1.0 PURPOSE

This Standard Test Procedure (STP) is to be used by Mechanical & Engineering Safety Division (M&ESD) investigators to determine the effectiveness of various sensors/safety shutdown systems on a diesel engine.

2.0 SCOPE

This procedure applies to safety system control tests conducted by the Mechanical & Engineering Safety Division on diesel power packages to determine compliance with the requirements of 30 CFR 7.103: "Safety System Control Test".

3.0 REFERENCES

3.1 30 CFR Part 7, Subpart F, "Diesel Power Packages Intended for Use in Areas of Underground Coal Mines Where Permissible Electric Equipment is Required"

4.0 DEFINITIONS

4.1 **Diesel Power Package –** A diesel engine with an intake system, exhaust system, and a safety shutdown system installed.

4.2 **Dry Exhaust Conditioner –** An exhaust conditioner that cools the exhaust gas without direct contact with water.

4.3 **Exhaust System –** A system connected to the outlet of the diesel engine which includes, but is not limited to, the exhaust manifold, the exhaust pipe, the exhaust conditioner, the exhaust flame arrester, and any adapters between the exhaust manifold and exhaust flame arrester.

4.4 **Flame Arrester –** A device so constructed that flame or sparks from the diesel engine cannot propagate an explosion of a flammable mixture through it.

4.5 **Intake System –** A system connected to the inlet of the diesel engine which includes, but is not limited to, the intake manifold, the intake flame

arrester, the emergency intake air shutoff device, the air cleaner, and all piping and adapters between the intake manifold and air cleaner.

4.6 **Safety Shutdown System** – A system which, in response to signals from various safety sensors, recognizes the existence of a potential hazardous condition and automatically shuts off the fuel supply to the engine.

4.7 **Wet Exhaust Conditioner** – An exhaust conditioner that cools the exhaust gas through direct contact with water, commonly called a water scrubber.

5.0 TEST EQUIPMENT

5.1 Dynamometer stand to provide loading on the engine.

5.2 Laminar air flow meter installed/connected into the air intake duct of the engine.

5.3 Methane analyzer for measuring/monitoring the percent of methane in the engine's intake air.

5.4 Pressure/vacuum sensors installed and located to measure the following:

5.4.1 Oil Pressure.

5.4.2 Exhaust Backpressure near the Exhaust Manifold Outlet.

5.4.3 Intake Vacuum Inby the Flame Arrester near the Intake Manifold.

5.4.4 Water Pump Outlet Pressure.

5.4.5 Laminar Flow Differential Pressure.

5.5 Thermocouples installed in the proper locations to measure the following temperatures:

5.5.1 Oil Temperature.

5.5.2 Fuel Temperature.

5.5.3 Intake Air Temperature (near intake manifold).

5.5.4 Test Cell Ambient Air Temperature.

5.5.5 Laminar Air Flow Temperature.

5.5.6 Raw Exhaust Gas Temperature near Exhaust Manifold Outlet.

5.5.7 Cooled Exhaust Gas Temperature.

5.5.8 Water Temperature into Engine.

5.5.9 Water Temperature Out of Engine.

5.5.10 Water Temperature Out of Exhaust Manifold.

5.5.11 Water Temperature Out of Exhaust Pipe.

5.5.12 Water Temperature Out of Air Compressor (if applicable).

NOTE: Depending on the design of the cooling system, thermocouples may be required in other locations.

6.0 PROCEDURE

6.1 Perform a detailed check of parts against the drawings and specifications submitted to MSHA under compliance with 30 CFR Part 7.97 to determine that the parts and drawings agree.

6.2 Fill the coolant system with a mixture of equal parts of antifreeze and water, following the procedures specified in the application, Part 7.97(a)(3).

6.3 If a wet exhaust conditioner is used to cool the exhaust gas, fill the exhaust conditioner to the high or normal operating water level and have a reserve water supply available, if applicable.

6.4 Install sufficient temperature measuring devices to measure the highest coolant temperature and exhaust gas temperature at discharge from the exhaust conditioner. The temperature measuring devices shall be accurate to +/- 4 ^{o}F (+/- 2 ^{o}C).

6.5 Determine the effectiveness of the coolant system temperature shutdown sensors which will automatically activate the safety shutdown system and stop the engine before the coolant temperature in the cooling jackets exceeds manufacturer's specifications or 212 °F (100 °C), whichever is lower, by operating the engine and causing the coolant in the cooling jackets to exceed the specified temperature.

6.6 For systems using a dry exhaust gas conditioner, determine the effectiveness of the temperature sensor in the exhaust gas stream which will automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas temperature exceeds 302 °F (150 °C), by operating the engine and causing the cooled exhaust gas to exceed the specified temperature.

6.7 For systems using a wet exhaust conditioner, determine the effectiveness of the temperature sensor in the exhaust gas stream which will automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas temperature exceeds 185 °F (85 °C), with the engine operating at a high idle speed condition. Temporarily disable the reserve water supply, if applicable, and any safety shutdown system control that might interfere with the evaluation of the operation of the exhaust gas temperature sensor. Prior to testing, set the water level in the wet exhaust conditioner to a level just above the minimum allowable low water level. Run the engine until the exhaust gas temperature sensor activates the safety shutdown system and stops the engine.

6.8 For systems using a wet exhaust conditioner as an exhaust flame arrester, determine the effectiveness of the low water sensor which will automatically activate the safety shutdown system and stop the engine at or above the minimum allowable low water level established from results of the explosion tests in Part 7.100 with the engine operating at a high idle speed condition. Temporarily disable the reserve water supply, if applicable, and any safety shutdown system control that might interfere with the evaluation of the operation of the low water sensor. Prior to testing, set the water level in the wet exhaust conditioner to a level just above the minimum allowable low water level. Run the engine until the low water sensor activates the safety shutdown system and stops the engine. Measure the low water level. Attempt to restart the engine.

6.9 Determine the effectiveness of the device in the intake system which is designed to shut off the air supply and stop the engine for emergency

purposes with the engine operating at both a high idle speed condition and a low idle speed condition. Run the engine and activate the emergency intake air shutoff device.

NOTE: In some cases, it may be desirable to drain the water from the exhaust conditioner prior to performing the emergency intake air shutoff device tests to eliminate the possibility of drawing exhaust conditioner water into the engine.

6.10 Determine the total air inlet restriction of the complete intake system, including the air cleaner, as measured between the intake flame arrester and the engine head with the engine operating at maximum air flow.

6.11 Determine the total exhaust backpressure with the engine operating at rated horsepower as specified in Part 7.97(a)(2). If a wet exhaust conditioner is used, it must be filled to the high or normal operating water level during the test.

6.12 The starting mechanism shall be tested to ensure that engagement is not possible while the engine is running. Operate the engine and attempt to engage the starting mechanism.

6.13 Where the lack of engine oil pressure must be overridden in order to start the engine, test the override to ensure that it does not override any of the safety shutdown sensors specified in Part 7.98(i). After each safety shutdown sensor test specified in 6.5 through 6.8 of this section, immediately override the engine oil pressure and attempt to restart the engine.

7.0 ACCEPTABLE PERFORMANCE

Tests of the safety system controls shall result in the following:

7.1 The coolant system temperature shutdown sensor shall automatically activate the safety shutdown system and stop the engine before the water temperature in the cooling jackets exceeds manufacturer's specifications or 212 ^{o}F (100 ^{o}C), whichever is lower.

7.2 The temperature sensor in the exhaust gas stream of a system using a dry exhaust conditioner shall automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas exceeds 302 ^{o}F

(150 °C).

7.3 The temperature sensor in the exhaust gas stream of a system using a wet exhaust conditioner shall automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas exceeds 185 °F (85 °C).

7.4 The low water sensor for systems using a wet exhaust conditioner shall automatically activate the safety shutdown system and stop the engine at or above the minimum allowable low water level and prevent restarting of the engine.

7.5 The emergency intake air shutoff device shall operate immediately when activated and stop the engine within 15 seconds.

7.6 The total intake air inlet restriction and the total exhaust backpressure shall not exceed the engine manufacturer's specifications.

7.7 It shall not be possible to engage the starting mechanism while the engine is running, unless the starting mechanism is constructed of non-sparking material.

7.8 The engine oil pressure override shall not override any of the shutdown sensors.