeze mixtures and other coolants typical of those approved for use by the manufacturer.

(6) Use representative exhaust and air-intake systems. Make sure the exhaust restriction is 80 to 100 percent of the recommended maximum specified exhaust restriction and the air inlet restriction is between that of a clean filter and the maximum restriction specification. As the manufacturer, you are liable for emission compliance from the minimum in-use restrictions to the

maximum restrictions you specify for that particular engine.

§ 1065.510 Engine mapping procedures.

(a) *Torque map.* Map your engine's torque while it is mounted on the dynamometer. Use the torque curve resulting from the mapping to convert the normalized torque values in the engine cycle to actual torque values for the test cycle. Make sure the speed ranges at least from the warm no-load idle speed to 105 percent of the maximum test speed. Because you determine the maximum test speed from the torque map, you may have to perform a preliminary torque map to determine the full mapping range. You may perform this preliminary torque map while the engine warms up. To map the engine, do the following things in sequence:

(1) Warm up the engine so oil and water temperatures (on an absolute scale such as the Kelvin scale) vary by less than two percent for two minutes; or until the thermostat opens if the engine-coolant system includes a thermostat.

(2) Operate the engine at the warm no-load idle speed.

(3) Fully open the throttle.

(4) While maintaining wide-open throttle and full-load, keep the engine at minimum speed for at least 15 seconds. Record the average torque during the last 5 seconds.

(5) In increments of 100 ± 20 rpm, determine the maximum torque curve for the full speed range. Hold each test point for 15 seconds and record the average torque over the last 5 seconds. You may use larger increments for engines with maximum test speed over 4000 rpm, as long as you include at least 40 points and space them evenly.

(6) Fit all data points recorded with a cubic spline, Akima, or other technique we approve in advance. The resultant curve must be accurate to within ± 1.0 ft-lbs. of all recorded engine torques.

(b) *Torque map with continual engine speed sweep.* In place of paragraphs (a)(1) through (a)(4) of this section, you may do a continual sweep of engine speed. While operating at wide-open throttle, increase the engine speed at an average rate of 8 ± 1 rpm/sec over the

full speed range. You may use higher sweeping rates for naturally-aspirated engines, in accordance with good engineering judgment. Record speed and torque points at a rate of at least one point per second. Connect all points generated under this approach by linear interpolation.

(c) *Alternate mapping.* You may use other mapping techniques if you believe those in paragraphs (a) and (b) of this section are unsafe or unrepresentative for any engine or engine family. These alternate techniques must satisfy the intent of the specified mapping procedures—to determine the maximum available torque at all engine speeds that occur during the test cycles. Report deviations from this section's mapping techniques for reasons of safety or representativeness. In no case, however, may you use descending continual sweeps of engine speed for governed or turbocharged engines.

(d) *Replicate tests.* You need not map an engine before every test, but you do need to remap the engine in any of the following situations:

(1) Good engineering judgment determines that an unreasonable amount of time has passed since the last map.

(2) The barometric pressure before the test begins has changed more than 25 mm Hg from the average barometric pressure observed during the map.

(3) The engine has undergone physical changes or recalibration that might affect its performance.

(e) *Power map.* Where applicable, generate a power map using the procedures this section specifies for torque maps. You may generate the power map directly or convert the torque map to a power map using engine speeds. The power map is also called a lug curve.

(f) *Cycles based only on torque/power at maximum test speed.* If the applicable test cycle for your engine does not require map information for engine speeds other than the maximum test speed, you may make the following simplifications:

(1) You need not perform the entire torque or power map, as long as you map the engines for speeds between 75 and 105 percent of the maximum test speed.