1.0 PURPOSE

This Standard Test Procedure (STP) is to be used by investigators to determine the maximum fuel-air ratio of a diesel engine.

2.0 SCOPE

This procedure applies to maximum fuel-air ratio tests conducted on diesel power packages to determine compliance with the requirements of 30 CFR 7.87: "Test to Determine the Maximum Fuel-Air Ratio".

3.0 REFERENCES

3.1. 30 CFR Part 7, Subpart E, "Diesel Engines Intended for Use in Underground Coal Mines"

4.0 DEFINITIONS

4.1. Brake Power – The observed power measured at the crankshaft or its equivalent when the engine is equipped only with standard auxiliaries necessary for its operation on the test bed.

4.2. Category A Engines – Diesel engines intended for use in areas of underground coal mines where permissible electric equipment is required.

4.3. Category B Engines – Diesel engines intended for use in areas of underground coal mines where nonpermissible electric equipment is allowed.

4.4. Diesel Engine – Any compression ignition internal combustion engine using the basic diesel cycle where combustion results from the spraying of fuel into air heated by compression.

4.5. Exhaust Emission – Any substance emitted to the atmosphere from the exhaust port of the combustion chamber of a diesel engine.

4.6. Intermediate Speed – Maximum torque speed if it occurs between 60 percent and 75 percent of rated speed. If the maximum torque speed is less than 60 percent of rated speed, then the intermediate speed shall be 60 percent of the rated speed. If the maximum torque speed is greater than 75 percent of the rated speed, then the intermediate speed shall be 75 percent of rated speed.

4.7. Low Idle Speed – The minimum no load speed as specified by the engine manufacturer.

4.8. Maximum Torque Speed – The speed at which an engine develops maximum torque.

4.9. Operational Range – All speed and load (including percent loads) combinations from the rated speed to the minimum permitted engine speed at full load as specified by the engine manufacturer.

4.10. Particulates – Any material collected on a specified filter medium after diluting exhaust gases with clean, filtered air at a temperature of less thanor equal to 125 °F (52 °C), as measured at a point immediately upstream of the primary filter. This is primarily carbon, condensed hydrocarbons, sulfates, and associated water.

4.11. Percent Load – The fraction of the maximum available torque at an engine speed.

4.12. Rated Horsepower – The nominal brake power output of a diesel engine as specified by the engine manufacturer with a specified production tolerance. For laboratory test purposes, the fuel pump calibration for the rated horsepower must be set between the nominal and the maximum fuel tolerance specification.

4.13. Rated Speed – Speed at which the rated power is delivered, as specified by the engine manufacturer.

4.14. Steady-State Condition – Diesel engine operating condition which is at a constant speed and load and at stabilized temperatures and pressures.

4.15. Total Oxides of Nitrogen – The sum total of the measured parts per millions (ppm) of nitric oxide (NO) plus the measured ppm of nitrogendioxide (NO2).

5.0 TEST EQUIPMENT

5.1. Dynamometer stand/test cell to provide loading on the engine.

5.2. An apparatus for measuring torque that provides an accuracy of +/-2.0 percent based on the engine's maximum value.

5.3. An apparatus for measuring revolutions per minute (rpm) that provides an accuracy of +/-2.0 percent based on the engine's maximum value.

5.4. An apparatus for measuring temperature that provides an accuracy of +/- 4 °F (2 °C) of the absolute value except for the exhaust gas temperature device that provides an accuracy of +/-27 °F (15 °C).

5.5. An apparatus for measuring intake and exhaust restriction pressures that provides an accuracy of +/-5 percent of maximum.

5.6. An apparatus for measuring atmospheric pressure that provides an accuracy of +/-0.5 percent of reading.

5.7. An apparatus for measuring fuel flow that provides an accuracy of +/-2 percent based on the engine's maximum value.

5.8. An apparatus for measuring the inlet air flow rate of the diesel engine that provides an accuracy of +/-2 percent based on the engine's maximum value.

5.9. For testing category A engines, an apparatus for metering in 1.0 +/-0.1 percent, by volume, of methane (CH4) into the intake air system shall be provided.

5.10. Gaseous emission sampling system.

5.11. Diesel fuel meeting the specifications in 30 CFR Part 7.86(a)(2) Table E-1.

6.0 TEST SAMPLES

N/A

7.0 PROCEDURES

7.1. Couple the diesel engine to the dynamometer and connect the sampling and measurement devices as specified in Part 7.86.

7.2. Prior to testing, zero and span the CO and NOx analyzers to the lowest analyzer range that will be used during this test.

7.3. While running the engine, the following shall apply:

7.3.1. The parameter for the laboratory atmospheric factor, fa, shall be: $0.98<fa<1.02$;

7.3.1.1. The equation is $fa=(99/Ps) * ((Ta+273)/298)0.7$ for a naturally aspirated and mechanically supercharged engines; or

7.3.1.2. The equation is $fa=(99/Ps) * ((Ta+273)/298)1.5$ for a turbocharged engine with or without cooling of the intake air.

Where:
P_s = dry atmospheric pressure (kPa)
T_a = intake air temperature (^oC)

7.3.2. The air inlet restriction shall be set within +/-10 percent of the recommended maximum air inlet restriction as specified by the engine manufacturer at the engine operating condition giving maximum air flow to determine the concentration of CO as specified in paragraph 6.6 of this section.

7.3.3. The exhaust backpressure restriction shall be set within +/-10 percent of the maximum exhaust backpressure as specified by the engine manufacturer at the engine operating condition giving maximum rated horsepower to determine the concentrations of CO and NOx as specified in paragraph 7.6 of this section.

7.3.4. The air inlet restriction shall be set within +/-10 percent of a recommended clean air filter at the engine operating condition giving maximum air flow as specified by the engine manufacturer to determine the concentration of NOx as specified in paragraph 6.6 of this section.

7.4. The engine shall be at a steady-state condition when the exhaust gas samples are collected and other test data is measured.

7.5. In a category A engine, 1.0+/-0.1 percent CH4 shall be injected into the engine's intake air.

7.6. Operate the engine at several speed/torque conditions to determine the concentrations of CO and NOx, dry basis, in the raw exhaust.

8.0 TEST DATA

N/A

9.0 PASS/FAIL CRITERIA

9.1. The CO and NOx concentrations in the raw exhaust shall not exceed the limits specified in Part 7.84(b) throughout the specified operational range of the engine.