

§ 90.409

40 CFR Ch. I (7–1–13 Edition)

period the engine emissions are decreasing for the remainder of the 12 hours, the service accumulation may be completed at that time. The manufacturer may elect to accumulate 12 hours on each test engine within an engine family without making this determination.

(2) During service accumulation, the fuel and lubricants specified in § 90.308 must be used.

(3) Engine maintenance during service accumulation is allowed only in accordance with § 90.118.

(b) *Engine pre-test preparation.* (1) Drain and charge the fuel tank(s) with the specified test fuel (see § 90.308(b)) to 50 percent of the tank's nominal capacity. If an external fuel tank is used, the engine fuel inlet system pressure must be typical of what the engine will see in use.

(2) An evaluation of the effects of test measurement systems on engine emissions shall be conducted using good engineering judgment to ensure that such test systems do not significantly impact exhaust emissions from the engine. For example, this would require evaluation of all types of emission sampling systems, and of fuel- and air-flow measurement systems for raw sampling. This can be accomplished by operating the engine at the highest engine torque value that will be encountered on the test cycle before and after such test systems are installed to ensure that the impact on measured torque is less than 5 percent. This may also be accomplished by measuring air-to-fuel ratio using a zirconia universal exhaust gas oxygen (UEGO) sensor to ensure that the impact on measured air-to-fuel ratio is less than 5 percent at the highest engine torque value that will be encountered on the test cycle before and after such test systems are installed. The impact of air- and fuel-flow measurement systems may be evaluated based on an engineering analysis of the impact of the change in pressure induced on air-intake pressure and fuel supply pressure by these measurement systems. While this would typically be done before testing, it may also be done as a post-test verification.

(c) *Analyzer pre-test procedures.* (1) If necessary, warm up and stabilize the

analyzer(s) before calibrations are performed.

(2) Replace or clean the filter elements and then leak check the system as required by § 90.324(a). If necessary, allow the heated sample line, filters, and pumps to reach operating temperature.

(3) Perform the following system checks:

(i) If necessary, check the sample-line temperature. Heated FID sample line temperature must be maintained between 110 °C and 230 °C; a heated NO_x sample line temperature must be maintained between 60 °C and 230 °C.

(ii) Check that the system response time has been accounted for prior to sample collection data recording.

(iii) A HC hang-up check is permitted (see § 90.413(e)).

(4) Check analyzer zero and span before and after each test at a minimum. Further, check analyzer zero and span any time a range change is made or at the maximum demonstrated time span for stability for each analyzer used.

(d) Check system flow rates and pressures and reset, if necessary.

[60 FR 34598, July 3, 1995, as amended at 65 FR 24312, Apr. 25, 2000; 70 FR 40449, July 13, 2005]

§ 90.409 Engine dynamometer test run.

(a) *Engine and dynamometer start-up.* (1) Only adjustments in accordance with § 90.119 may be made to the test engine prior to starting a test.

(2) If necessary, warm up the dynamometer as recommended by the dynamometer manufacturer or use good engineering practice.

(3) For Phase 1 engines, at the manufacturer's option, the engine can be run with the throttle in a fixed position or by using the engine's governor (if the engine is manufactured with a governor). In either case, the engine speed and load must meet the requirements specified in paragraph (b)(12) of this section. For Phase 2 Class I, Phase 2 Class I-B, and Phase 2 Class II engines equipped with an engine speed governor, the governor must be used to control engine speed during all test cycle modes except for Mode 1 or Mode 6, and no external throttle control may

be used that interferes with the function of the engine's governor; a controller may be used to adjust the governor setting for the desired engine speed in Modes 2–5 or Modes 7–10; and during Mode 1 or Mode 6 fixed throttle operation may be used to determine the 100 percent torque value.

(b) Each test consists of the following steps.

(1) Record the general test data as specified in § 90.405(b).

(2) Precondition the engine in the following manner:

(i) Operate the engine at a power greater than or equal to 50 percent maximum power at the appropriate speed (rated or intermediate) for 20 minutes;

(ii) Option. If the engine has been operating on service accumulation for a minimum of 40 minutes, the service accumulation may be substituted for step (i).

(3) Record all pre-test data specified in § 90.405(c).

(4) Start the test cycle (see § 90.410) within five minutes of the completion of the steps required by paragraph (b)(2) of this section.

(5) Modes are to be performed in the numerical order specified for the appropriate test cycle (see "Mode Points" Table 2 in Appendix A of this subpart).

(6) For Class I, I-B, and II engines, during the maximum torque mode calculate the torque corresponding to 75, 50, 25, and 10 percent of the maximum observed torque (see Table 2 in Appendix A to this subpart).

(7) Once engine speed and load are set for a mode, run the engine for a sufficient period of time to achieve thermal stability. At the manufacturer's option, determine and document the appropriate criterion for thermal stability for each engine family. If the manufacture chooses not to make this determination, an acceptable alternative is to run the engine at each mode until the cylinder head temperature remains within a 10 °C bandwidth for three minutes. Cylinder head temperature may be measured at the base of the spark plug. After stability is achieved, emission measurements are initiated.

(8) Record all modal data specified in § 90.405(d) for a minimum time period of

the last two minutes of each mode. Longer averaging periods are acceptable, but the data averaged must be from a continuous time period. The duration of time during which this data is recorded is referred to as the "sampling period." The data collected during the sampling period is used for modal emission calculations.

(9) Continuously record the analyzer's response to the exhaust gas during each mode.

(10) Modes may be repeated.

(11) If a delay of more than one hour occurs between the end of one mode and the beginning of another mode, the test is void and must be restarted at paragraph (b)(1) of this section.

(12) The engine speed and load must be maintained within the requirements of § 90.410 during the sampling period of each mode. If this requirement is not met, the mode is void and must be restarted.

(13) If at any time during a mode the test equipment malfunctions or the specifications in § 90.410 can not be met, the test is void and must be aborted. Corrective action should be taken and the test restarted.

(14) If at any time during an operating mode the engine stalls, restart the engine immediately and continue the test starting with the steps required by paragraph (b)(6) of this section. If the engine will not restart within five minutes the test is void. If maintenance is required on the engine, advance approval from the Administrator is required as specified in § 90.119. After corrective action is taken, the engine may be rescheduled for testing. Report the reason for the malfunction (if determined) and the corrective action taken.

(15) Fuel flow and air flow during the idle condition may be determined just prior to or immediately following the dynamometer sequence, if longer times are required for accurate measurements. If the dilute sampling method (Constant Volume Sampling) is used, neither fuel flow nor air flow measurements are required.

(c) *Exhaust gas measurements.* (1) Measure HC, CO, CO₂, and NO_x concentrations in the exhaust sample. Use the same units and modal calculations as for your other results to report a

§ 90.410

40 CFR Ch. I (7–1–13 Edition)

single weighted value for CO₂; round CO₂ to the nearest 1 g/kW–hr.

(2) Each analyzer range that may be used during a test mode must have the zero and span responses recorded prior to the start of the test. Only the range(s) used to measure the emissions during the test is required to have its zero and span recorded after the completion of the test. Depending on the stability of each individual analyzer, more frequent zero checks or spans between modes may be necessary.

(3) It is permitted to change filter elements between modes.

(4) A leak check is permitted between modes.

(5) A hang-up check is permitted between modes (see § 90.413).

(6) If, during the emission measurement portion of a mode, the value of the gauges downstream of the NDIR analyzer(s) G3 or G4 (see Figure 1 in Appendix B of this subpart), differs by more than ± 0.5 kPa from the pretest value, the test mode is void.

[60 FR 34598, July 3, 1995, as amended at 64 FR 15244, Mar. 30, 1999; 65 FR 24313, Apr. 25, 2000; 70 FR 40449, July 13, 2005; 74 FR 56374, Oct. 30, 2009]

§ 90.410 Engine test cycle.

(a) Follow the appropriate 6-mode test cycle for Class I, I-B and II engines and 2-mode test cycle for Class I-A, III, IV, and V engines when testing spark-ignition engines (see Table 2 in Appendix A of this subpart).

(b) For Phase 1 engines and Phase 2 Class I-A, III, IV, and V, and Phase 2 Class I and II engines not equipped with an engine speed governor, during each non-idle mode, hold both the specified speed and load within \pm five percent of point. During the idle mode, hold speed within \pm ten percent of the manufacturer's specified idle engine speed. For Phase 2 Class I, I-B, and II engines equipped with an engine speed governor, during Mode 1 or Mode 6 hold both the specified speed and load within \pm five percent of point, during Modes 2–3, or Modes 7–8 hold the specified load within \pm five percent of point, during Modes 4–5 or Modes 9–10, hold the specified load within the larger range provided by ± 0.27 Nm (± 0.2 lb-ft), or \pm ten (10) percent of point, and during the idle mode hold the specified speed

within \pm ten percent of the manufacturer's specified idle engine speed (see Table 1 in Appendix A of this subpart for a description of test Modes). The use of alternative test procedures is allowed if approved in advance by the Administrator.

(c) If the operating conditions specified in paragraph (b) of this section for Class I, I-B, and II engines using Mode Points 2, 3, 4, and 5 cannot be maintained, the Administrator may authorize deviations from the specified load conditions. Such deviations may not exceed 10 percent of the maximum torque at the test speed. The minimum deviations, above and below the specified load, necessary for stable operation shall be determined by the manufacturer and approved by the Administrator prior to the test run.

(d) Do not include power generated during the idle mode, Mode 11, in the calculation of emission results.

[60 FR 34598, July 3, 1995, as amended at 64 FR 15244, Mar. 30, 1999; 65 FR 24313, Apr. 25, 2000]

§ 90.411 Post-test analyzer procedures.

(a) Perform a HC hang-up check within 60 seconds of the completion of the last mode in the test. Use the following procedure:

(1) Introduce a zero gas or room air into the sample probe or valve V2 (see Figure 2 in Appendix B of Subpart D) to check the “hangup zero” response. Simultaneously start a time measurement.

(2) Select the lowest HC range used during the test.

(3) Within four minutes of beginning the time measurement in paragraph (a)(1) of this section, the difference between the zero gas response and the hang-up zero response may not be greater than 5.0 percent of full scale or 10 ppmC, whichever is greater.

(b) Begin the analyzer span checks within six minutes after the completion of the last mode in the test. Record for each analyzer the zero and span response for each range used during the preceding test or test segment.

(c) If during the test, the filter element(s) were replaced or cleaned, a vacuum check must be performed per § 90.324(a) immediately after the span checks. If the vacuum side leak check