

(2) For constant-speed engines, apply only the statistical criteria for torque in the Table 2 of this section.

TABLE 2 OF § 1065.514—DEFAULT STATISTICAL CRITERIA FOR VALIDATING DUTY CYCLES

Parameter	Speed	Torque	Power
Slope, $a_i$ .....	$0.950 \leq a_i \leq 1.030$ .....	$0.830 \leq a_i \leq 1.030$ .....	$0.830 \leq a_i \leq 1.030$ .
Absolute value of intercept, $ a_0 $ .....	$\leq 10\%$ of warm idle .....	$\leq 2.0\%$ of maximum mapped torque.	$\leq 2.0\%$ of maximum mapped power.
Standard error of estimate, SEE .....	$\leq 5.0\%$ of maximum test speed.	$\leq 10\%$ of maximum mapped torque.	$\leq 10\%$ of maximum mapped power.
Coefficient of determination, $r^2$ .....	$\geq 0.970$ .....	$\geq 0.850$ .....	$\geq 0.910$ .

**§ 1065.520 Pre-test verification procedures and pre-test data collection.**

(a) If your engine must comply with a PM standard, follow the procedures for PM sample preconditioning and tare weighing according to §1065.590.

(b) Unless the standard-setting part specifies different values, verify that ambient conditions are within the following tolerances before the test:

(1) Ambient temperature of (20 to 30) °C.

(2) Atmospheric pressure of (80.000 to 103.325) kPa and within ±5% of the value recorded at the time of the last engine map.

(3) Dilution air as specified in §1065.140(b).

(c) You may test engines at any intake-air humidity, and we may test engines at any intake-air humidity.

(d) Verify that auxiliary-work inputs and outputs are configured as they were during engine mapping, as described in §1065.510(a).

(e) You may perform a final calibration of the speed, torque, and proportional-flow control systems, which may include performing practice duty cycles.

(f) You may perform the following recommended procedure to precondition sampling systems:

(1) Start the engine and use good engineering judgment to bring it to 100% torque at any speed above its peak-torque speed.

(2) Operate any dilution systems at their expected flow rates. Prevent aqueous condensation in the dilution systems.

(3) Operate any PM sampling systems at their expected flow rates.

(4) Sample PM for at least 10 min using any sample media. You may

change sample media during preconditioning. You may discard preconditioning samples without weighing them.

(5) You may purge any gaseous sampling systems during preconditioning.

(6) You may conduct calibrations or verifications on any idle equipment or analyzers during preconditioning.

(7) Proceed with the test sequence described in §1065.530(a)(1).

(g) After the last practice or preconditioning cycle before an emission test, verify the amount of contamination in the HC sampling system as follows:

(1) Select the HC analyzer range for measuring the flow-weighted mean concentration expected at the HC standard.

(2) Zero the HC analyzer at the analyzer zero or sample port. Note that FID zero and span balance gases may be any combination of purified air or purified nitrogen that meets the specifications of §1065.750. We recommend FID analyzer zero and span gases that contain approximately the flow-weighted mean concentration of O<sub>2</sub> expected during testing.

(3) Span the HC analyzer using span gas introduced at the analyzer span or sample port. Span on a carbon number basis of one (C<sub>1</sub>). For example, if you use a C<sub>3</sub>H<sub>8</sub> span gas of concentration 200 μmol/mol, span the FID to respond with a value of 600 μmol/mol.

(4) Overflow zero gas at the HC probe or into a fitting between the HC probe and its transfer line.

(5) Measure the HC concentration in the sampling system, as follows:

(i) For continuous sampling, record the mean HC concentration as overflow zero air flows.

(ii) For batch sampling, fill the sample medium and record its mean HC concentration.

(6) Record this value as the initial HC concentration,  $x_{HCinit}$ , and use it to correct measured values as described in § 1065.660.

(7) If  $x_{HCinit}$  exceeds the greatest of the following values, determine the source of the contamination and take corrective action, such as purging the system during an additional preconditioning cycle or replacing contaminated portions:

(i) 2% of the flow-weighted mean concentration expected at the standard.

(ii) 2% of the flow-weighted mean concentration measured during testing.

(iii) For any compression-ignition engines, any two-stroke spark ignition engines, or 4-stroke spark-ignition engines that are less than 19 kW, 2  $\mu$ mol/mol.

(8) If corrective action does not resolve the deficiency, you may request to use the contaminated system as an alternate procedure under § 1065.10.

**§ 1065.525 Engine starting, restarting, and shutdown.**

(a) Start the engine using one of the following methods:

(1) Start the engine as recommended in the owners manual using a production starter motor and adequately charged battery or a suitable power supply.

(2) Use the dynamometer to start the engine. To do this, motor the engine within  $\pm 25\%$  of its typical in-use cranking speed. Stop cranking within 1 second of starting the engine.

(b) If the engine does not start after 15 seconds of cranking, stop cranking and determine why the engine failed to start, unless the owners manual or the service-repair manual describes the longer cranking time as normal.

(c) Respond to engine stalling with the following steps:

(1) If the engine stalls during warm-up before emission sampling begins, restart the engine and continue warm-up.

(2) If the engine stalls during preconditioning before emission sampling begins, restart the engine and restart the preconditioning sequence.

(3) If the engine stalls at any time after emission sampling begins for a

transient test or ramped-modal cycle test, the test is void.

(4) If the engine stalls at any time after emission sampling begins for a discrete mode in a discrete-mode duty cycle test, void the test or perform the following steps to continue the test:

(i) Restart the engine.

(ii) Use good engineering judgment to restart the test sequence using the appropriate steps in § 1065.530(b)

(iii) Precondition the engine at the previous discrete mode for a similar amount of time compared with how long it was initially run.

(iv) Advance to the mode at which the engine stalled and continue with the duty cycle as specified in the standard-setting part.

(v) Complete the remainder of the test according to the requirements in this subpart.

(d) Shut down the engine according to the manufacturer's specifications.

**§ 1065.530 Emission test sequence.**

(a) Time the start of testing as follows:

(1) Perform one of the following if you precondition sampling systems as described in § 1065.520(f):

(i) For cold-start duty cycles, shut down the engine. Unless the standard-setting part specifies that you may only perform a natural engine cooldown, you may perform a forced engine cooldown. Use good engineering judgment to set up systems to send cooling air across the engine, to send cool oil through the engine lubrication system, to remove heat from coolant through the engine cooling system, and to remove heat from an exhaust aftertreatment system. In the case of a forced aftertreatment cooldown, good engineering judgment would indicate that you not start flowing cooling air until the aftertreatment system has cooled below its catalytic activation temperature. For platinum-group metal catalysts, this temperature is about 200 °C. Once the aftertreatment system has naturally cooled below its catalytic activation temperature, good engineering judgment would indicate that you use clean air with a temperature of at least 15 °C, and direct the air through the aftertreatment system in the normal direction of exhaust flow.